TRABAJO DE FIN DE GRADO

Grado en Odontología

PRÓTESIS DE NYLON.

ACTUALIZACIÓN Y RESULTADOS

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1. Resumen

Introducción: la falta de dientes es un problema que la actual población quiere corregir con la mayor estética posible, una buena comodidad y con el objetivo de sumar calidad de vida. Por estas razones, el nylon, siendo un polímero cristalino, se está abriendo paso en el mundo de la odontología. Se sigue estudiando hoy en día, en relación a las ventajas y desventajas de las prótesis flexibles, si esta alternativa con respecto a las prótesis convencionales pueden ser una opción mejor. Objetivos: conocer las características de estas prótesis, con base de poliamida, para entender si puede llegar a ser una buena alternativa o no. Metodología: se ha realizado una búsqueda de artículos científicos entre 2010 y 2021, usando bases de datos como PubMed y Medline. Discusión: es indudable la ventaja superior del nylon en cuanto a la estética, sin embargo, necesita de diferentes cambios e investigaciones para afirmar las propiedades superiores al PMMA. Conclusión: existe poca evidencia científica y es necesario seguir investigando para poder afirmar su superioridad en cuanto a las prótesis con metal.

Palabras clave: prótesis flexible, resina-poliamida, nylon

2. Abstract

Introduction: tooth loss is a problem that everyone wants to correct, achieving the best aesthetics, good comfort in order to reach a greater quality of life. For these reasons, nylon, being a crystalline polymer, is making its way into the world of dentistry. It is still being studied until this day, regarding the advantages and disadvantages of flexible prostheses and whether it could become a better alternative against conventional prostheses. Objectives: knowing the characteristics of these polyamide-based prostheses to understand if they could be a good alternative or not. Methodology: a systematic literature review of scientific publications has been carried out between 2010 and 2021, using databases such as PubMed and Medline. Discussion: nylon has undoubtedly proven its superiority in terms of aesthetics, however, it needs different changes and investigations to affirm the properties superior to PMMA. Conclusion: there is little scientific evidence, and more research is needed to assert its superiority over metal prostheses.

Key words: flexible prosthesis, resin-polyamide, nylon

3. Índice

4. Introducción.

4.1 Definición.

Un gran porcentaje de la población adulta tiene falta de uno o más dientes en sus arcadas, por lo que, debido a una máxima importancia de una estética y función óptima, una de las alternativas prioritarias, para este grupo poblacional, es solventar el problema del edentulismo, insertando en su medio oral prótesis removibles.

Una de las alternativas frecuentes de tratamiento de la falta de dientes, es el uso de prótesis parciales removibles (PPR) convencionales, las cuales llevan en su estructura ganchos metálicos, esto supone aversión en el área de la estética y la psicología.

Otra desventaja de estas prótesis es la necesidad de preparaciones en los dientes pilares, en los que van sujetos estos ganchos, por lo que ha sido necesario, con el paso del tiempo, el hallazgo de alternativas de tratamiento[1].

Las prótesis flexibles son la consecuencia del avance de la tecnología y es por lo que se desarrollaron nuevos materiales, como el nylon. Estas prótesis por primera vez se describieron en 1955 en Estados Unidos (EE.UU.), tratándose de una prótesis parcial removible que no contiene metal, por lo tanto, concede una mayor comodidad y estética al paciente al mimetizarse con la encía del paciente, debido a que es un material translúcido y por tanto puede verse el tejido subyacente[1,2].

Fig. 1. Base de prótesis sin elementos metálicos. Fueki y colaboradores (2014)[21].

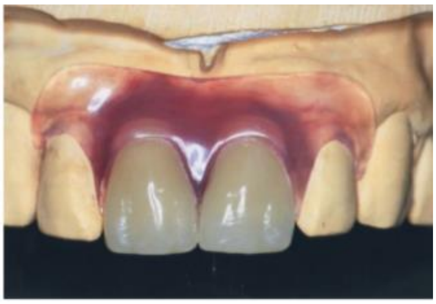

Fig. 2. Prótesis de nylon que reemplaza los incisivos centrales maxilares en un modelo de escayola. Visión frontal. Fueki y colaboradores (2014)[21].

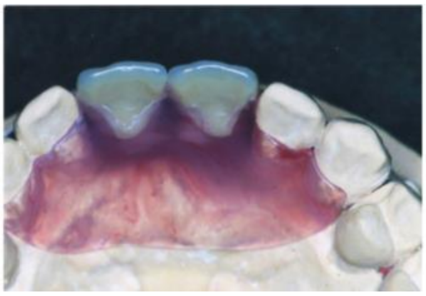

Fig. 3. Prótesis de nylon que reemplaza los incisivos centrales maxilares en un modelo de escayola. Visión por palatino. Fueki y colaboradores (2014)[21].

Ofrece ciertas ventajas en los pacientes alérgicos al polimetilmetacrilato (PMMA), sin embargo, no tiene los elementos principales de la PPR convencional, como son los topes oclusales y los retenedores colados, por lo tanto, no tiene tanta rigidez[3]. Los retenedores, están fabricados de igual modo por materiales termoplásticos, utilizándose diferentes diseños, como pueden ser circunferenciales, continuos o combinados[2].

Uno de los factores más importantes para usar estas prótesis es la gran demanda de estética que reclaman los pacientes y también una mejora psicológica, mejorando su calidad de vida. Hoy en día, se le está dando mucha importancia al aspecto físico, por lo que se rechazan las PPR convencionales ya que pueden vincularse con el envejecimiento[1].

Otros puntos en contra, a parte de la aparente antiestética de las prótesis convencionales, es la inquietud por la corrosión del metal y la alteración del reborde alveolar después de haber portado éstas prótesis[4].

El nylon, siendo un polímero cristalino, es un nombre genérico para denominar a materiales termoplásticos, más concretamente poliamidas. Al ser un polímero cristalino, expresa la falta de solubilidad de dicho material, alta resistencia al calor y alta fuerza junto con ductilidad[5].

Estas poliamidas están suscitadas por reacciones de condensación entre una diamina y un ácido básico[5]. Este material, se vuelve flexible cuando se supera cierta temperatura y posteriormente al enfriarse vuelve a un estado sólido[2]. A estos polímeros de resina, pueden ser añadidas resinas elastoméricas para dar una mayor flexibilidad y a su vez pueden estar reforzadas con fibras de vidrio[6]. En cuanto a la técnica de laboratorio, de estas PPR, se realizan mediante la técnica de moldeado por inyección y a su vez, se realizan unas retenciones mecánicas para poder unir los dientes de acrílico ya que no se adhieren químicamente al nylon[2].

4.2 Desarrollo histórico.

Fisher y Carothers, en 1931, lanzaron al mercado las poliamidas, quienes vendieron el preparado a Du Pont el cual impulsó el término genérico nylon o poliamida (PA) pudiéndose llamar de ambas maneras [7]. Años más tarde se cambió la fórmula debido a que presentaba gran absorción acuosa, y pasó a llamarse nylon 6.

Éstas últimas todavía eran inadecuadas en vista de que aun cuando se redujo la absorción acuosa que las hacía tener una inestabilidad dimensional y gran pigmentación, seguían siendo inaceptables para su uso en prótesis removibles[8].

Supeditado a la estructura química, hay diferentes nombres con los que denominar al material, siendo así: nylon-6,6; nylon-6-10 o nylon-12[7].

En 1956, la empresa Valplast fomentó la superpoliamida, que es un tipo de nylon. Por lo que una de las maneras de llamar a estas prótesis puede ser como el nombre de dicha empresa, Valplast[1].

En Japón se emplearon a modo de ensayo de forma individual antes de que el Ministerio de Salud, Trabajo y Bienestar lo admitiese para su uso colectivo[1].

Desde su aprobación un elevado número de fabricantes han desarrollado numerosas resinas termoplásticas, por lo que indebidamente las prótesis han sido conocidas por el nombre de dichos proveedores: Flexonon, Valplast, Flexite, etc. En cambio, su nombre general es "prótesis flexibles"[1,8].

En un primer momento, estaba indicado su uso eventualmente como parte de aparatos de ortodoncia, para prótesis provisionales o como alternativa después de reiteradas fracturas de la prótesis convencional[9,10].

Es en los años 70 cuando se hace una mejora de las propiedades, y se convirtió en un componente apto para el uso clínico, que ofrece grandes ventajas[8].

El nylon moderno tiene una estructura química con diferencias notorias a la PA surgida en la década de los 50. No se conoce la estructura química exacta ya que los fabricantes no propagan ese dato, por lo que hay poca evidencia científica[7].

En definitiva, el problema más recurrente de las prótesis de nylon es que debido a su novedad no existe una evidencia científica clara y concisa que permita elegir esta alternativa de tratamiento frente a otras PPR. Actualmente se siguen haciendo estudios sobre la satisfacción en pacientes y también desde un punto de vista odontológico. En el futuro, podría considerarse una gran alternativa ya que cada vez tanto los individuos como los profesionales de la prostodoncia están dejando a un lado únicamente la sustitución de los dientes perdidos y escogen la opción de la comodidad, estética y salud psicológica[11].

4.3 Ventajas respecto a otras PPR.

En primer lugar, cabe decir que las resinas acrílicas utilizadas para las bases de las prótesis han manifestado diferentes grados de citotoxicidad in vitro, así como reacciones alérgicas in vivo ocasionado probablemente por elementos que no han reaccionado y por lo tanto permanecen después de la reacción de polimerización [5]. También se añade que debido al área extensa de mucosa oral que está en contacto con el reborde de la PPR tiene gran probabilidad de sufrir infecciones por hongos, como *Candida albicans*[12].

Para que una superficie no retenga placa debe tener una rugosidad superficial máximo de 0,2 μm, esto está influido por técnicas mecánicas o químicas de pulido. La manera más óptima de producir una erosión selectiva de la superficie es con técnicas mecánicas de pulido con abrasivos, se hace de manera cautelosa por lo que la superficie rugosa se reduce[12].

Entre otra de las desventajas provenientes del polimetacrilato, es la contracción de polimerización, baja resistencia a la fatiga, menor resistencia al impacto y baja flexibilidad[13].

Es por ello, por lo que se han empezado a utilizar las poliamidas para el uso de las bases de las prótesis.

Entre las ventajas que concede el nylon se pueden destacar[6,9,10,13–16]:

- Seguridad toxicológica
- Mejor aceptación psicológica debido a su alta estética
- Alta resistencia a fractura
- Grosor reducido de la prótesis
- Alta flexibilidad, por lo que facilita unas fuerzas masticatorias equilibradas a la cresta alveolar
- Disminución de la tensión a los dientes pilares
- Ausencia de monómero residual
- Menor fuerza transmitida a la mucosa subyacente a la prótesis con respecto a las PPR con apoyo metálico

4.4 Desventajas respecto a otras PPR

Así como las PPR convencionales ofrecen muchos aspectos negativos y es por ello que se decide el uso de las prótesis con base de poliamida, hay otros muchos aspectos en los que las prótesis de nylon en diferentes circunstancias no sería la mejor opción.

Se recalcan sus presentaciones desfavorables[2,4,5,7–9,13]:

- Debido al proceso de fabricación mediante inyección imposibilita un rebasado de la prótesis
- En pacientes con problemas para tener una higiene óptima no se debería utilizar ya que no permite un proceso de limpieza óptimo en vista de la facilidad del material poroso a alcanzar manchas indeseables.
- El coste es mayor
- Deterioro del color

- Dificultad para pulir
- Poca retención con los dientes de acrílico debido a la unión mecánica
- Las técnicas para la inserción y el ajuste de estas prótesis son diferentes a las conocidas por las PPR convencionales, por lo que será necesario aprenderlas.
- Mala conducción, por lo que los pacientes en ocasiones pueden percibir el calor y frío en mucha menor medida.

4.5. Indicaciones[1,2,8,17]

- Torus maxilar o mandibular
- Pacientes con enfermedad periodontal
- Hipersensibilidad
- Pacientes con alergia al metal
- Pacientes a los que le faltan pocos dientes anteriores
- Reposición de dientes en zonas estéticas
- Pacientes a los que le falten pocos dientes y además tengan soporte oclusal
- Pacientes en los que la PPR no tiene carga funcional
- Pacientes que recriminan el consentimiento del acondicionamiento de dientes pilares
- Pacientes que dan primacía a la estética
- Pacientes con apertura bucal limitada
- Para su utilización como prótesis temporales o mantenedores de espacio
- Pacientes con ausencia de dientes adyacentes y que éstos se hayan inclinado.
- Pacientes cuya condición económica impida la colocación de implantes dentales

4.6. Contraindicaciones[1,8]

Las contraindicaciones abarcan diferentes puntos a tener en cuenta; como pueden ser la curvatura de arco edéntulo, la relación oclusal existente entre ambas arcadas y factores anatómicos. Lo resumimos en los siguientes puntos:

- Mala higiene oral que pueda alterar la conservación de la PPR
- Alérgicos al nylon
- Pacientes con pocos dientes remanentes
- Oclusión inestable
- Reabsorción del reborde edéntulo
- Pacientes con corona clínica corta
- Pacientes con pocos dientes en la arcada opuesta

5. Objetivos del trabajo

- **Objetivo principal:**

  Detallar las propiedades de las prótesis de nylon en pacientes parcialmente desdentados.

- **Objetivos secundarios:**

  Analizar sus diferencias respecto a las PPR convencionales.

  Revisar los principios de retención y estabilidad de las prótesis flexibles.

6. Metodología del trabajo

Este estudio es una revisión bibliográfica estructurada de artículos publicados entre 2010 y 2020.

Para la búsqueda de revistas de impacto, se ha utilizado las bases de datos como PubMed, Medline y la biblioteca de la Universidad Europea de Madrid indagando mediante palabras clave como “prótesis flexible”, “resina-poliamida”, “nylon”.

La búsqueda se ha limitado en gran parte a publicaciones en inglés. Los artículos han sido revisados por expertos del campo de la prótesis, y como criterios de inclusión, los artículos debían de estar estrechamente vinculado a las palabras clave.

En cuanto a criterios de exclusión se han desechado todos los artículos con fecha anterior a 2010.

	Autores	**Año**	**Número de sujetos**	**Intervencio-nes**	**Metodología**	**Propósito del estudio**
Artículo 1	Fueki K, Ohkubo C y col.	2014	21 miembros del panel de expertos, los cuales tuvieron que hacer un cuestionario. De los cuales se recopiló información en JPS y se seleccionaron 9 miembros con al menos 5 años de experiencia en PPR; éstos se unieron al panel de expertos junto con 5 miembros que tenían experiencia con PPR. Por lo que hay un total de 14 miembros.	Todos los participantes redactaron el borrador siendo discutido vía internet. El documento final fue revisado por un comité de guías clínicas.	Búsquedas bibliográficas en Pubmed y Ichushi para hacer búsquedas de literatura.	Llegar al término y definición para denominar a las PPR con resina termoplástica y una guía de aplicación clínica.
Artículo 2	Sharma DA, H.S DS	2014	Revisión bibliográfica de distintos materiales como base para PPR.			Comparar las prótesis flexibles con otras opciones de PPR
Artículo 3	Gonçalves, Fernanda de Cássia Papaiz Amaral.	2018	24 prótesis soportadas con implantes y se dividieron en 2 subgrupos según la longitud de la prótesis y en otros 2 subgrupos según la presencia o ausencia de malla metálica	Las muestras se sometieron a una prueba de rotura de carga máxima	Se analizó la varianza en las distintas mediciones y una prueba de comparación múltiple	Evaluar el nylon en la resistencia a la fractura

Artículo 4	Ucar Y, Akova T y col.	2011	10 muestras que cumplían con los requisitos ISO.	Prueba de flexión en tres puntos. Se utilizó la prueba de dureza Knoop.	Los datos se analizaron mediante ANOVA y REGWQ.	Comparar las propiedades mecánicas de las poliamidas con otros dos tipos de prótesis de PMMA.
Artículo 5	Sepúlveda-Navarro, Wilmer Fabián	2011	40 discos de cada resina se separaron y almacenaron en agua destilada a 37ºC durante 24 horas	El color se midió espectrofotomé tricamente. Cada disco se sumergió en café, Coca-Cola, vino, y agua destilada como medio de control. Después de 15 días (T1) y 30 días (T2) el color se midió de nuevo.	Se utilizó sistema Commission Internationale de L 'Eclairage (CIE) para determinar los valores medios de cambio de color para cada material y se comparó estadísticamente con ANOVA bidireccional e intervalos de Bonferroni a 0,95	Valorar la estabilidad del color después de la inmersión en bebidas
Artículo 6	Tandon R, Gupta S	2010	Revisión bibliográfica de varios materiales utilizados como base de prótesis.			Explorar la historia de los diferentes materiales utilizados como base de prótesis hasta la actualidad y visualizar un punto de vista hacia las áreas de investiga-ción y el futuro.

Artículo 7	Nguyen LG, Kopperud HM	2017	10 discos de cada material (Valplast, Breflex y PMMA) preparados siguiendo las indicaciones de los fabricantes	Las muestras se evaluaron para absorción de agua y solubilidad. Los resultados se evaluaron mediante espectrometría de masas	Análisis mediante GC/MS.	Medir la absorción de agua y solubilidad de las poliamidas en comparación con PMMA y asimismo evaluar los componentes de las poliamidas y efecto sobre la dureza de los materiales.
Artículo 8	Rosany M Denis Echezarreta, Yohanis Denis Echezarreta	2019	Revisión bibliográfica de diferentes artículos en los que se estudia en nylon como base de prótesis.			
Artículo 9	Polychronakis NC, Polyzois GL y col.	2014	30 discos de nylon y 30 de acrílico termopolimerizable, sumergiendo 10 de cada material en agua y dos soluciones de peróxido añadiendo micro-ondas durante un periodo que simula 30 días de limpieza diaria.	La rugosidad y el brillo se midió antes y después de la limpieza utilizando Perfilómetro interferométrico, medidor de brillo y colorímetro.	Se analizaron estadísticamente los resultados mediante pruebas de regresión, paired-t, Mann-Whitney y Kruskal-Wallis.	Establecer los efectos de los métodos de limpieza de las PPR sobre la rugosidad, brillo y el color de las bases de las PPR.

Artículo 10	Takabayashi Y	2010	6 resinas termoplásticas y resinas acrílicas convencionales que fueron almacenadas durante 5 horas.	Se realizaron pruebas de flexión en 3 puntos, prueba de absorción de agua, estabilidad de color y resistencia a la tracción	Se analizaron estadísticamente mediante ANOVA seguido de pruebas comparativas Tukey.	Evaluar propiedades mecánicas y físicas y la posibilidad de aplicación clínica de las prótesis dentales sin metal.
Artículo 11	Akinyamoju CA, Dosumu OO	2019	Estudio cuasi-experimental durante 8 meses a 30 pacientes con clase de Kennedy III y IV.	Se realizó un cuestionario a los pacientes	Los resultados se analizaron mediante un análisis descriptivo y multivariado.	Determinar la calidad de vida relacionada con la salud bucal de los pacientes portadores de PPR acrílicas y flexibles antes y después del uso de la prótesis
Artículo 12	Buzar, Menaka A. Bellur, Suman Duong	2010	10 muestras en escayola y otras 10 muestras en cera. Todas las muestras se metieron en 10 ml de agua dejando la mitad de la muestra sin pulir como grupo control.	Un mismo operador realizó todas las mediciones	Se utilizó ANOVA para comparar las superficies de ambos materiales.	Evaluar la rugosidad de la superficie y aplicación clínica de prótesis de poliamidas y PMMA

Artículo 13	Mahroo Vojdani, Rashin Giti	2015	Búsqueda bibliográfica dando como resultado 82 artículos, de los cuales se les impone los criterios de inclusión y quedan 24 artículos a revisar.	Dos expertos en el campo de la prostodoncia revisaron los artículos seleccionados	Búsqueda bibliográfica en PubMed, Scopus, y Wiley Inter Science.	Examinar la biocompatibilidad, propiedades físicas y mecánicas de las prótesis con base de poliamidas.
Artículo 14	Manzon L, Fratto G y col.	2019	120 pacientes, de media 73 años. 48 varones y 72 mujeres. Se dividieron en dos grupos. Grupo 1, edéntulos bilaterales o clase 1 o 2 de Kennedy. Y grupo 2, clases 3 y 4 de Kennedy. Recibieron 3 tipos de prótesis, generando 6 subgrupos.	Se realizó un cuestionario a pacientes y expertos en cuanto al grado de satisfacción, estética, funcionalidad y resultados clínicos. También se evaluó que la localización de las ausencias puede agregar diferencias en los resultados	Los datos se analizaron mediante la prueba de X^2. El análisis estadístico se realizó utilizando el Software Statview de SAS	Evaluar diferentes parámetros clínicos y funcionales mediante cuestionarios a un paciente anciano que usa 3 tipos diferentes de prótesis: Valplast, CoCr-PPRy PMMA-PPR.
Artículo 15	Wadachi J, Sato M y col.	2013	Estudio experimental en el que se utilizan 2 PPR fabricadas, una con poliamida y otra con poliéster y otra PPR convencional. Todas las PPR son de dos dientes en la región molar	Se aplicó una fuerza en las fosas mesiales de los molares y se comparó la presión aplicada con la tasa de hundimiento de estas.	Se realizó un análisis estadístico utilizando la prueba Tukey	Comparar el grado de hundimiento de los 3 tipos de prótesis y cuál ejerce mayor presión sobre la mucosa

Artículo 16	Akinyamoju CA, Ogunrinde TJ	2017	Estudio cuasiexperimental con 30 pacientes de 16 años o menos con ausencia de 1 a 3 dientes en el sector anterosuperior y anteroinferior.	Cuestionario llevado a cabo por un entrevistador para recopilar datos sociodemográficos y variables de salud	Se utilizó una escala analógica visual para evaluar nivel de satisfacción. Los datos se analizaron mediante estadística descriptivas y multivariantes.	Comparar la satisfacción de las prótesis fabricadas con acrílico frente a las flexibles
Artículo 17	Shah J, Bulbule N, Kulkarni S	2014	Bases de prótesis flexibles y PMMA.	Se utilizaron protocolos de evaluación y todos los instrumentos utilizados fueron calibrados en relación a las recomendaciones de los fabricantes.	Los resultados se evaluaron mediante análisis estadísticos y observacionales	Evaluar y comparar la absorción de agua, solubilidad y microdureza de las prótesis flexibles en comparación con PMMA.
Artículo 18	Soygun K, Bolayir G	2013	5 grupos: PMMA, PMMA E-glass, PMMA nylon 6, PMMA-nylon 6.6 y Valplast. Se utilizaron probetas de acuerdo con ANSI/ADA nº 12 y la norma ASTM D-256.	Se realizó una prueba de flexión en 3 puntos y se utilizó un dispositivo de resistencia al impacto. Las pruebas se analizaron mediante un análisis termomecánico	Los resultados fueron evaluados mediante pruebas de Kruskal-Wallis y Tukey.	Indagar en las características mecánicas y térmicas de Valplast y PMM.
Artículo 19	Hundal M, Madan BR	2015	30 pacientes con clase II de Kennedy que se dividieron en dos grupos iguales y se evaluaron clínicamente.	Después de la inserción de la prótesis los parámetros clínicos se evaluaron durante 1 año y medio	Los datos se analizaron mediante la prueba de Man Whitney y tabulaciones cruzadas.	Comparar Cr-Co con nylon para nueve parámetros clínicos.

Artículo 20	Hamanaka I, Takahashi Y	2011	Cuatro resinas termoplásticas moldeadas por inyección y un PMMA moldeado por calor convencional como grupo control.	Las propiedades de flexión y la resistencia al impacto se midieron según ISO.	Los datos se evaluaron con ANOVA y test Tukey	Investigar las propiedades mecánicas de las resinas termoplásti-cas como bases de prótesis.
Artículo 21	Fueki K, Ohkubo C	2014	Revisión bibliográfica por un panel de expertos de diferentes artículos donde se habla de las propiedades de las resinas sin metal .			Describir las propiedades físicas y mecánicas de la resina termo-plástica utilizada en PPR sin metal describien-do sus característi-cas y las complica-ciones basadas en la experiencia clínica.
Artículo 22	Takahashi Y, Hamanaka I	2012	Cuatro resinas termoplásticas y PMMA como grupo control.	Para evaluar las muestras se utilizó la prueba de impacto de Charpy .	Los datos se analizaron con ANOVA y Newman-Kleus post-hoc.	Investigar el efecto del choque térmico en las propiedades mecánicas de las resinas termoplásti-cas.

Artículo 23	Yavuz T, Aykent F	2012	Caso clínico de una paciente con pérdida extensa del sector anterior tratada temporalmente con una PPR flexible .			Revisión de la evolución de una paciente con gran pérdida de la dentición tratada con una prótesis flexible.
Artículo 24	Sasaki H, Hamanaka I	2017	Tres resinas termoplásticas moldeadas por inyección y PMMA como bases de prótesis.	Se midió la resistencia a la flexión y módulo de elasticidad mediante una prueba de flexión en 3 puntos.	Los datos se analizaron con ANOVA	Evaluar el efecto del refuerzo sobre las propiedades de flexión de diferentes resinas termoplásti-cas.
Artículo 25	Nasution H, Kamonkhantikul K	2018	Tres materiales como base de prótesis de resinas termoplásticas moldeadas por inyección y un acrílico convencional.	Se utilizaron láminas sensibles a la presión y un sistema de ultra microindentaci ón.	Los datos fueron estadísticamente analizados con ANOVA, Tamhane y Tukey HSD.	Examinar el área de transmisión de presión y cuánta transmisión como máximo a la base de la prótesis de resina termoplásti-ca y evaluar el módulo de elasticidad y microdureza de las resinas termoplásti-cas

Artículo 26	Ito M, Wee AG, Miyamoto T, Kawai Y	2013	Paciente femenina de 61 años con prótesis de nylon.	Se hizo un seguimiento de la evolución durante 2 años.		Describir el diseño de una prótesis con la combinación del nylon y PPR tradicional.
Artículo 27	Wieckiewicz M, Opitz V	2014	Muestras de Valplast y PMMA como control.	El color se evaluó mediante CIE L*a*b y se realizó una prueba de flexión en tres puntos.	Los datos se evaluaron con el test de Tukey y ANOVA.	Investigar la rugosidad superficial, estabilidad de color y elasticidad.
Artículo 28	Goiato MC, dos Santos DM	2010	3 muestras divididas en tres grupos: Triplex, Ppflex y Valplast.	Se hizo una evaluación comparando el color inicial y posteriormente el color con alteración.	Los datos se analizaron con ANOVA y la prueba Tukey HSD.	Evaluar la microdureza y el color de diferentes materiales sometidos a un envejecimiento acelerado.
Artículo 29	Jang DE, Lee JY	2015	Tres tipos de bases para prótesis; resina acrílica convencional termopolimerizada, resina acrílica termoplástica, resina de poliamida termoplástica. Utilizándose 105 ejemplares.	Se realizó un test de estabilidad del color donde las muestras fueron sumergidas en café y té verde y el cambio de color se midió con un espectómetero. Se sumergió en agua y se realizó el test. Finalmente se analizó la viabilidad celular mediante FE-SEM.	Los datos fueron analizados con ANOVA y con la prueba de comparación múltiple de Newman-Keull.	Comparar la estabilidad de color, la absorción de agua y la citotoxicidad entre las resinas acrílicas termoplásticas sin metal, las poliamidas y las resinas convencionales para bases de prótesis.

Artículo 30	Jain AR	2015	Revisión bibliográfica de diferentes materiales de prótesis flexibles con exposición de 3 casos clínicos.			Revisión de diferentes materiales para bases de prótesis flexibles y exponer sus indicaciones e instrucciones en el mantenimiento y uso.
Artículo 31	Gomes SG, Cury AADB	2015	Paciente femenina de 53 años así como una revisión bibliográfica de diferentes materiales como bases de prótesis.			Exponer un caso clínico y explicar las indicaciones y considera-ciones clínicas de las prótesis flexibles.
Artículo 32	Zheng Zhou, Yun-dong Hu	2011	76 pacientes divididos a su vez en grupo A, usando Valplast y grupo B usando prótesis convencionales			Valorar la valía de Valplast en una restauración temporal en la ausencia de un diente.
Artículo 33	Singh K, Aeran H	2013	Paciente femenina de 55 años insatisfecha con su estética por la falta de dientes.			Detallar el diagnóstico, planificación y técnica de inserción para las prótesis flexibles .

Artículo 34	Hamanaka I, Shimizu H	2013	Cuatro resinas termoplásticas moldeadas por inyección. Las muestras fueron divididas en ocho grupos según el tratamiento superficial dado.	La fuerza de unión se midió utilizando una máquina de prueba universal.	Los datos se analizaron con ANOVA y la prueba de comparaciones de Newman-Keuls.	Investigar la fuerza de unión de las resinas de reparación autopolime-rizable con las resinas termoplásti-cas
Artículo 35	Kim JH, Choe HC	2014	Resina acrílica convencional y resina de poliamida termoplástica, usándose seis grupos de prueba.	Se usó una microscopía electrónica de barrido para ver los resultados.	Los datos resultantes se analizaron con ANOVA y el test de Tukey HSD	Evaluar la resistencia a la tracción de las prótesis sin metal.
Artículo 36	Hafezeqoran A, Koodaryan R	2019	84 moléculas de poliamidas moldeadas de acuerdo con las instrucciones del fabricante.	La superficie de estas prótesis se investigó mediante espectroscopía infrarroja transformada de Fourier y microscopía de fuerza atómica.	Los datos se analizaron mediante ANOVA y Tukey.	Introducir un nuevo método para mejorar la adhesión de las prótesis flexibles al acrílico autopolimer izable
Artículo 37	Yumiko T, Ichiro S	2011	Modelo con ausencias distales en la zona superior izquierda.	Creando cuatro diseños diferentes a comparar.	Los resultados se evaluaron mediante el test de Kruskal-Wallis y Mann-Whitney.	Identificar los criterios de diseño para prótesis removibles de poliamidas en relación al diseño del retenedor y fuerza de retención

Artículo 38	Thakral GK, Aeran H	2012	Revisión bibliográfica de ciertos parámetros clínicos de las prótesis flexibles.			Comparar diferentes propiedades de las prótesis convencionales frente a las flexibles y exponer las ventajas y desventajas de éstas últimas.
Artículo 39	Horie N, Ouchi T	2019	Modelos con extensión unilateral de diferentes materiales.	Los resultados de midieron mediante máquinas que miden con precisión la fuerza establecida.	Se hicieron comparaciones con ANOVA y Bonferroni.	Investigar diferencias en los desplaza-mientos entre las prótesis flexibles y las convencio-nales.

7. Discusión de resultados

Resistencia a la fractura, resistencia a la flexión y módulo de elasticidad

Según los estudios previos llevados a cabo por Yunus y colaboradores en 2005, donde valoran la flexibilidad del nylon, encontraron una menor resistencia a la flexión en comparación con los polímeros PMMA[13].

Ucar y colaboradores en 2010, encuentran una resistencia a la flexión menor en las poliamidas respecto al PMMA[4].

Takabayashi en 2010 al comparar la resistencia a la flexión y el módulo de elasticidad en poliamidas encuentra que dichas características también son menores, sin embargo, aunque la flexibilidad sea menor que los polímeros PMMA, las poliamidas tienen varias características que superan a los polímeros convencionales, como es en la resistencia a la fractura[10].

Hamanaka y colaboradores en 2011, también demostraron que el nylon tiene una resistencia a la flexión menor que PMMA, a su vez también afirman el menor módulo de elasticidad de estos materiales[13].

Sin embargo, Ucar y colaboradores en 2012 al comparar la resistencia a la flexión de las poliamidas y PMMA no encuentran diferencias significativas, aunque en cuanto al módulo de elasticidad sí que es menor el de las poliamidas[4].

En 2013, Wadachi y colaboradores también vieron el menor módulo de elasticidad de estas prótesis y afirman que cuando se usan poliamidas con bajo módulo de elasticidad necesitan de refuerzos metálicos para prevenir deformaciones de la mucosa[15].

Koray Soygun y colaboradores en 2013, tras los resultados obtenidos en el estudio, se observaron unos valores de resistencia al impacto mayores en Valplast debido a sus propiedades químicas que absorben las fuerzas. También se encontró, al igual que en anteriores estudios, un módulo de elasticidad bajo. Este estudio, además de exponer las buenas propiedades de las poliamidas, también enseña las limitaciones del estudio, afirmando que se necesitan más investigaciones clínicas[18].

Hundal M y colaboradores en 2015, encontraron que la resistencia a la fractura es ligeramente mayor en las prótesis de nylon afirmando que las poliamidas son un material virtualmente irrompible[19].

Hamanaka y colaboradores en 2011, en su estudio comparativo, de igual manera que en los estudios anteriores, encontraron que las prótesis de nylon tienen una resistencia al impacto igual o superior que las de PMMA[20].

Fueki y colaboradores en 2014, afianzan el concepto de que las prótesis de nylon tienen un módulo de elasticidad bajo. Por otro lado, otro punto a analizar es la gran flexión de estos materiales, por lo que es poco probable que se fracturen[21].

Takahashi y colaboradores en 2012, evalúan en su estudio que gracias a la flexibilidad de las prótesis, la inserción y desinserción en boca se realiza con facilidad[22].

Yavuz y colaboradores en 2012, en relación al estudio anterior también exponen que las prótesis de nylon debido a su flexibilidad tienen una inserción excelente y más cómoda[23].

Sasaki y colaboradores en 2017, en su estudio confirman una resistencia a la flexión menor en comparación con PMMA[24].

En el estudio realizado por Gonçalves y colaboradores en 2018 donde se evalúa la resistencia a la fractura en prótesis flexibles concluyen que el refuerzo con nylon aumenta dicha resistencia, sin embargo, determinan las limitaciones de dicho estudio[3].

Nasution y colaboradores en 2018, tras su estudio visualizan que la poliamida tiene un módulo de elasticidad bajo lo que se traduce en flexibilidad. Observan, de acuerdo con los autores anteriores, que en la práctica clínica en las áreas con grandes socavados es más sencilla la inserción y desinserción de las prótesis con base de poliamidas[25].

Dureza

Ucar y colaboradores en 2010, afirmaba que las poliamidas no eran tan duras como otros materiales[4]. Además, en 2015 compara la dureza de las poliamidas frente a otros materiales como el PMMA y encontró que los materiales de las prótesis flexibles no tienen tanta dureza con respecto a otros materiales[13].

Shah y colaboradores en 2014, al comparar ambos materiales en cuanto a su dureza también demostró que los materiales compuestos por PMMA también presentaban una mayor dureza que los compuestos por una resina flexible[13,17].

Nguyen y colaboradores en 2017, hallan una disminución de la dureza al sumergir las prótesis en agua[7].

Rugosidad superficial y dificultad de pulido

Abuzar y colaboradores en 2010, encontraron que las poliamidas producen una superficie más rugosa con respecto a las PMMA[12].

Menaka y colaboradores en 2010, demuestra la superficie más rugosa tanto antes como después del pulido de las prótesis flexibles, por lo que el color se deteriora. Añaden que la dificultad del pulido de estas prótesis es debido al bajo punto de fusión de las poliamidas[12].

Ito y colaboradores en 2013, afirman que uno de los aspectos negativos de las poliamidas es la rugosidad superficial y la dificultad en el pulido. Este aspecto puede conducir a la colonización de la superficie por parte de las bacterias por lo que los pacientes que porten las prótesis de poliamidas deberían tener una mayor higiene que si usaran prótesis convencionales[26].

Fueki y colaboradores en 2014, en comparación con las resinas acrílicas también observan una mayor rugosidad superficial por lo que la adhesión de la placa será mayor y por consiguiente habrá un cambio en su coloración[21].

Wieckiewicz y colaboradores en 2014, afirman que la rugosidad superficial podría causar una decoloración y además puede ayudar a la formación de una biopelícula ya que hongos y bacterias se adhieren a esta superficie. Estos autores en el estudio realizado no encontraron diferencias significativas en cuanto a la diferencia en la rugosidad superficial de las prótesis de PMMA y poliamidas[27].

Estética, estabilidad del color y absorción de agua

Es de bien sabido que las prótesis de nylon tienen una mimetización con los tejidos circundantes al diente sin igual, sin embargo, con el paso del tiempo esta característica estética podría verse afectada.

Lai y colaboradores en 2003, demostró que las prótesis flexibles llegan a teñirse con la ingesta de sustancias colorantes como pueden ser el té o café [13].

Takabayashi y colaboradores en 2010, también mostró el cambio de color de las prótesis de nylon bajo la influencia del café[10].

Goiato y colaboradores en 2010, tras un estudio realizando un envejecimiento acelerado observaron que Valplast constituyó una alteración cromática mayor en comparación con otras resinas[28].

Sepúlveda-Navarro y colaboradores en 2011, denotan una inestabilidad en el color de las prótesis después de haber sido sumergidas en líquidos cómo vino y café. Asimismo, concluyeron la alteración del color de las bases flexibles, afirmando que esta inestabilidad se debe a la mayor absorción de agua[5].

Fueki y colaboradores en 2014, también observa un cambio de color alto en prótesis Valplast después de ser sumergidas en sustancias colorantes[21].

Sharma y colaboradores en 2014, igualmente asegura que Valplast tiene una inestabilidad del color y que con el paso del tiempo puede verse afectada con una significativa decoloración y aparición de manchas[2].

Tras el estudio realizado por Jang y colaboradores en 2015, de igual modo afirma un cambio de coloración tras ser sumergidos en sustancias colorantes con el paso del tiempo[29].

Jain y colaboradores en 2015, exponen que si no se lleva a cabo un correcto pulido de la superficie y un buen mantenimiento por parte de los pacientes la coloración por sustancias como té o café dará lugar[30].

En cuanto a la estética propiamente dicha, y con la intención de exponer un caso clínico Gomes y colaboradores en 2015, describieron a una paciente femenina de 53 años parcialmente edéntula a la que se le había puesto una PPR convencional recientemente, pero se sentía disgustada en cuanto a la estética, ya que al sonreír podía verse el metal fácilmente. Es por ello, que la prótesis de nylon estaba indicada en esta paciente debido a sus demandas estéticas. La paciente refiere gran satisfacción estética debido a la naturalidad del resultado final[31].

Hundal y colaboradores en 2015, expusieron la superioridad estética de las prótesis de nylon frente a las metálicas convencionales debido a la translucidez que presentan. También aportan que no hubo casos de cambios en la coloración[19].

Fig. 4. Prótesis de nylon donde puede verse la mimetización con los tejidos adyacentes. Ito y colaboradores (2013)[26].

Licia Manzón y colaboradores en 2019, expuso la gran satisfacción de los pacientes portadores de prótesis de nylon desde una perspectiva estética. Sin embargo, en ese mismo estudio los pacientes denotaron falta de facilidad a la hora de la limpieza de la prótesis y a su vez, cierta incomodidad debido a la rugosidad[19].

Se observó del mismo modo, dos casos en los que la coloración cambia con el paso del tiempo[14].

Fig. 5. Prótesis de nylon donde después de dos años puede verse descoloración en la superficie. Ito y colaboradores (2013)[26].

Una de las indicaciones más comunes sobre estas prótesis es la de reposición de pocos dientes anteriores y también para la utilización de prótesis temporales, sin embargo, Zheng Zhou en 2011, tras la realización de su estudio, concluyeron que el uso de Valplast en la ausencia de un solo diente y usándose como prótesis temporales provocaba recesión gingival de los dientes adyacentes[32]. Por lo que, a la larga, aunque exista una mimetización con los tejidos, las recesiones gingivales podrían suponer para los pacientes una estética indeseable.

Pese a la afirmación anterior, Gomes y colaboradores en 2015, en su revisión bibliográfica afirman que después de años portando las prótesis de nylon, los tejidos adyacentes se encuentran en perfecto estado[31].

A propósito de un caso clínico en el que Singh y colaboradores en 2013, realizaron un estudio en el que la paciente es una mujer de 55 años que reclama una mejora en su estética ya que por la falta de dientes no está satisfecha. La paciente presenta en el maxilar una clase I de Kennedy y en la mandíbula una clase III de Kennedy.

En la arcada inferior debido a que la estética no era un problema y al ser una prótesis dentosoportada optaron por una prótesis parcial removible convencional. Para la arcada superior se optó por una prótesis de nylon, ya que los brazos retentivos irán en los caninos y es necesario que exista estética.

Los dientes de acrílico al no retenerse químicamente con la base flexible, se retienen de manera mecánica en forma de T con agujeros donde la resina fluye para retenerse mecánicamente mediante la técnica Retento-Grip. En el mismo estudio realizado a otra paciente que no quería insertar en su boca metal debido a la preocupación por la apariencia. En este caso, había una ausencia de los dientes posteriores mandibulares y se optó por una prótesis flexible inferior. Finalmente, la paciente terminó muy satisfecha con la estética de su prótesis.

El punto en común de ambos casos clínicos, es que debido a un inadecuado mantenimiento de ambas prótesis flexibles se vio una tinción amarillenta con el paso del tiempo ya que estas prótesis son propensas a mancharse si no tienen un buen pulido y así mismo, como se ha comentado anteriormente, si los pacientes no llevan una limpieza regular de sus prótesis, por lo que habrá que instruir a los pacientes para que lo lleven a cabo de manera correcta[33].

Fig. 6. Prótesis de nylon insertada en la boca de la paciente. Singh y colaboradores (2013)[33].

Por lo que concierne a la absorción de agua, en un estudio realizado por Shah y colaboradores en 2014, las prótesis flexibles tienen menor absorción de agua con respecto a las fabricadas con PMMA. En este mismo artículo Hayashi y colaboradores sugieren que debido al alto ángulo de contacto entre el nylon y el agua con poca energía superficial libre, la repelencia al agua es también alta, lo que se traduce en valores de absorción de agua más bajos[17].

Jang y colaboradores en 2015, demostró que poliamidas y resinas convencionales con base de PMMA al ser sumergidas tuvieron una absorción de agua de manera similar. Sin embargo afirman que es necesario realizar más estudios adicionales[29].

Hundal y colaboradores en 2015, afirman que las prótesis flexibles tienen una estabilidad volumétrica en ambientes húmedos[19].

Nguyen y colaboradores en 2017, encuentran una absorción de agua continua hasta 8 semanas en poliamidas, sin embargo, no hay suficiente evidencia científica para conocer si esta característica es una problemática para la aplicación clínica[7].

Reparación prótesis flexibles

Generalmente las prótesis convencionales cuando sufren algún tipo de rotura, o es necesario realizar un rebase, se puede optar por el uso de resinas autopolimerizables para llevar a cabo dichas reparaciones[13].

Katsumata y colaboradores en 2009, concluyen que se necesita un revestimiento de sílice para aumentar una unión entre la base de la prótesis y la resina autopolimerizable. Se demostró que la fuerza de unión entre la base de la prótesis y el material de arreglo aumenta cuando se somete a la base de las prótesis a procedimientos químicos[13].

Ito y colaboradores en 2013, afirman que si la cresta alveolar se reabsorbe con el tiempo, el hecho de que pueda ser difícil su rebasado implicaría una preocupación por la estabilidad[26].

Singh y colaboradores en 2013, apuntan que el rebase en las prótesis flexibles tiene una dificultad notoria a la hora de realizar la reparación con resinas acrílicas[33].

Hamanaka y colaboradores en 2013, siguiendo la misma línea planteada, dan como conclusión que las poliamidas son muy difíciles de unir a las resinas autopolimerizables de rebase, por lo que necesitan un revestimiento de sílice para asegurar la unión[34].

Fueki y colaboradores en 2014, de acuerdo con los estudios anteriores, afirman que la reparación de las prótesis de nylon es difícil de conseguir, ya que estos materiales no se adhieren a las resinas de reparación. Se propone que después del pulido se revista la superficie con una sustancia química para conseguir mayor adhesión[21].

Kim y colaboradores en 2014, de acuerdo con los autores anteriores, apoyan que la resina utilizada para rebase tiene un menor grado de unión con las poliamidas en comparación con otros materiales[35].

Jain y colaboradores en 2015, afirman el difícil rebasado de estas prótesis[30].

Hafezeqoran y colaboradores en 2019, siguiendo la misma línea, finalizan diciendo que revestir las bases de poliamidas con sílice incrementa la reparación con resina autopolimerizable[36].

Contracción de polimerización/estabilidad dimensional

El problema que tienen las prótesis confeccionadas con PMMA es la contracción de polimerización por lo que es necesario la búsqueda de otros materiales para resolver dicho problema[13].

Sin embargo, aunque el propósito fue encontrar alternativas para atender esta problemática, Parvizi y colaboradores en 2004, encontraron que en las prótesis de nylon existe un porcentaje mayor de contracción. Estos cambios dimensionales afectan a la adaptación final de la prótesis, por lo que no sería una buena alternativa en cuanto a solventar la contracción de polimerización debido a que ésta es mayor debido, de modo principal, a la absorción de agua que poseen estos materiales[13].

Fueki y colaboradores en 2014, afirman que las prótesis Valplast así mismo tienen una alta contracción térmica, por lo que la precisión en el ajuste podría ser pobre, no siendo recomendable en pacientes con múltiples dientes ausentes. Sin embargo, ante este punto, los autores aseguran la falta de estudios[21].

Sin embargo, Hundal y colaboradores en 2015, afirman que tienen una buena estabilidad dimensional por lo que a la hora de ajustar la prótesis en boca al paciente se mantienen sin cambios[19].

Citotoxicidad

Una de las ventajas que pueden ofrecer las poliamidas con respecto a las prótesis convencionales es el menor grado de citotoxicidad que ofrecen. Sin embargo, no existe mucha evidencia científica que haga afirmar este concepto.

En contraposición a lo que la literatura afirma, Uzun y colaboradores en 2013 en su estudio encontraron que ambos materiales tienen un grado de citotoxicidad similar en un corto periodo de tiempo[13].

A su vez, Jang y colaboradores en 2015, demostraron que las poliamidas y las prótesis con base de PMMA de igual modo tienen un grado similar de grado citotoxicidad, siendo en ambas un grado bajo[29].

Hundal y colaboradores en 2015, de acuerdo con los autores anteriores afirman que las prótesis de nylon tienen un grado de biocompatibilidad similar al encontrado en las prótesis de PMMA[19].

Retención

Las poliamidas, como se ha explicado anteriormente, tienen un módulo de elasticidad bajo por lo que carecería de resistencia mecánica suficiente para poder ejercer la función de un conector en prótesis parciales, sin embargo, Tandon y colaboradores en 2010, tras su revisión bibliográfica fijan el hecho de que estas prótesis son lo suficientemente retentivas manteniéndose con su forma indefinidamente gracias a los ganchos flexibles[6].

En otro estudio realizado por Yumiko y colaboradores en 2011, comparando diferentes diseños, concluyen que el retenedor fabricado en resina de poliamida puede ofrecer suficiente retención si hay un especial cuidado en su diseño[37]. Por lo que, haciendo la equivalencia de las estructuras metálicas de las prótesis convencionales, un diseño correcto de las prótesis flexibles se asemeja a una retención igual que las prótesis metálicas.

Thakral y colaboradores en 2012, comentan que el efecto de palanca de las prótesis convencionales se puede solventar con las prótesis flexibles sin comprometer a una buena retención. En cuanto a la retención indirecta, estos autores afirman que las prótesis de nylon no necesitan de topes oclusales ya que la distribución del estrés está de manera natural en equilibrio[38].

Takahashi y colaboradores en 2012, afirman en su estudio, que las prótesis de nylon al tener flexibilidad con el paso del tiempo en las áreas de retención esta flexibilidad puede cambiar[22].

Con intención de exponer un caso clínico, Yavuz y colaboradores en 2012, evalúan a una paciente femenina de 24 años quiere reemplazar las ausencias del sector anterosuperior. La paciente refiere gran preocupación por su estética debido a la ausencia que sufre. Se decidió colocarle una prótesis sobre implantes en el sector ausente, y como provisional se le puso una prótesis de nylon para dar los resultados estéticos que la paciente demanda, restablecer la oclusión y que la paciente se vaya familiarizando con las prótesis en su boca. Tras la colocación de la prótesis en boca, la paciente refiere gran satisfacción por la estética que posee y la flexibilidad que aportan estas prótesis ayudan a la comodidad y retención[23].

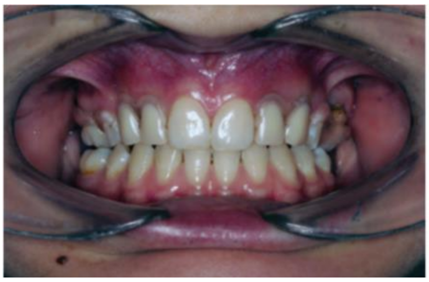

Fig. 7. Prótesis final insertada en boca. Yavuz y colaboradores (2012)[23].

Por otro lado, Fueki y colaboradores en 2014, apoyan el concepto de que las prótesis flexibles tengan una capacidad de retención difícil de ajustar[21].

Kim y colaboradores en 2014, sujetan la opción de que las prótesis flexibles al tener un bajo módulo de elasticidad y ser manipulables, necesitan de una preparación mayor en los dientes para dar retención en comparación con las prótesis convencionales[35].

Wieckiewicz y colaboradores en 2014, aportan que en las prótesis de nylon los brazos retentivos con una flexibilidad constante son primordial para una función satisfactoria[27].

Gomes y colaboradores en 2015, en su revisión bibliográfica declaran que la retención era similar en pacientes con PMMA y poliamidas al cabo de 6 meses, y que los pacientes preferían las prótesis de poliamidas[31].

Hundal y colaboradores en 2015, afirman que la retención de las prótesis flexibles depende principalmente del tejido subyacente, por lo que los pilares se encuentran aliviados de tensión[19].

Jain y colaboradores en 2015, exponen que la retención de las prótesis con base de poliamidas son buenas y además puede llegarse a ella sin necesidad de preparación de dientes pilares[30].

Estabilidad

Tandon y colaboradores en 2010, declaran que las prótesis de poliamidas son extremadamente estables[6].

A su vez, Gomes y colaboradores en 2015, al comparar las prótesis de PMMA y las poliamidas, vieron que la función y estabilidad en ambas prótesis eran similares[31].

Sin embargo, Ito y colaboradores en 2013, no están de acuerdo con los autores anteriores, ya que promueven que la cresta alveolar con el paso del tiempo puede sufrir reabsorciones y de acuerdo con apartados atrás, la dificultad de rebasado de las prótesis de nylon tiene bastante dificultad, por lo que la estabilidad podría verse comprometida[26].

Desplazamiento vertical

Sharma y colaboradores en 2014, ratifican que las prótesis flexibles como su propio nombre indica se flexionan bajo carga oclusal, por lo que existirá un desplazamiento vertical y a su vez no es posible el mantenimiento de la dimensión vertical[2].

Nasution y colaboradores en 2018, de acuerdo con los autores anteriores evalúan que debido a la flexibilidad que poseen se produce un desplazamiento vertical y por tanto se aplicó más carga a la mucosa donde apoya la prótesis[25].

Asimismo, y en concordancia con los autores anteriores, Horie y colaboradores en 2019, tras su estudio afirman que las poliamidas tuvieron un gran desplazamiento vertical debido a la elasticidad que poseen y también por la contracción de polimerización[39].

8. Conclusiones

- La estética es una de las propiedades más evidentes de las prótesis de nylon, sin embargo, muchos autores demuestran el cambio de coloración que estas prótesis sufren si no se lleva a cabo un exhaustivo mantenimiento de la prótesis.
- La mala unión con los dientes acrílicos con la base de la prótesis sugiere en un futuro la continua investigación. Así como, la dificultad de rebase debido a una mala unión con las resinas de reparación, pero este problema puede ser solventado con una cubierta de sílice.
- Las prótesis de nylon poseen alta flexibilidad, elasticidad y menor dureza que las prótesis convencionales, esto se traduce en comodidad para los pacientes. A su vez, pese a la gran indicación de la menor citotoxicidad respecto a las prótesis con metal, se reportan casos en los que el grado de biocompatibilidad de ambos materiales es similar.
- Existen incongruencias con respecto a la retención, ya que se reportan casos con diferentes conclusiones, por lo que se debe de seguir investigando.
- En cuanto a la estabilidad no hay suficientes autores que hayan estudiado este punto y por tanto no se puede dar una conclusión exacta, se ha estudiado tanto que son estables como todo lo contrario.
- La poca evidencia científica que acontece en general este tema es una clara limitación para poder dar conclusiones definitivas sobre las prótesis de nylon. Con perspectiva a futuro, es necesario seguir investigando sobre el tema en cuestión donde muchos autores recalcan la necesidad de este punto.

9. Responsabilidad

Hoy en día el uso de implantes dentales está universalmente utilizado, sin embargo, es un procedimiento invasivo, costoso y puede no estar indicado para todo el mundo.

Las prótesis de nylon son una buena alternativa en cuanto al beneficio económico y la eficiencia de la técnica con respecto a los implantes dentales para reponer pocas piezas ausentes ya que suponen un menor costo y la complejidad de la técnica es mucho menor, siendo un tratamiento mucho menos invasivo.

Por otro lado, vivimos en una época donde existe una gran preocupación por parte de la sociedad por la imagen, tener una buena sonrisa puede ser equivalente a tener buena salud y es nuestra carta de presentación al mundo, por lo que estas prótesis pueden solventar la problemática de las prótesis convencionales donde el metal puede verse expuesto y por tanto, la estética que tanto se desea puede verse afectada.

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11. Anexos

Tabla 1. Tabla comparativa nylon versus PMMA; resistencia a la fractura, resistencia a la flexión y módulo de elasticidad

Nylon			
	Resistencia a la fractura	**Resistencia a la flexión**	**Módulo de elasticidad**
Yunus y col. en 2005		Menor	
Ucar Y y col. en 2010		78,3 MPa	Menor
Takabayashi en 2010	Mayor	39 MPa	826,17 MPa
Hamanaka y col. en 2011.	6,86 kJ/m2	Menor	1,04 GPa
Ucar y col. en 2012		No hay diferencias	
Wadachi y col. en 2013			Menor
Koray Soygun y col. en 2013	117,22 MPa	Menor	Menor
Hundal M y col. en 2015.	Mayor		
Sasaki H y col. en 2017		Menor	

PMMA			
	Resistencia a la fractura	**Resistencia a la flexión**	**Módulo de elasticidad**
Yunus y col. en 2005		Mayor	Mayor
Ucar Y y col. en 2010		81,1 MPa	Mayor
Takabayashi en 2010	Menor	101 MPa	2916,78 MPa
Hamanaka y col. en 2011	1,06 kJ/m2	Mayor	2,77 GPa
Ucar y col. en 2012		No hay diferencias	
Wadachi y col. en 2013			Menor
Koray Soygun y col. en 2013	92,00 MPa	Mayor	Mayor
Hundal M y col. en 2015	Menor		
Sasaki H y col. en 2017		Mayor	

Tabla 2. Tabla comparativa nylon versus PMMA; dureza

Nylon	
	Dureza
Ucar Y y col. en 2010	7,5 kg/mm2
Ucar y col. en 2012	Menor
Shah y col. en 2014	10,20 kg/mm2

PMMA	
	Dureza
Ucar Y y col. en 2010	16,9 kg/mm2
Ucar y col. en 2012	Mayor
Shah y col. en 2014	12,08 kg/mm2

Tabla 3. Tabla comparativa nylon versus PMMA; rugosidad superficial

Nylon	
	Rugosidad superficial
Abuzar y col. en 2010	Mayor
Fueki K y col. en 2014	Mayor
Wieckiewicz M y col. en 2014	No existen diferencias

PMMA	
	Rugosidad superficial
Abuzar y col. en 2010	Menor
Fueki K y col. en 2014	Menor
Wieckiewicz M y col. en 2014	No existen diferencias

Tabla 4. Tabla comparativa nylon versus PMMA; estética, estabilidad de color y absorción de agua.

Nylon			
	Estética	**Estabilidad del color**	**Absorción de agua**
Gomes SG y col. en 2015	Mayor satisfacción		
Hundal M y col. en 2015	Mayor satisfacción	No cambios de coloración	
Licia Manzon y col. en 2019	Mayor satisfacción	Cambio de coloración	
Shah J y col. en 2014			Menor absorción de agua
Hayashi y col. en 2014			Menor absorción de agua
Jang DE y col. en 2015			Similar

PMMA			
	Estética	**Estabilidad del color**	**Absorción de agua**
Gomes SG y col. en 2015	Menor satisfacción		
Hundal M y col. en 2015	Menor satisfacción		
Licia Manzon y col. en 2019	Menor satisfacción		
Shah J y col. en 2014			Mayor absorción de agua
Hayashi y col. en 2014			Mayor absorción de agua
Jang DE y col. en 2015			Similar

Tabla 5. Tabla comparativa nylon versus PMMA: contracción de polimerización

Nylon	
	Contracción de polimerización
Parvizi y col. en 2004	Mayor
Fueki K y col. en 2014	Similar

PMMA	
	Contracción de polimerización
Parvizi y col. en 2004	Menor
Fueki K y col., en 2014	Similar

Tabla 6. Tabla comparativa nylon versus PMMA: citotoxicidad

Nylon	
	Viabilidad celular
Uzun y col. 2015	Similar
Jang DE y col. en 2015	3,7
Hundal M y col. en 2015	Similar

PMMA	
	Viabilidad celular
Uzun y col. en 2015	Similar
Jang DE y col. en 2015	3,8
Hundal M y col. en 2015	Similar

Tabla 7. Tabla comparativa nylon versus PMMA; resistencia a la fractura, resistencia a la flexión y módulo de elasticidad

Nylon			
	Resistencia a la fractura	**Resistencia a la flexión**	**Módulo de elasticidad**
Yunus y col. en 2005		Menor	
Ucar Y y col. en 2010		78,3 MPa	Menor
Takabayashi en 2010	Mayor	39 MPa	826,17 MPa
Hamanaka y col. en 2011.	6,86 kJ/m2	Menor	1,04 GPa
Ucar y col. en 2012		No hay diferencias	
Wadachi y col. en 2013			Menor
Koray Soygun y col. en 2013	117,22 MPa	Menor	Menor
Hundal M y col. en 2015.	Mayor		
Sasaki H y col. en 2017		Menor	

PMMA			
	Resistencia a la fractura	**Resistencia a la flexión**	**Módulo de elasticidad**
Yunus y col. en 2005		Mayor	Mayor
Ucar Y y col. en 2010		81,1 MPa	Mayor
Takabayashi en 2010	Menor	101 MPa	2916,78 MPa
Hamanaka y col. en 2011	1,06 kJ/m2	Mayor	2,77 GPa
Ucar y col. en 2012		No hay diferencias	
Wadachi y col. en 2013			Menor
Koray Soygun y col. en 2013	92,00 MPa	Mayor	Mayor
Hundal M y col. en 2015	Menor		
Sasaki H y col. en 2017		Mayor	

Tabla 8. Tabla comparativa nylon versus PMMA; dureza

Nylon	
	Dureza
Ucar Y y col. en 2010	7,5 kg/mm2
Ucar Y y col. en 2012	Menor
Shah y col. en 2014	10,20 kg/mm2

PMMA	
	Dureza
Ucar Y y col. en 2010	16,9 kg/mm2
Ucar Y y col. en 2012	Mayor
Shah y col. en 2014	12,08 kg/mm2

Tabla 9. Tabla comparativa nylon versus PMMA; rugosidad superficial

Nylon	
	Rugosidad superficial
Abuzar y col. en 2010	Mayor
Fueki K y col. en 2014	Mayor
Wieckiewicz M y col. en 2014	No existen diferencias

PMMA	
	Rugosidad superficial
Abuzar y col. en 2010	Menor
Fueki K y col. en 2014	Menor
Wieckiewicz M y col. en 2014	No existen diferencias

Tabla 10. Tabla comparativa nylon versus PMMA; estética, estabilidad de color y absorción de agua.

Nylon			
	Estética	**Estabilidad del color**	**Absorción de agua**
Gomes SG y col. en 2015	Mayor satisfacción		
Hundal M y col. en 2015	Mayor satisfacción	No cambios de coloración	
Licia Manzon y col. en 2019	Mayor satisfacción	Cambio de coloración	
Shah J y col. en 2014			Menor absorción de agua
Hayashi y col. en 2014			Menor absorción de agua
Jang DE y col. en 2015			Similar

PMMA			
	Estética	**Estabilidad del color**	**Absorción de agua**
Gomes SG y col. en 2015	Menor satisfacción		
Hundal M y col. en 2015	Menor satisfacción		
Licia Manzon y col. en 2019	Menor satisfacción		

Shah J y col. en 2014			Mayor absorción de agua
Hayashi y col. en 2014			Mayor absorción de agua
Jang DE y col. en 2015			Similar

Tabla 11. Tabla comparativa nylon versus PMMA: contracción de polimerización

Nylon	
	Contracción de polimerización
Parvizi y col. en 2004	Mayor
Fueki K y col, en 2014	Similar

PMMA	
	Contracción de polimerización
Parvizi y col. en 2004	Menor
Fueki K y col, en 2014	Similar

Tabla 12. Tabla comparativa nylon versus PMMA: citotoxicidad

Nylon	
	Citotoxicidad
Uzun y col. en 2015	Similar
Jang DE y col. en 2015	Similar
Hundal M y col. en 2015	Similar

PMMA	
	Citotoxicidad
Uzun y col. en 2015	Similar
Jang DE y col. en 2015	Similar
Hundal M y col. en 2015	Similar

<u>Portada artículos</u>

THE JOURNAL OF PROSTHETIC DENTISTRY

RESEARCH AND EDUCATION

Fracture load of complete-arch implant-supported prostheses reinforced with nylon-silica mesh: An in vitro study

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ABSTRACT

Statement of problem. Complete-arch implant-supported prostheses without a framework have a high risk of failure: a straightforward and inexpensive reinforcement material, such as nylon mesh, could improve their longevity.

Purpose. The purpose of this in vitro study was to evaluate a nylon-silica mesh compound on the fracture strength of acrylic resin and the fracture load of complete-arch implant-supported prostheses.

Material and methods. Twenty-four complete mandibular arch implant-supported prostheses were divided into 2 groups according to cantilever length (molar and premolar) and subdivided into another 2 subgroups according to the presence or absence of reinforcing mesh. The specimens were submitted to a maximum load-to-fracture test in a universal testing machine, with a 100-N load cell, a 2 mm/min crosshead speed, and a spherical metal tip diameter of 4 mm at different points (molar and premolar). These were submitted to 1-way analysis of variance for repeated measurement and the post hoc Tukey multiple comparison test (α=.05).

Results. The mean maximum load ±standard deviation for the molar group was 393.4 ±95.0 N with reinforcement and 305.4 ±76.3 N without reinforcement (P=.02); and for the premolar group was 1083.3 ±283.7 N with reinforcement and 605.3 ±90.5 N without reinforcement (P=.001).

Conclusions. Reinforcement with nylon mesh increased the mean maximum load of implant-supported complete-arch prostheses at both cantilever lengths. The cantilever to the premolar (5 mm) presented the highest maximum load values to fracture. (J Prosthet Dent 2018;119:606-10)

Tissue-supported dentures may cause discomfort in patients and present support, stability, and retention challenges.[1] The use of implant-supported prostheses brings better function to patients with complete edentulism, improving masticatory efficency.[1] But the masticatory loads on implants must be controlled and well distributed. Loads that are higher than is acceptable to the bone lead to resorption around implants of approximately 0.06 to 0.08 mm per year.[2,3] The load distribution depends directly on the design of the prosthesis and on the passive adjustment of components and occlusion with the opposite arch.[4-6] The materials used in the fabrication of the implants and prosthesis also play an important role in load distribution.[7]

The incidence of mechanical complications or failure with implant-based treatments has been described and is mostly associated with overloading, which may manifest in damage to the implants, to the implant-supported prostheses, or to the bone.[8] Fracture or loosening of fixation screws, fracture of occlusal veneering materials, fracture of prostheses, continuous crestal bone loss, and fracture of implants as a consequence of bone loss have been reported.[8,9] Therefore, reinforcement fibers have

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Position Paper

Clinical application of removable partial dentures using thermoplastic resin—Part I: Definition and indication of non-metal clasp dentures

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ARTÍCULO DE REVISIÓN

Prótesis flexible. Alternativa de restauración protésica

Flexible prosthesis. Alternative of prosthetic restoration

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RESUMEN

En nuestros días se pueden encontrar numerosas alternativas a la hora de elegir una prótesis que se ajuste a nuestras necesidades y es que son muchas las opciones que propone la Estomatología con el desarrollo de nuevas tecnologías. Por ello, es momento de conocer las prótesis flexibles. Son aquellas prótesis removibles que tienen la propiedad de ser blandas, por ser confeccionadas de un material de base llamado resina-poliamida o mejor conocido como el nylon, dicho material es traslúcido, ideal para matizar los colores de la encía, aunque lo podemos encontrar en diversidad de colores. Es importante destacar las prestaciones que nos ofrece esta prótesis y tener en cuenta los inconvenientes, para ver si realmente estamos ante un método que se ajusta a nuestra situación.

Palabras clave: prótesis flexible, prótesis removible, resina –poliamida

ABSTRACT

Nowadays can find several alternative sometime to select a prosthesis that it conforms to our needs and it is that are many the options that proposes us the stomatology with the development of new technologies. Therefore, is moment to know the flexible prosthesis. Which is those removibles prosthesis that have the property of being soft for being made of a material of call base extracts resin

ACP AMERICAN COLLEGE OF PROSTHODONTISTS

Color Stability of Resins and Nylon as Denture Base Material in Beverages

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Keywords
Color stability; denture base acrylic resin.

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Abstract

Purpose: Staining of prosthodontic materials may result in patient dissatisfaction and additional expense for replacement. This study aimed to determine the color stability of two heat-cured denture base acrylic (Lucitone 550, Vipi Cril) and one nylon denture base resin (Transflex) after immersion in beverages.

Materials and Methods: Forty disks of each resin (20.0-mm diameter, 3.0-mm thick) were prepared and stored in distilled water for 24 hours at 37°C. During that time (T_0), the color of all specimens was spectrophotometrically measured. Each specimen was immersed in coffee, cola, red wine, and distilled water as a means of control. After 15-day (T_1) and 30-day (T_2) periods of immersion, the color of the specimens was measured again. The CIE (Commission Internationale de L' Eclairage) $L^*a^*b^*$ system was used to determine mean ΔE (color changes) values for each material and compared statistically with two-way ANOVA and Bonferroni intervals at 0.95.

Results: In ΔET_0T_1 and ΔET_0T_2 the most severe staining was apparent with red wine ($p < 0.001$), followed by coffee ($p < 0.01$), when compared to the specimens stored in distilled water. Transflex also showed significant color change after immersion in cola ($p < 0.01$). In ΔET_1T_2 only red wine promoted significant staining of all resins ($p < 0.0001$).

Conclusion: Chromatic changes were exhibited by specimens immersed in red wine, followed by coffee. For Transflex, cola also promoted color changes. The values of color changes converted to National Bureau of Standard units showed them to be perceivable to the human eye.

Many resins have been used for denture base construction. These materials include heat-activated (polymerized using a water bath or microwave oven), chemically activated (cold-polymerized resins), and light-activated denture base acrylic resins. Polymethyl methacrylate (PMMA) polymers were introduced as denture base materials in 1937. Most PMMA resin systems include powder and liquid components. A cross-linking agent may also be added to the monomer component to improve solvent resistance of the cured polymer and so, reduce its susceptibility to solvent crazing.[1,2] Acrylic resins used for the manufacture of denture bases have displayed various degrees of in vitro cytotoxicity and in vivo allergic responses, probably caused by nonreacting components remaining after the polymerization process.[3] Some potential alternative materials to PMMA used in these cases include polycarbonate and nylon. Nylon is a generic name for certain types of thermoplastic polymers belonging to the class known as polyamides. These polyamides are produced by the condensation reactions between a diamine NH_2-$(CH_2)_6$-NH_2 and a dibasic acid CO_2H-$(CH_2)_4$-COOH.[4-6] The use of nylon as a denture base material has been described in the literature since the 1950s.[7] Nylon is a crystalline polymer, whereas PMMA is amorphous. This crystalline effect accounts for nylon's lack of solubility in solvents, high heat resistance, and high strength coupled with ductility.[7]

Some of the disadvantages reported in the early forms of nylon included a tendency to color deterioration, staining, high water sorption, and the development of a rough surface after a short period of time.[5,8] Color change of the denture base polymers may be caused by the oxidation of the amine accelerator

Review Article

Polyamide as a Denture Base Material: A Literature Review

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KEY WORDS
Polyamide;
Denture base;
Nylon

ABSTRACT

The purpose of this article was to review the biocompatibility, physical, and mechanical properties of the polyamide denture base materials. An electronic search of scientific papers from 1990-2014 was carried out using PubMed, Scopus and Wiley Inter Science engines using the search terms "nylon denture base" and "polyamide denture base". Searching the key words yielded a total of 82 articles. By application of inclusion criteria, the obtained results were further reduced to 24 citations recruited in this review. Several studies have evaluated various properties of polyamide (nylon) denture base materials. According to the results of the studies, currently, thermo-injectable, high impact, flexible or semi-flexible polyamide is thought to be an alternative to the conventional acrylic resins due to its esthetic and functional characteristics and physicochemical qualities.

It would be justifiable to use this material for denture fabrication in some cases such as severe soft/ hard tissue undercuts, unexplained repeated fracture of denture, in aesthetic-concerned patients, those who have allergy to other denture base materials, and in patients with microstomia.

Although polyamide has some attractive advantages, they require modifications to produce consistently better properties than the current polymethyl methacrylate (PMMA) materials. Moreover, since there is a very limited knowledge about their clinical performance, strict and careful follow-up evaluation of the patients rehabilitated with polyamide prosthesis is recommended.

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Introduction

Polymethyl methacrylate (PMMA) has been the most popular material used for denture fabrication since its introduction in 1937. [1] It has several advantages such as an excellent esthetic characteristic, low water sorption and solubility, adequate strength, low toxicity, easy repair, and a simple molding processing technique. Nonetheless, it has some problems such as polymerization shrinkage, weak flexural, lower impact strength, and low fatigue resistance. [1-4] These often lead to denture failure during chewing or when fall out of the patient's hand. In order to enhance some properties of PMMA, various efforts have been taken including addition of metal wires or plates, fibers, [5-8] metal inserts, [9] and modification of chemical structure. In recent years, nylon polymer has attracted attention as a denture base material. Polyamide resin was proposed as a denture base material in the 1950s. [10] Nylon is a generic name for certain types of thermoplastic polymers belonging to the class known as polyamides. These polyamides are produced by the condensation reactions between a diamine NH_2-$(CH_2)_6$-NH_2 and a dibasic acid, CO2H-$(CH_2)_4$-COOH. [11-15] Nylon is a crystalline polymer, whereas PMMA is amorphous. This crystalline effect accounts for the lack of solubility of nylon in solvents, as well as high heat resistance and high

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Patient and Clinical Evaluation of Traditional Metal and Polyamide Removable Partial Dentures in an Elderly Cohort

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Keywords
Removable partial denture; elderly; polyamide; polymethil methacrylate; cobalt-chromium.

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Abstract

Purpose: To evaluate several clinical and functional parameters by administration of specific questionnaires to an elderly patient's cohort wearing three different types of removable partial denture (RPD): VALPLAST-RPD (Polyamide VALPLAST), CoCr-RPD (cobalt-chromium alloy), and PMMA-RPD (heat polymerized polymethyl methacrylate).

Materials and Methods: One hundred twenty patients (mean age 73 years) were included in this study. All patients were treated with a removable partial denture for the maxillary arch. After 1 year of use, patients and clinicians were asked to compile specific questionnaire on patient satisfaction, including aesthetic, functional, and clinical outcomes. It was also evaluated whether the localization of the missing teeth according to Kennedy classification may affect these parameters. Categorical data obtained from the questionnaires were analyzed by chi-squared test.

Results: VALPLAST-RPD was the most satisfactory aesthetically. Nevertheless, patients of VALPLAST-RPD group reported increased difficulty in cleaning the prosthesis, roughness perceived by the tongue, and increased retention loss ($p < 0.001$). Patients with PMMA-RPD claimed a higher level of encumbrance ($p < 0.001$) and increased speech difficulties ($p = 0.002$). Clinically, patients of VALPLAST-RPD and PMMA-RPD groups displayed redness of the mucosa area around abutment teeth ($p < 0.001$). Patients of VALPLAST-RPD group had four cases of artificial teeth loss and two cases of discoloration. The position of missing teeth did not significantly influence any parameter.

Conclusions: Each RPD material utilized may present advantages and disadvantages in an elderly population. VALPLAST-RPD may be recommended to older patients with non-extensive edentulous areas supported by anterior and posterior teeth, and not subjected to strong chewing loads. The main advantages are aesthetic satisfaction and easiness to insert and remove it.

Conventional removable partial dentures (RPD) are made of polymethyl methacrylate (PMMA), a synthetic resin, with stainless steel clasps, or of a cast alloy (CoCr) structure equipped with clasps and rests attached to natural teeth.[1,2] The framework is covered by resin. The PMMA-RPD prosthesis has satisfying mechanical property[3,4] but low impact strength and low fatigue resistance.[5] These factors may lead to fractures during strong chewing or if the prosthesis falls. The CoCr-RPD is very attractive for its corrosion resistance, high modulus of elasticity and strength, low density and cost.[2]

Both types of prostheses are supported by the underlying mucosa, but PMMA-RPD clasps engage teeth undercuts only for retention whereas CoCr-RPD contact the abutment teeth using clasps and rests. In the latter case, teeth must be periodontally healthy.

Metal clasps, however, are well tolerated by the patients only when the clasps are positioned posteriorly and cannot be seen. Another problem is the increase in allergy development to resins and metals. These problems were overcome by the use of non-allergic materials to realize RPD. Polyamide is an alternative material with lower allergic reaction because of the absence of metal and chemical additives and catalysts in the prosthesis structure.[5]

Polyamide is a thermoplastic material whose detailed chemical structure is not declared by the manufacturers. There are various types and brands on the market, with different properties. RPD made by polyamide became popular for aesthetic reasons, such as the absence of metal clasps on the prosthesis. Other reasons are the reduced thickness of the prosthesis, compared to those with acrylic resin with/without metal, and

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Evaluation of the rigidity of dentures made of injection-molded materials

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Dentures made of 2 different types of injection-molded thermoplastic resins (polyamide resin and polyester resin) and a denture made of conventional heat-polymerized resin were used to create an experimental model of a mandibular molar region with a two-tooth gap. In the experimental model, a force of 100 N was applied onto the mesial fossa of the first molars of the dentures, and comparisons were performed by measuring the pressure applied under the denture base and the subsidence rate of the denture. The polyamide resin denture showed the highest subsidence, exerted the highest pressure on the underlying mucosa, and showed significant differences with the other types of dentures. The findings showed that polyamide resins have the lowest degree of elasticity, and that when resins with such low elasticities are used in the denture base, they should preferably be reinforced with metals.

Keywords: Denture, Thermoplastic resins, Non-metal clasp dentures

INTRODUCTION

In recent years, injection-molded thermoplastic resins such as polycarbonate, polyamide, and polyester have been used as denture-base materials[1-2]. These materials have high toughness and low elasticity, and have found applications as non-metal clasp dentures, which are mainly characterized by the non-use of metal clasps[3-5]. Nevertheless, these materials are controversial because of various issues such as their adhesion to heat-curing resins (which are conventional base materials) and their resistance to abrasion[6-11]. With regard to the effect on the mucosa underlying the denture base made of polyamide resin, the difference in the force transmitted onto the denture base by the existence of a metal rest was reported, and the application of a metal rest with the non-metal clasp denture was recommended[10].

Therefore, simulation models of intermediate missing teeth were created using dentures made of thermoplastic resin and conventional dentures made of polymethyl methacrylate resin. The movements of the models, as well as the load applied onto the denture base, were measured and compared between the models. The aim of this study is to examine whether dentures made of injection-molded resin have sufficient stiffness in comparison with conventional dentures.

MATERIALS AND METHODS

Materials
As shown in Table 1, two types of injection-molded thermoplastic resins [the polyamide resin (Valplast; VAL) and the polyester resin (EstheShot; PET)] were used for the manufacture of dentures in this study. In addition, dentures made of polymethyl methacrylate resin (Physio Resin; PMMA) were used as controls.

Fabrications of dentures
The dentures used in the experiments consisted of missing tooth models (E16-516; Nisshin, Kyoto, Japan); that is, with a missing left mandibular second premolar and first molar (Fig. 1). A load sensor was placed on the slope on the buccolingual side of the alveolar ridge, under a silicon membrane corresponding to the mucosa directly under the first molar. An impression was taken under this condition, and a denture was manufactured.

The design of the denture used in the experiment is shown in Fig. 2. The dentures used in this study were designed in such a way that at the site of the missing middle teeth, a metal rest was set to the tooth adjacent to the deletion; however, inside the denture base, the pedicles of the metal rest were not connected to each other. The Co-Cr alloy (Wironit®, Bego, Bremen, Germany) was used for making the metal rest. Table 2 shows heating temperature, heating time, injection pressure and the temperature of the flask. Five dentures made with each of the materials were manufactured and used for the measurements.

Method
To apply a load on the denture, the occlusal force was estimated using a universal testing machine (Autograph, Shimadzu Corporation, Kyoto, Japan); the experimental denture was set to a fixed position that allowed for the load to be applied on the mesial fossa of the first molar, and a pressure of 100 N was applied at a crosshead speed of 0.5 mm/min. The amounts of displacement upon the application of pressure and the output from the load sensor were recorded. The distance covered by the head (amount of movement of the head) from the time when

Color figures can be viewed in the online issue, which is available at J-STAGE.

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Mechanical Properties of Polyamide Versus Different PMMA Denture Base Materials

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Keywords
Denture base materials; mechanical properties; polyamide.

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Abstract

Purpose: Polymethyl methacrylate (PMMA) resins are the most commonly used denture materials; however, they do not have a high flexural strength (FS). This study aimed to compare the mechanical properties of a polyamide-based, injection-molded denture material (Deflex) with another injection-molded PMMA base material (SR-Ivocap) and a conventional compression-molded PMMA (Meliodent).
Materials and Methods: Flexural properties (deflection, bending strength, and bending modulus) of denture base materials were evaluated (n = 10). Specimens meeting International Standards Organization (ISO) specification number 20795–1 requirements were prepared ($65 \times 10 \times 3$ mm^3). A three-point bending test was carried out on an Instron testing machine at a 5 mm/min crosshead speed. The Knoop hardness test was used to compare microhardness values. Data were analyzed using ANOVA, followed by REGWQ.
Results: The group results, standard deviations, and statistical differences ($p < 0.01$) for Deflex, SR-Ivocap, and Meliodent were (A) flexural strength (MPa: $78.3 \pm 1.0,^{a}$ $69.8 \pm 1.4,^{b}$ 81.1 ± 1^{a}), (B) flexural modulus (GPa: $0.70 \pm 0.13,^{a}$ $0.85 \pm 0.27,^{a}$ 1.70 ± 0.23^{b}), (C) Knoop Hardness (kg/cm^2: $7.5 \pm 1.0,^{a}$ $13.5 \pm 1.4,^{b}$ 16.9 ± 1.0^{c}). Different superscript letters indicate significant difference. All Meliodent specimens fractured during flexural testing, but no Deflex specimens did.
Conclusions: While polyamide denture material produced good fracture resistance, its modulus is not yet sufficiently high to be equal to standard PMMA materials. *Clinical Implications.* Polyamide has some attractive advantages, but will require modification to produce consistently better properties than current PMMA materials.

Even though different materials have been used for denture construction,[1] polymethyl methacrylate (PMMA) resins are the most commonly used.[2] However, PMMA resin fracture strength is not high.[2] Denture wearers are generally older with potentially less muscle control,[3] resulting in accidents causing denture fractures.[1,4] Using metal frameworks within dentures increases the strength of the denture; nevertheless, concerns like corrosion of the metal framework, allergic reactions, permanent deformation following dropping of a denture, unesthetic appearance of the metal clasps, and difficulties encountered during casting remain problems for metal-supported dentures.[1] Continuous efforts to increase material strength to decrease the risk of denture fractures can be listed as: (1) reinforcement of denture materials by adding filling materials,[4,5] (2) changing the chemistry of the denture base polymer by copolymerization and cross-linking of resin materials, (3) incorporation of techniques new to the dental field; and (4) manufacturing new materials with increased resistance to fracture.

One technique that improves the physical properties of dentures is injection molding.[6] The SR-Ivocap system (Ivoclar AG, Schaan, Liechtenstein) is one of the current systems used for making injectable PMMA dentures.[7] Anderson et al[8] and Strohaver[9] reported that the dimensional stability was improved with the injection-molding technique compared to the compression-molding technique, in addition to the decreased polymerization shrinkage and diminished changes in vertical dimension. Results by Huggett et al[10] demonstrated that dentures produced by the injection molding procedure exhibit less shrinkage than those produced by conventional press-pack procedures.

Polyamides, known as "nylon," are thermoplastic polymers produced by condensation reaction between a diamine and a

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ORIGINAL ARTICLE

Effects of cleansing methods on 3-D surface roughness, gloss and color of a polyamide denture base material

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Abstract

Objective. The purpose of this study was to determine the effects of two denture cleansing methods on 3-D surface roughness, gloss and color of denture base materials. Materials and methods. Thirty disks from nylon (Valplast) and 30 from heat-polymerized acrylic denture base material (Paladon 65) were made and 10 of each material were immersed in water (control), Val-Clean (peroxide cleanser) and Corega Extradent (peroxide cleanser) plus microwaving for a period simulating 30 days of daily cleansing. 3-D surface roughness, gloss and color parameters were measured before and after cleansing using an interferometric profilometer, a gloss meter and a colorimeter. The results were statistically analysed by regression, paired-t, Mann-Whitney and Kruskal-Wallis tests at $\alpha = 0.05$ level of significance. ***Results.*** The results showed significant differences at baseline in L^* and b^* parameters between materials ($p < 0.01$), with a significantly lower gloss ($p < 0.05$) and higher roughness ($p < 0.05$) for Valplast. After cleansing, Δe^* was significantly greater in Valplast than Paladon 65 ($p < 0.05$). Gloss of both materials decreased significantly within the Corega Extradent plus microwave solution ($p < 0.05$), while roughness increased significantly only for Paladon 65 ($p < 0.05$). ***Conclusions.*** Valplast was found to have a significantly lower gloss and a higher roughness than Paladon 65 before cleansing. After cleansing, ΔE^* increased more in Valplast than in Paladon 65, gloss of both materials decreased and roughness only of Paladon 65 increased within the Corega extradent plus microwaving method.

Key Words: *denture cleansers, microwave irradiation, nylon, PMMA*

Introduction

The need for dentures has been estimated to reach 37.9 million adults in the US alone [1]. The material most commonly use for the construction of denture prostheses is acrylic or polymethyl methacrylate (PMMA). The primary reason for this selection is that the material satisfies most of the requirements as a denture base material [2].

However, PMMA presents important disadvantages like low impact strength and fatigue properties [2–4]. Combining disadvantages with allergic reactions in hypersensitive patients to residual monomer, one can easily understand the efforts of researchers to introduce alternative materials for the fabrication of denture prostheses. Some potential alternative materials to PMMA include polycarbonate and nylon. Nylon is a generic name of polyamide materials ($NH(CH_2)mCOn$). It has been attempted to use this as a denture base material since 1950, but only in recent years, due to new nylon generations, its use was extended for the construction of removable denture prostheses [5,6]. The advantages of polyamides, as denture base materials, depending on the specific trade product, include high flexibility, low density, high impact resistance, low water sorption and solubility [7–12]. They are free residual monomers containing materials and, thus, non-toxic, with a low possibility of allergic reactions, presenting a relatively good color stability [9,10]. However, the main concerns of polyamides as denture base materials are centered in its low modulus of elasticity, flexural and tensile strength [12,13], its low adherence ability with denture liners [14] and its inability for a chemical retention of acrylic teeth and repair [15]. There is also a concern for the staining of the material following a

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Characteristics of denture thermoplastic resins for non-metal clasp dentures

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Six thermoplastic resins and conventional acrylic resin were examined to characterize their mechanical and physical properties, water sorption, solubility, flexural strength, modulus of elasticity, tensile strength and color stability. Thermoplastic resins for non-metal clasp dentures exhibiting low water sorption and solubility offer hygienic advantages. Since they have a low modulus of elasticity and are easily manipulated, these materials make it possible for larger undercuts to be used for retention compared to acrylic resin. Not all of the thermoplastic resins tested fractured after the bending test in contrast to the conventional denture base resin, which fractured when tested beyond its proportional limit. It was also found that clinically noticeable staining may occur on the polyamide resins and polyethylene terephtalate resins.

Keywords: Non-metal clasp dentures, Thermoplastic resins, Mechanical and chemical properties

INTRODUCTION

Most dental patients of all ages prefer to avoid the use of metal in dental treatment because of their desire for a bright, white smile. Due to such increased esthetic expectations, non-metal clasp dentures using thermoplastic resins have recently become a treatment option for patients. Several types of non-metal clasp dentures are available, all with the advantages of superior esthetics and the reduced potential for allergic reactions to metals[1]. Additional advantages of these dentures are their flexibility and highly elastic nature, which decrease the stress on abutment teeth. After investigations into these types of materials were published, clinicians in Europe and the United States began using them for various clinical procedures, such as for orthodontic appliances and temporary dentures after implant placement instead of conventional dentures[2-7].

However, the present concern about these materials is that there is insufficient scientific evidence regarding the properties of the thermoplastic resins due to the small number of studies, as well as a lack of studies comparing the various clasp materials[8-14]. Even though the indications and contraindications for the use of thermoplastic resins have never been clearly defined, some practitioners have already begun using them based on their preferences and clinical experience.

The purpose of this study was to characterize the mechanical and physical properties of most of the currently commercially available thermoplastic resins for non-metal clasp dentures for the aid in determining the clinical suitability of thermoplastic resins. An evaluation of some mechanical and physical properties, *i.e.*, flexural strength, tensile strength, contact angle, water sorption, and color stability was conducted using conventional acrylic resin as a control.

MATERIALS AND METHODS

Thermoplastic resins

As shown in Table 1, the following three types of commercially available thermoplastic resins were tested in this study: Polyamide (PA-type) resins [Valplast (VAL), Lucitone® FRS™ (LTF) and Flexite® supreme (FLS)], Polycarbonate (PC-type) resins [Reigning (RP) and Jet Carbo Resin (JCR)], and Polyethylene terephthalate (PET-type) resin [Estheshot (EST)]. The chemical structure of polyamide, polycarbonate and polyethylene terephtalate was shown in Fig. 1. As a control, polymethyl methacrylate (PMMA) [Acron (AC)] specimens were prepared.

All the materials tested were in the shade of "pink" due to its common use in removable prosthodontic practice, although each material has its own shade system. All the materials used in this study were Type 3 denture base resins: thermoplastic blank or powder as defined in ISO 20795-1: 2008, Dentistry-based Polymers-Part 1: Denture base polymer[15].

Fabrication of specimens

Metal molds and/or wax patterns were prepared in the desired shape for each sample. For water sorption test, flexural test for VAL, LTF, AC, metal molds were used to manufacture the specimens, and wax patterns were produced for other specimens. The samples were fabricated by the manufacturers or the manufacturers' recommended laboratories. Table 2 shows heating temperature, heating time, injection pressure, the temperature of the flask. The fabricated samples were reshaped with abrasive paper for each test. The AC specimens were fabricated in the conventional manner, *i.e.*, polymerization in a water bath at 70°C for 90 min and 100°C for 30 min.

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ORIGINAL ARTICLE

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Water sorption and solubility of polyamide denture base materials

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ABSTRACT

Purpose: Some patients experience adverse reactions to poly(methyl methacrylate)-based (PMMA) dentures. Polyamide (PA) as an alternative to PMMA has, however, not been well documented with regard to water sorption and water solubility. The aim of this *in vitro* study was to measure water sorption and water solubility of two PA materials compared with PMMA, and to evaluate the major components released from the PA materials and the effect on hardness of the materials.

Methods: Ten discs (40.0 mm diameter, 2.0 mm thick) of each material (PA: Valplast and Breflex; PMMA: SR Ivocap HIP) were prepared according to manufacturers' recommendations. The specimens were tested for water sorption and water solubility, according to a modification of ISO 20795-1:2008. Released substances were analysed by gas chromatography/mass spectrometry (GC/MS).

Results: There were statistically significant differences among the materials regarding water sorption, water solubility and time to water saturation. Breflex had the highest water sorption (30.4 μg/mm³), followed by PMMA-material (25.8 μg/mm³) and Valplast (13.6 μg/mm³). Both PA materials had statistically significant lower water solubility than the PMMA. Both PA had a net increase in weight. Analysis by GC/MS identified release of the compound 12-aminododecanolactam from the material Valplast. No release was found from the Breflex material.

Conclusions: The PA denture materials show differences in water sorption and solubility, but within the limits of the standard requirements. The PA showed a net increase in weight after long-term water sorption. The clinical implications of the findings are not elucidated.

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KEYWORDS
Denture base materials; nylon; polyamide

1. Introduction

There are several challenges with the use of removable partial dentures. Most denture materials are hard and can cause mechanical traumas and discomfort. Many patients experience problems with loose and poor fitting dentures and would like to have a denture that can be more securely fitted to the gums and remaining teeth. One study reported that only 64% still used their removable partial dentures regularly one year after insertion [1] while other studies report higher patient satisfaction [2,3]. The most commonly used materials for removable partial dentures are combinations of metal alloys and poly(methyl methacrylate) (PMMA) to support the denture teeth. Fabrication is complicated, time-consuming and costly. Fractures and wear of both metal and PMMA occurs frequently and repairs are difficult. Furthermore, denture base materials have a potential to cause adverse reactions due to release of monomers and biofilm-related infections [4–6]. Since the dentures are in direct contact with large areas of the oral mucosa there is potential for fungi infections and allergic reactions [7–10]. Finally, the aesthetics of conventional removable partial dentures is not optimal, with metal clasps visible on the buccal side of the teeth.

Several materials have been suggested as alternatives to PMMA. Polyamide (PA), or nylon, was introduced as a flexible alternative in the 1950s [11]. Nylon was initially the trade name for a synthetic polymer from the company DuPont. Nylon is now a generic term for a group of polymers that are made of aliphatic chains linked by amide bonds (-CO-NH-) with the chemical term PA [12]. The two terms are used interchangeably. Depending on the chemical structure of the PA, different designations may be used for the material, such as nylon-6,6; nylon-6-10; or nylon-12, referring to the building blocks used in the production of the material.

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Original

Evaluating surface roughness of a polyamide denture base material in comparison with poly (methyl methacrylate)

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Abstract: Polyamide denture base materials are more flexible than the commonly used poly (methyl methacrylate) (PMMA). However polishability of polyamides has not been examined adequately. This study investigated the surface roughness (Ra) and clinical acceptability of samples of a polyamide denture base material and PMMA fabricated by injection moulding and traditional heat processing systems, respectively. Half of each sample surface was polished using the conventional technique (lathe with pumice followed by high shine buffs) and the other half was left unpolished. A profilometer was used to measure Ra along 3 tracks on each surface before and after polishing. Two-way ANOVA was used to compare the two surfaces of the two materials for variations in Ra values. Polyamide denture base material when polished with conventional laboratory technique became more than 7 times smoother whereas processed PMMA when polished became more than 20 times smoother using the same polishing technique. However the surface roughness of polyamide is well within the accepted norm of 0.2 μm Ra. Polyamide produces a clinically acceptable smoothness after conventional polishing by lathe. (J Oral Sci 52, 577-581, 2010)

Keywords: polyamide denture base; profilometer; surface roughness.

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Introduction

Poly (methyl methacrylate) (PMMA) resin has been widely used as a denture base material due to its desirable properties of excellent aesthetics, low water sorption and solubility, relative lack of toxicity, ability to repair, and simple processing techniques. Conversely some disadvantages have also been described. Hypersensitivity to PMMA and allergic reactions to residual monomer have been reported (1-6). Increased proportion of monomer in the mixture, reduced water storage phase of the polymerized denture, and chemical curing of PMMA rather than heat curing have been shown to increase the risk of residual monomer which may cause cytotoxicity in some patients (5). PMMA has a relatively low impact strength causing fractures of acrylic based dentures (7,8). A clinical problem commonly encountered is the inability to choose a suitable path of insertion of PMMA removable partial dentures while maintaining close adaptation to the tissues in the presence of soft and hard tissue undercuts. Researches have attempted to improve the mechanical properties of PMMA denture bases by reinforcement with fibres (glass or carbon) and also by chemical modification (9,10). Development of alternative materials such as polyamides has also been reported in the literature. In the past, these polyamides exhibited specific problems, such as warpage, water sorption, surface roughness and difficulty in polishing (11-13). Lack of chemical bonding between the base and the acrylic teeth, and the inability to reline and repair the denture also posed problems for clinicians. Modified polyamide denture base materials have become available with improved water sorption levels, and with superior flexural and impact strengths (14,15). In comparison with PMMA, due to its increased flexibility, polyamide dentures

Original Article

Comparison of Patient Satisfaction with Acrylic and Flexible Partial Dentures

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Abstract

Purpose: Restoration of partial edentulous mouth may be done using a variety of treatment options. Removable partial denture (RPD) is commonly used because of its availability. RPDs from flexible resins unlike those from acrylic engage hard and soft tissue undercuts and feel more comfortable in the mouth. The aim of the study was to compare satisfaction with dentures made from these two types of materials. **Materials and Methods:** It was a quasi-experimental study among thirty patients at the Prosthetics Clinic, University College Hospital, Ibadan. Patients aged 16 years or more, requiring RPDs with one to three missing teeth in the anterior region of either the upper or lower arch participated. A modified semi-structured interviewer-administered questionnaire was used to collect data on sociodemographics and oral health variables. The level of satisfaction was assessed using a visual analogue scale. Data were analysed using descriptive and multivariate statistics at a significance level of $P < 0.05$. **Results:** The participants' ages ranged between 16 and 51 years, mean age was 33.8 ± 10.01 years. Male: female ratio was 1:1 and mean duration of edentulousness was 11.37 ± 10.52 years (median - 9.50). Most 28 (93.3%) subjects delayed replacement of their missing teeth; reasons were indifference 13 (43.4%), financial constraint 10 (33.3%), ignorance 4 (13.3%) and fear of aspiration 1 (3.3%). Overall, 21 (70.0%) participants were more satisfied with the flexible dentures, 6 (20.0%) with acrylic dentures while 3 (10.0%) were equally satisfied with both types of dentures ($P = 0.04$). **Conclusion:** Subjects were more satisfied with the flexible RPD than the acrylic resin RPD.

Keywords: Acrylic denture, flexible denture, satisfaction

Introduction

Individuals seek replacement of their missing teeth to improve their appearance, speech, social confidence and self-esteem, ability to chew more comfortably and to preserve the remaining natural teeth.[1] Among Nigerians (89.2%), aesthetics has been indicated as a major reason for replacing missing teeth.[2] Functional and aesthetic restoration of partially edentulous mouth may be done using a variety of treatment options, each with its advantages and disadvantages.[3] The options are removable partial dentures (RPDs), fixed partial dentures and dental implants.[4] The factors that may affect the choice of prosthesis used are the periodontal status, aesthetic requirements, cost, anatomical constraints and patient's acceptability.[5] RPDs outnumber conservative implant tooth replacements because of their accessibility to lower socioeconomic groups in whom the highest rates of tooth loss occur.[6,7]

RPDs may be made with cast metal, acrylic resin with or without wrought metal component and acrylic resin with some cast units and those made with thermoplastic resin.[8,9] The use of all-acrylic RPDs in the replacement of missing teeth varies with countries, with more frequent use in developing countries. The prevalence of use of the all-acrylic RPD among adults across Europe is between 13% and 29%; while in Nigeria, it was placed at between 86.0% and 92.3%.[10,11] This is because the all-acrylic RPD is more affordable and easier to fabricate.[12] However, some disadvantages of using the all-acrylic resin dentures are increased risk of developing caries, gingivitis and periodontal disease relative to other RPD

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Oral health-related quality of life: acrylic versus flexible partial dentures

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SUMMARY

Background: Teeth lost are usually replaced by all-acrylic removable partial dentures (RPD) because of its affordability and ease of fabrication. The all-acrylic RPD is said to cause significant periodontal injury and consequently affect the oral health related quality of life (OHRQoL) of denture wearers.
Objective: To determine and compare OHRQoL of all-acrylic and flexible RPD wearers at baseline and after use of dentures.
Design and setting: Study was quasi-experimental using a cross-over design, involving 30 patients with Kennedy class IV and anterior class III arches. Patient recruitment and review were done over an eight-month period in the Prosthetic Unit of a tertiary health facility. OHRQoL was assessed with the oral health impact profile-14 questionnaire. Data were analysed using descriptive and multivariate analysis at asignificant level of $p <.05$.
Results: Mean age of patients was 33.8 ±10.0 years; at baseline, patient reported occasionally, fairly often or very often for 11(78.6%) OHIP items. However, after using the acrylic and flexible partial dentures, 11(36.6%) patients reported having trouble pronouncing words and 9(30.0%) found it uncomfortable to eat respectively. At baseline, there was a difference in mean OHIP scores with age ($p=.02$); scores reduced from 12.4 ± 9.8 to 4.8±5.3 (CI= 3.3–12.0, $p=.001$) after using the all-acrylic denture and 3.8±5.6 (CI= 4.3–13.0, $p<.001$) with the flexible denture.
Conclusion: There was improvement in the OHRQoL of patients with use of flexible partial dentures. Therefore, thermoplastic materials are possible alternative RPD base materials in patient management.

Keywords: OHIP-14, Removable partial dentures, Quality of Life, acrylic dentures, flexible dentures
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INTRODUCTION

Tooth loss has been attributed to several causes including trauma, caries, periodontal disease and other oral pathologies. It affects an individual's psychological health and also distorts aesthetics, phonetics, and functional occlusion.[1] Modern dentistry offers many options for the restoration of partial edentulous mouths, including removable partial dentures (RPDs), fixed bridges and dental implants. RPDs are viable methods for replacing missing natural teeth.[2] Benefits of restoring missing teeth include the prevention of pathological drifting of adjacent teeth as well as the supra-eruption of opposing teeth. Other benefits include reduction of occlusal loading on the remaining natural teeth and the enhancement of oral function and comfort.[2]

Traditionally, cast metal is used for fabrication of dentures while polymethyl methacrylate has also been used when facilities for cast metal dentures are unavailable or due to the lower cost of acrylic.[3] Its advantages include satisfactory aesthetic property and clearly defined processing method in dental application. However, it has the disadvantage of poor mechanical property, difficulty with insertion in undercut areas, brittleness which leads to fracture and allergy to methyl methacrylate monomer.[4,5]

Despite these challenges, they are the most commonly used prostheses in replacing missing teeth in developing countries; this is because they are cheaper and easier to fabricate.[3]

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Mechanical and thermal properties of polyamide versus reinforced PMMA denture base materials

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PURPOSE. This *in vitro* study intended to investigate the mechanical and thermal characteristics of Valplast, and of polymethyl methacrylate denture base resin in which different esthetic fibers (E-glass, nylon 6 or nylon 6.6) were added. **MATERIALS AND METHODS.** Five groups were formed: control (PMMA), PMMA-E glass, PMMA-nylon 6, PMMA-nylon 6.6 and Valplast resin. For the transverse strength test the specimens were prepared in accordance with ANSI/ADA specification No.12, and for the impact test ASTM D-256 standard were used. With the intent to evaluate the properties of transverse strength, the three-point bending (n=7) test instrument (Lloyd NK5, Lloyd Instruments Ltd, Fareham Hampshire, UK) was used at 5 mm/min. A Dynatup 9250 HV (Instron, UK) device was employed for the impact strength (n=7). All of the resin samples were tested by using thermo-mechanical analysis (Shimadzu TMA 50, Shimadzu, Japan). The data were analyzed by Kruskal-Wallis and Tukey tests for pairwise comparisons of the groups at the 0.05 level of significance. **RESULTS.** In all mechanical tests, the highest values were observed in Valplast group (transverse strength: 117.22 ± 37.80 MPa, maximum deflection: 27.55 ± 1.48 mm, impact strength: 0.76 ± 0.03 kN). Upon examining the thermo-mechanical analysis data, it was seen that the E value of the control sample was 8.08 MPa, higher than that of the all other samples. **CONCLUSION.** Although Valplast denture material has good mechanical strength, its elastic modulus is not high enough to meet the standard of PMMA materials. ***[J Adv Prosthodont 2013;5:153-60]***

KEY WORDS: PMMA; Polyamide; Mechanical and thermal properties; Reinforced

INTRODUCTION

Polymethy methacrylate (PMMA) resin, widely used in denture base, has lots of advantageous properties: it is easy to apply and to repair, its low cost, acceptability by most of the patients, stability in the oral cavity, and aesthetical properties. Its mechanical feature, however, is far from the ideal because it has weak flexural and impact strength and low fatigue resistance. These often lead to denture failure during chewing or when it is dropped.[1-4] There has been ongoing effort to enhance the strength and fatigue resistance of PMMA. These efforts can be listed as: (1) reinforcement of denture materials with the addition of filling materials,[1,5,6] (2) altering the chemistry of PMMA resin materials and (3) manufacturing alternative denture base materials.[5,7]

Fiber-reinforced resin seemed to be the best option. With choices ranging from carbon, aramid, rayon, E-glass and nylon fibers as resin strengtheners, favourable result on impact and transverse strength properties of PMMA resin have been reported and discussed in detail.[5,6,8-11] There are a number of the studies focusing on the effect of glass fibers on the mechanical qualities of PMMA resin.[3,5,6,10] Reinforcement of the resin has been achieved in clinical environment with good strength results, and glass fibers were regarded to be esthetically fit for this purpose.[4-6,11-13] Nevertheless, there is progressing search for alternative resin materials with better mechanical strength than PMMA.[7,14]

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AMERICAN COLLEGE OF PROSTHODONTISTS

Double-Layer Surface Modification of Polyamide Denture Base Material by Functionalized Sol-Gel Based Silica for Adhesion Improvement

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Keywords
Denture bases; phase transition; polyamides; shear strength; silane; sol-gel.

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Abstract

Purpose: Limited surface treatments have been proposed to improve the bond strength between autopolymerizing resin and polyamide denture base materials. Still, the bond strength of autopolymerizing resins to nylon polymer is not strong enough to repair the fractured denture effectively. This study aimed to introduce a novel method to improve the adhesion of autopolymerizing resin to polyamide polymer by a double layer deposition of sol-gel silica and N-2-(aminoethyl)-3-aminopropyltrimethoxysilane (AE-APTMS).
Materials and Methods: The silica sol was synthesized by acid-catalyzed hydrolysis of tetraethylorthosilicate (TEOS) as silica precursors. Polyamide specimens were dipped in TEOS-derived sol (TS group, n = 28), and exposed to ultraviolet (UV) light under O_2 flow for 30 minutes. UV-treated specimens were immersed in AE-APTMS solution and left for 24 hours at room temperature. The other specimens were either immersed in AE-APTMS solution (AP group, n = 28) or left untreated (NT group, n = 28). Surface characterization was investigated by fourier transform infrared spectroscopy (FTIR) and atomic force microscopy (AFM). Two autopolymerizing resins (subgroups G and T, n = 14) were bonded to the specimens, thermocycled, and then tested for shear bond strength with a universal testing machine. Data were analyzed with one-way ANOVA followed by Tukey's HSD ($\alpha = 0.05$).
Results: FTIR spectra of treated surfaces confirmed the chemical modification and appearance of functional groups on the polymer. One-way ANOVA revealed significant differences in shear bond strength among the study groups. Tukey's HSD showed that TS_T and TS_G groups had significantly higher shear bond strength than control groups ($p = 0.001$ and $p < 0.001$, respectively). Moreover, bond strength values of AP_T were statistically significant compared to controls ($p = 0.017$).
Conclusion: Amino functionalized TEOS-derived silica coating is a simple and cost-effective method for improving the bond strength between the autopolymerizing resin and polyamide denture base. Clinical implications: Amino-functionalized silica coating could represent a more applicable and convenient option for improving the repair strength of autopolymerizing resin to polyamide polymer.

Polyamide polymers have attracted attention as denture base materials due to their advantages such as adequate strength, higher elasticity, and the absence of residual monomer.[1-3] Despite all these advantages, a consistent problem associated with polyamide polymer is poor bond strength to autopolymerizing resins.[4-6] Several procedures for bonding autopolymerizing reline resin to denture base acrylic material have been investigated.[7,8] However, only a few papers aimed to improve the repair strength of polyamide denture base materials. Tribochemical silica-coating and subsequent application of silane coupling agents has been largely investigated, and resulted in higher bond strength to autopolymerizing reline resins compared to other surface treatments; however, the results were inconsistent and diminished with aging process in water-saturated conditions.[4,7,8] Hamanaka et al[5] showed improvements in bond strength of polyamide air-abraded specimens to autopolymerizing resin. Air abrasion with aluminum oxide roughens the surface and increases the surface area for bonding, but the bond

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Original Article

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Vertical Displacement in Unilateral Extension Base Flexible Removable Dentures

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Abstract

The need for flexible thermoplastic denture base materials has increased due to patient demand for better esthetic outcomes. Designs aimed at improving esthetic outcomes can cause difficulties for prosthodontists, however, from the viewpoint of function and maintenance. Therefore, the purpose of this study was to investigate vertical displacement in unilateral extension base denture models, comparing that obtained by flexible removable dentures with that by conventional metal clasp dentures. Models of unilateral extension base flexible removable dentures for mandibular defects were prepared. Periodontal ligament and jaw mucosa were simulated using a silicone impression material. Four types of flexible removable denture, with or without a metal rest, and two metal clasp dentures made of acrylic resin as a conventional design were used as dental prostheses. The amount of vertical displacement in the defect areas was measured under a load of 50 N at the first and second molars. Among the 6 types of dentures investigated, the amount of vertical displacement was greater with flexible removable dentures than with metal clasp dentures. This vertical displacement tended to decrease significantly, however, with the use of a metal rest with the flexible removable dentures. Esteshot with a metal rest, in particular, showed the smallest amount of displacement in the flexible removable dentures (first molar, 0.265 ± 0.007 mm; second molar, 0.423 ± 0.008 mm). These results indicate the importance of the application of rests in unilateral extension base flexible removable dentures. It may be useful to employ a metal rest in conjunction with a flexible removable denture to reduce load on the underlying mucosa, as is done with conventional partial dentures.

Key words: Flexible removable denture — Vertical variation — Unilateral extension base

*These authors contributed equally to this work.

The combination of a nylon and traditional partial removable dental prosthesis for improved esthetics: A clinical report

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A benefit of a nylon partial removable dental prosthesis (PRDP) is the absence of a metal framework, providing improved esthetics. Unfortunately, the lack of a traditional framework reduces rigidity and the support of occlusal rests. This clinical report describes a combination of a nylon PRDP (polyamide denture base resin) and a traditional PRDP (framework/resin) for a Kennedy Class II, Modification 1, partially edentulous mandible. (J Prosthet Dent 2013;109:5-8)

The nylon partial removable dental prosthesis (PRDP), which has no metal framework or retentive metal clasp and which provides patients with improved esthetics[1] and improved comfort, was first described in 1955.[2] In addition, polyamide denture base resin is thought to offer some advantages for those patients who are allergic to heat-polymerized poly(methyl methacrylate) (PMMA) resin.[3] Unfortunately, the nylon PRDP lacks important elements of the traditional PRDP, in particular, occlusal rests and a rigid framework. Therefore, the reinforcement of a denture base fabricated from a polyamide denture base resin is recommended.[4]

The major connector provides the traditional PRDP with sufficient rigidity, and support is provided by rests and the residual ridge.[1,4] However, the visibility of the retentive arm sometimes causes a cosmetic problem for patients. For these patients, an attachment may be considered, but the need for a crown prosthesis, possible endodontic treatment, additional chair time, and postinsertion care may make such an option financially unacceptable.[1]

A combination of the nylon and traditional PRDP could enhance the removable prosthesis and benefit patients in terms of esthetics and reduced cost. A nylon PRDP could be an easy and inexpensive way to improve the esthetics of a traditional PRDP by replacing the anterior retentive clasp with nylon clasps as part of the anterior flange. This clinical report describes the essentials of the design of a combined nylon and traditional PRDPs.

CLINICAL REPORT

A 61-year-old Asian woman was seen at the Department of Prosthodontics, Nihon University School of Dentistry at Matsudo, Chiba, Japan for a comprehensive examination in April 2006. The patient was treated in the following manner. The second maxillary right molar, first maxillary left premolar, second left mandibular molar, and second left mandibular premolar were extracted. Endodontic therapy of the right and left maxillary canine and the second and maxillary left premolar was performed. A maxillary partial fixed dental prosthesis and a mandibular traditional PRDP were fabricated.

The patient's dental treatment was completed in November 2007, and periodontal supportive therapy was performed approximately every 3 to 4 months. The patient returned in June 2008 complaining that the mandibular right partial fixed dental prosthesis spanning the right mandibular first premolar and right mandibular second molar had fractured. The patient also requested the fabrication of a nylon PRDP instead of a fixed prosthesis. She had worn the traditional PRDP for 2 years and disliked the metal clasps that were visible when she smiled. However, the patient was satisfied with the labial esthetics and was not concerned about the visibility of the mandibular metal occlusal rests. In November 2008, the maxillary left lateral incisor was extracted because of a root fracture, and a maxillary traditional PRDP was fabricated.

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Experimental Research

Dentistry Section

Comparative Evaluation of Sorption, Solubility and Microhardness of Heat Cure Polymethylmethacrylate Denture Base Resin & Flexible Denture Base Resin

JAY SHAH, NILESH BULBULE, SHILPA KULKARNI, RIDDHI SHAH, DILIP KAKADE

ABSTRACT

Aim: The aim of the study was to evaluate and compare sorption, solubility and microhardness of heat cure polymethylmethacrylate (PMMA) denture base resin and flexible (thermoplastic polyamide nylon) denture base resin.

Materials and Methods: Sorption, solubility and microhardness were assessed to determine compliance with ADA Specification no. 12. Results were assessed using statistical and observational analyses.

Result: All materials satisfied ADA requirements for sorption, solubility and microhardness. Heat cure PMMA showed more sorption, solubility and microhardness than flexible (thermoplastic polyamide nylon).

Conclusion: Flexible (thermoplastic polyamide nylon) resin absorbs less water, is less soluble and is more flexible than PMMA.

Keywords: Microhardness, PMMA, Sorption, Solubility

INTRODUCTION

According to the Glossary of Prosthodontic terms "Complete denture is defined as a removable dental prosthesis that replaces the entire dentition and associated structures of maxilla and mandible [1]."

Some of the requirements of a clinically acceptable denture base material are biocompatibility, strength, durability, satisfactory thermal properties, chemical stability, colour stability, ease of fabrication, repair and moderate cost [2]. An additional requirement that would benefit both the clinician and the patient is a denture base material that has a soft tissue fitting surface and a hard occlusal surface so that tissue health is maintained along with an uncompromised masticatory efficiency.

Acrylic resins were introduced in 1936 as denture base materials. Amongst their characteristics, are easy handling, good thermal conductivity, low permeability to oral fluids and colour stability [3]. Dimensional stability being a critical factor for the retention and stability of prostheses, polymerisation shrinkage is the greatest disadvantage of this material. Factors like water sorption by the acrylic resin, resilience of the gingival mucosa and the action of saliva may compensate this effect. Hypersensitivity and mucosal irritation caused by the release of methylmethacrylate are not unknown. Another problem encountered while providing acrylic prosthesis is the limitation of strength and design in meeting the functional demands of the oral cavity [4].

Flexible resins were initially developed for the construction of provisional prosthesis such as immediate RPD's. They are indicated for the construction of RPD's, mainly for anterior retention where esthetics is required. This is because of its translucency and a natural appearance without laboratorial characterization. Furthermore, the flexibility of these materials prevents prosthesis from getting fractured. It also adds to patient comfort as it is light by weight [5].

Although the related literature shows the properties of these materials in terms of deformation and retention, there is a lack of information about sorption, solubility & microhardness [3]. Therefore, the purpose of the present in-vitro study is to evaluate and compare the sorption, solubility and microhardness of flexible (thermoplastic polyamide nylon) and heat cure polymethyl methacrylate denture base resin.

MATERIALS AND METHODS

Flexible (thermoplastic polyamide nylon) and heat cure PMMA denture base resin were included in this investigation. Manufacturers' recommendations were used in fabrication and recovery of all the specimens. Established testing protocols were employed when available, and are identified in the following sections. All instruments and devices used in this investigation were calibrated and monitored in accordance with manufacturers' recommendations.

SORPTION AND SOLUBILITY

In compliance with ADA Specification No. 12, two specimens of each denture base material were fabricated for sorption, solubility, and microhardness testing. Individual specimens were 50 mm x 0.5 mm in thickness for sorption and solubility & 65 mm x 10 mm x 2.5 mm for microhardness [Table/Fig-1-4]. Standard tests of sorption, solubility, and microhardness were performed in accordance with ADA Specification No. 12.

Sorption testing was accomplished by creating ten disks using each material. Disks were 50 ± 1 mm in diameter and 0.8 ± 0.1 mm thick. Subsequently, the thickness of each disk was reduced to 0.5 ± 0.05 mm using abrasive papers in successive grits of 120, 240, 400, and 600. Grinding was performed to ensure that the surfaces of these disks were flat and parallel. Abrasive papers were flooded with water throughout the grinding procedures.

Upon completion of grinding procedures, disks were dried in a desiccator containing anhydrous calcium sulfate at 37 ± 2°C

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Original article

Effect of buccal part designs of polyamide resin partial removable dental prosthesis on retentive force☆,☆☆

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Abstract

Purpose: To indentify buccal design criteria for retainer on polyamide resin removable partial dentures.
Methods: A left upper distal extension model was used for this study. Undercut was given on the buccal side of first and second premolars. Four different retainer designs were created. Undercuts of 0.5 and 0.75 mm were used. All 4 retainer designs started from distal surface of second premolar. The retainer extended to Design 1: covering to the mesial surface of second premolar; Design 2: covering to the distal surface of first premolar; Design 3: covering to the mesial surface of first premolar; and Design 4: covering to the distal surface of canine. For the 0.75 mm undercut experiment, only Design 1 and Design 3 were used. Each experimental denture was pulled and the force maximum required to remove the denture measured.
Results: On 0.5 mm undercut, no significant difference was found between Designs 1 and 2 or between Designs 3 and 4. Significant differences were found between all other combinations, however. On 0.75 mm undercut, a significant difference was found between the two.
Conclusion: The retentive force of a design for the buccal part of retainers in polyamide resin using large undercut was more effective than that of a design covering to the anterior abutment tooth.

Keywords: Polyamide resin; Retentive force; Retainer; Partial removable dental prosthesis

1. Introduction

Polyamide resin began to garner attention as a polymer material for dentures in the past years. It did not come into common usage as a material for dentures, however, as it is a water absorbent polymer, meaning humidity control during molding is complicated, it has a high processing temperature, and special molding apparatus with meticulous temperature control is required. It has been used clinically in dentures in recent years though, since development of polyamide resin copolymers, combining polyamide with other polymers [1], has led to improvements in water absorption properties, as well as in molding methods.

In bilateral removable partial dentures, the denture base is connected on both sides and with the indirect retainer to prevent rotation of the denture base, which is important for increasing the load bearing ability of underlying mucosa and reducing rotational forces on the abutment teeth. The connector must therefore have sufficient mechanical strength [2–6]. Polyamide resin, however, has a low elastic modulus [7], so does not possess sufficient mechanical strength to be used as a connector.

On the other hand, polyamide resin can offer advantages for some patients since it can be used for patients allergic to PMMA resin [8]; does not use metallic clasps; is esthetically pleasing; feels comfortable for the wearer since it is thin; and does not fracture easily [9].

The above points show that for the denture to maintain mechanical strength, it is preferable for polyamide resin to be used only for the denture base and the buccal part of the retainer and for metal to be used for the connector, rest, and lingual arm. However, the shape of the polyamide resin retainer is usually designed only based on experience. The design criteria of polyamide resin retainer different from a usual clasp will be

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Position paper

Clinical application of removable partial dentures using thermoplastic resin. Part II: Material properties and clinical features of non-metal clasp dentures

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Denture base materials: From past to future

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Abstract

There is evidence that Dentistry was practised as far back as 3000 B.C. in Egypt. Dentures are believed to have surfaced as a mode of treatment for replacing missing teeth around 700 B.C. Thereafter, a process began towards improvement in the quality of materials used for fabricating dentures, as the patients demanded better aesthetics, function and comfort. This review tracks the history of materials used as a denture base to the present stage and points towards the areas of research and development in the future.

Keywords

Denture base material, Vulcanite, Acrylic resin, Methyl methacrylate, Flexible denture, Fibre-reinforced resin

Dentistry as a speciality is believed to have begun about 3000 BC. Egypt was the medical centre of ancient world. The first dental prosthesis was believed to have been constructed in Egypt about 2500 BC. Skilfully designed dentures were made as early as 700 BC. During medieval times, dentures were seldom considered as a treatment option. They were hand carved and tied in place with silk threads and had to be removed before eating.

WOOD:

For years, dentures were designed from wood because it was readily available, relatively inexpensive and could be carved to desired shape. However, it warped and cracked in moisture, lacked aesthetics and got degraded in the oral environment.

BONE:

Dentures made from bone became very popular due to its availability, reasonable cost and carvability. It is reported that Fauchard fabricated dentures by measuring individual arches with a compass and cutting bone to fit the arches. It had better dimensional stability than wood, however, esthetic and hygienic concerns remained.

IVORY:

Ivory denture bases and prosthetic teeth were fashioned by carving this material to desired shape. These were relatively stable in the oral environment, offered esthetic and hygienic advantages compared to wood or bone. However, ivory was not readily available and was relatively expensive.

PORCELAIN:

Alexis Duchateau (1774) was the first to fabricate porcelain dentures. In 1788 AD, a French dentist, Nicholas Dubois de Chemant, made a baked-porcelain complete denture in a single block. The advantages were that it could be shaped easily, ensured intimate contact with the underlying tissues, was stable, had minimal water sorption, smooth surfaces after glazing, less porosity, low solubility and could be tinted but its drawbacks were brittleness and difficulty in grinding and polishing. Loomis (1854), Charles H Land (1890) and Alexander Gutowski (1962) experimented with different types of porcelain dentures.

GOLD:

In 1794 AD, John Greenwood began to swage gold bases for dentures. He also made dentures for George Washington. Usually 18 to 20 carat gold was alloyed with silver and teeth were riveted to it.

VULCANITE DENTURES:

Charles Goodyear, in 1839, discovered the process of dry-heat vulcanization of rubber by heating caoutchouc, sulphur and white lead together. In 1851, Goodyear used this technique to produce a highly cross-linked hard rubber named Vulcanite after the Roman god. The fit of these vulcanite bases allowed self retaining dentures, making earlier spring type dentures obsolete. These were the first functional, durable and affordable dentures, marking a great

Prosthodontics

Effect of accelerated aging on the microhardness and color stability of flexible resins for dentures

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Abstract: Acrylic resins have been widely used due to their acceptable esthetics and desirable characteristics such as easy handling, good thermal conductivity, low permeability to oral fluids and color stability. Flexible resins were introduced on the market as an alternative to the use of conventional acrylic resins in the construction of complete and partial removable dentures. Although these resins present advantages in terms of esthetics and comfort, studies assessing chromatic and microhardness alterations of these materials are still scarce in the related literature. The aim of this study was to evaluate the chromatic and microhardness alterations of two commercial brands of flexible resins in comparison to the conventional resin Triplex when submitted to accelerated aging. The resins were manipulated according to manufacturers' instructions and inserted into a silicone matrix to obtain 21 specimens divided into 3 groups: Triplex, Ppflex and Valplast. Triplex presented the highest microhardness value ($p < 0.05$) for all the aging periods, which was significantly different from that of the other resins, followed by the values of Valplast and Ppflex. Comparison between the flexible resins (Ppflex and Valplast) revealed a statistically significant difference ($p < 0.05$) as regards color. The flexible resin Ppflex and the conventional resin Triplex presented no statistically significant difference ($p < 0.05$) as regards aging. The accelerated aging significantly increased the microhardness values of the resins, with the highest values being observed for Triplex. Valplast presented the greatest chromatic alteration after accelerated aging.

Descriptors: Hardness; Color; Acrylic resins.

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Introduction

Acrylic resins were introduced in 1936 as an alternative to vulcanized rubber and have been used to construct the bases of complete and partial removable dentures. Among their characteristics are easy handling, good thermal conductivity, low permeability to oral fluids and color stability.[1]

However, polymerization shrinkage is the greatest disadvantage[1] of this material. Dimensional alteration is a critical factor for the retention and stability of prostheses,[2] although some factors may compensate this effect, including water absorption by the acrylic resin,[3] resilience of the gingival mucosa and the action of saliva.[4]

An increased awareness of esthetics in dentistry has led to the need for removable partial dentures (RPDs) that reveal little or none of the

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Color stability, water sorption and cytotoxicity of thermoplastic acrylic resin for non metal clasp denture

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PURPOSE. The aim of this study was to compare the color stability, water sorption and cytotoxicity of thermoplastic acrylic resin for the non-metal clasp dentures to those of thermoplastic polyamide and conventional heat-polymerized denture base resins. **MATERIALS AND METHODS.** Three types of denture base resin, which are conventional heat-polymerized acrylic resin (Paladent 20), thermoplastic polyamide resin (Bio Tone), thermoplastic acrylic resin (Acrytone) were used as materials for this study. One hundred five specimens were fabricated. For the color stability test, specimens were immersed in the coffee and green tee for 1 and 8 weeks. Color change was measured by spectrometer. Water sorption was tested after 1 and 8 weeks immersion in the water. For the test of cytotoxicity, cell viability assay was measured and cell attachment was analyzed by FE-SEM. **RESULTS.** All types of denture base resin showed color changes after 1 and 8 weeks immersion. However, there was no significant difference between denture base resins. All specimens showed significant color changes in the coffee than green tee. In water sorption test, thermoplastic acrylic resin showed lower values than conventional heat-polymerized acrylic resin and thermoplastic polyamide resin. Three types of denture base showed low cytotoxicity in cell viability assay. Thermoplastic acrylic resin showed the similar cell attachment but more stable attachment than conventional heat-polymerized acrylic resin. **CONCLUSION.** Thermoplastic acrylic resin for the non-metal clasp denture showed acceptable color stability, water sorption and cytotoxicity. To verify the long stability in the mouth, additional *in vitro* studies are needed. ***[J Adv Prosthodont 2015;7:278-87]***

KEY WORDS: Denture base; Color stability; Water sorption; Cytotoxicity

INTRODUCTION

As patient expectations about cosmetic dentistry have been increasing, dissatisfaction among patients with removable partial dentures is also rising because of the unpleasant appearance of metal frameworks, especially with regard to the exposure of a metal clasp. In response to this trend, the non-metal clasp denture was introduced as an alternative in which the clasp is fabricated with a thermoplastic polymer instead of the conventional heat-polymerized polymethylmethacrylate (PMMA) resin.

Non-metal clasp dentures are made of elastic denture base resins instead of conventional metals, and they have the following advantages: enhanced esthetic appeal, no metal-induced allergic reactions, no need for additional prosthodontic treatment or tooth reduction, and reduced chair time.[1] Because of such esthetic and clinical benefits, they are preferred for the cases of anterior partial denture, growing patients, temporary dentures after implant surgery,

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AMERICAN COLLEGE OF PROSTHODONTISTS

Effect of Reinforcement on the Flexural Properties of Injection-Molded Thermoplastic Denture Base Resins

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Keywords
Polyamide; polyester; polycarbonate; fiber-reinforced composite.

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Abstract

Purpose: To evaluate the effect of reinforcement on the flexural properties of injection-molded thermoplastic denture base resins.
Materials and Methods: Three injection-molded thermoplastic denture base resins (polyamide, polyester, polycarbonate) were selected for this study, and a conventional heat-polymerized denture base resin (PMMA) was used as a control. Continuous unidirectional glass fiber-reinforced composite (FRC) and metal wire were used for reinforcement. Reinforced bar-shaped specimens (65 mm long, 10 mm wide, 3.3 mm high) were fabricated ($n = 10$). The flexural strength at the proportional limit (FS-PL) and the elastic modulus were measured using a three-point bending test.
Results: All the denture base material specimens reinforced with FRC possessed a significantly higher FS-PL compared to those without reinforcement. The FS-PL of the polycarbonate specimens reinforced with metal wire was significantly higher than that without reinforcement, and there was no significant difference in the FS-PL between the polycarbonate specimens reinforced with FRC and those with metal wire. The order of the elastic modulus according to the denture base material, arranged in terms of statistical significance, was as follows: PMMA (3.46 ± 0.53 GPa) > polycarbonate (2.69 ± 0.48 GPa) > polyester (2.00 ± 0.39 GPa) > polyamide (1.14 ± 0.35 GPa). The order of the elastic modulus according to the reinforcement, arranged in terms of statistical significance, was as follows: metal wire (2.74 ± 0.96 GPa) > FRC (2.40 ± 0.89 GPa) > no reinforcement (1.82 ± 0.83 GPa).
Conclusion: Continuous unidirectional glass fiber-reinforced composite (FRC) reinforcement had a satisfactory reinforcing effect for the injection-molded thermoplastic denture base resins.

A removable partial denture (RPD) includes components that prevent displacement of the prosthesis from the patient's mouth during function. In general, there are two types of direct retainers: intracoronal direct retainers and extracoronal direct retainers. Retentive metal clasp assemblies represent the most common method for extracoronal direct retention.[1] Generally, a metal clasp is used to retain and stabilize an RPD.[2] However, the location of the metal clasps may affect the esthetics, for example, the view of the anterior and premolar teeth region. Recently, an RPD without metal clasps has been used in dental practice.[3-5] The entire structure of the denture, except for the artificial teeth, was made from a denture base resin and was integrated. The clinical purpose of this prosthesis is that problems resulting from the metal clasps, such as poor esthetics and metal allergies, can be eliminated.[5,6] The prosthesis is retained at the undercuts of the abutment teeth using retentive arms made from denture base resin, and the retentive arms are deflected during the insertion and removal of the denture. Injection-molded thermoplastic resins are used for RPDs without metal clasps because these thermoplastic resins have a higher elasticity compared to a conventional heat-polymerized denture base resin (PMMA). The flexibility of the injection-molded thermoplastic resin is important because it affects the ease of insertion and removal of the RPD without metal clasps as well as its retention and the stress to the abutment teeth.[7,8] Nevertheless, since a denture base is placed on the soft tissue and underlying hard tissue, it is preferable for the denture base to remain stiff and undergo little deflection during chewing.[7]

Injection-molded thermoplastic resins for denture base material have been investigated, and the flexural properties of injection-molded thermoplastic denture base resins studied.[7-13] Previous studies[7,8,12] found that injection-molded thermoplastic denture base resins had a significantly lower elastic modulus and a significantly lower flexural strength at the proportional limit (FS-PL), compared with conventional heat-polymerized acrylic denture base resin (PMMA). These properties mean that injection-molded thermoplastic denture base resins are flexible and weak compared to PMMA. Flexible materials are

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ORIGINAL ARTICLE

Mechanical properties of injection-molded thermoplastic denture base resins

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Abstract
Objective. To investigate the mechanical properties of injection-molded thermoplastic denture base resins. ***Material and methods.*** Four injection-molded thermoplastic resins (two polyamides, one polyethylene terephthalate, one polycarbonate) and, as a control, a conventional heat-polymerized polymethyl methacrylate (PMMA), were used in this study. The flexural strength at the proportional limit (FS-PL), the elastic modulus, and the Charpy impact strength of the denture base resins were measured according to International Organization for Standardization (ISO) 1567 and ISO 1567:1999/Amd 1:2003. ***Results.*** The descending order of the FS-PL was: conventional PMMA > polyethylene terephthalate, polycarbonate > two polyamides. The descending order of the elastic moduli was: conventional PMMA > polycarbonate > polyethylene terephthalate > two polyamides. The descending order of the Charpy impact strength was: polyamide (Nylon PACM12) > polycarbonate > polyamide (Nylon 12), polyethylene terephthalate > conventional PMMA. ***Conclusions.*** All of the injection-molded thermoplastic resins had significantly lower FS-PL, lower elastic moduli, and higher or similar impact strength compared to the conventional PMMA. The polyamide denture base resins had low FS-PL and low elastic moduli; one of them possessed very high impact strength, and the other had low impact strength. The polyethylene terephthalate denture base resin showed a moderately high FS-PL, moderate elastic modulus, and low impact strength. The polycarbonate denture base resin had a moderately high FS-PL, moderately high elastic modulus, and moderate impact strength.

Key Words: *Injection-molded thermoplastic denture base resin, mechanical properties, polyamide, polycarbonate polyethylene terephthalate*

Introduction

A removable partial denture (RPD) without metal clasps has recently been used in dental practice [1,2]. The clinical purpose of such an RPD without metal clasps is that problems relating to the clasps, such as poor esthetics and metal allergies, can be eliminated [3]. Injection-molded thermoplastic resins (polyamides, polyethylene terephthalate, and polycarbonate) are used for denture bases of RPDs without metal clasps because of their advantageous characteristics, such as a higher elasticity than heat-polymerizing base resins, and the fact that they can facilitate denture retention by utilizing the undercuts of abutment teeth in the denture base design [3]. Conventional RPDs are commonly retained at the undercuts of the abutment teeth using metal clasps; the undercut value is 0.25–0.75 mm [4]. Although the retentive clasp arm is deflected during the insertion and removal of an RPD, the denture base material is not deflected. Since a denture base is placed on the soft tissue and underlying hard tissue, it is preferable for the denture base to remain stiff and undergo little deflection during chewing. The flexibility of the retentive clasp arm may be influenced by the length, cross-sectional form, cross-sectional diameter, longitudinal taper, clasp curvature, and metallurgical characteristics of the alloy [5], and the undercut value depends on the metal clasp. However, an RPD without metal clasps is retained at the undercuts of the abutment teeth by means of the denture base. Therefore, the flexibility of the injection-molded thermoplastic resin affects the ease of insertion and removal of the RPD, its retention, and the stress transmitted to the abutment teeth.

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CLÍNICO | CLINICAL

Flexible resins: an esthetic option for partially edentulous patients

Resinas flexíveis: uma opção estética para desdentados parciais

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ABSTRACT

Flexible thermoplastic resins have been used as an alternative to partially edentulous patients for decades in the USA. However, they are neither popular nor widespread in Brazil. This material represents an excellent treatment option to solve clinical problems such as compromised esthetics caused by visible metal clasps, and fall fracture of dentures made of conventional resins. Additionally, there is little researching and no controlled clinical studies about the use of flexible resins in prosthodontics. For these reasons, this study presents a case report of a dissatisfied patient treated with a conventional removable partial denture, which was replaced by a modified metal framework without metal clasps in combination with flexible resin, and a literature review about this material focusing on the dental practitioner. The study also reports how these polymers can be used, their indications, and their clinical and laboratory considerations.

Indexing terms: *Acetates. Denture, removable partial. Nylons.*

RESUMO

As resinas termoplásticas flexíveis têm sido uma alternativa para tratamento de pacientes parcialmente desdentados disponível há décadas nos EUA. No Brasil, no entanto, ainda são pouco utilizadas e conhecidas. Este material pode representar uma excelente opção de tratamento reabilitador, para solucionar problemas tais como o aparecimento de grampos metálicos com comprometimento da estética e fratura de próteses confeccionadas com resinas convencionais devido a quedas. Além disso, pesquisas acerca desse material são escassas e não há estudos clínicos de sua utilização na área de prótese dentária na literatura. Por essas razões, este estudo apresenta um caso clínico de uma paciente insatisfeita tratada com prótese removível convencional, a qual foi substituída por uma estrutura metálica modificada sem grampos em combinação com resina, e uma revisão da literatura, com o objetivo de elaborar um apanhado de informações para o clínico sobre estes materiais, além de apresentar como estes polímeros podem ser utilizados, as suas indicações em prótese parcial removível, suas considerações clínicas e laboratoriais.

Termos de indexação: Acetatos. Prótese parcial removível. Nylons.

INTRODUCTION

Prosthetic rehabilitation should be able to recover patients' function and esthetics. However, conventional removable partial dentures (RPDs) are fabricated on a metal framework that uses clasps for retention. The clasps are usually visible when the patient smiles. These visible components occasionally cause dissatisfaction, leading patients to reject treatment[1] because of how they attribute maximum importance of their smile to their self-esteem and to their personal, social, and professional relationships[2].

Some resources are available for promoting better esthetics, such as attachment-retained removable partial dentures. However, this type of treatment has higher biological and financial costs since abutment teeth need to be prepared to receive fixed partial dentures[1]. Another esthetic solution is the rotational path removable partial denture, which can have excellent results but its indication is very limited and fabrication technique very sensitive[3]. Careful planning of removable partial dentures, such as the use of the distal surfaces for retention and bar clasps instead of circumferential clasps[4], can yield better esthetic results. A favorable esthetic result can also be reached by changing the design of the metal structure by using a lingual retentive arm and leaving the labial side metal free[5]. This requires the fabrication of a plane guide on the free proximal surface of the abutment tooth such that this plane, parallel to the insertion axis of the denture, receives a proximal plate, which has a reciprocity function[1,5] originally performed by the reciprocal arm. Despite all these resources, sometimes it is not possible to provide good esthetics, usually leaving the metal used for the framework visible[6].

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Evaluation of adhesion of reline resins to the thermoplastic denture base resin for non-metal clasp denture

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This study aimed to evaluate the tensile and transverse bond strength of chairside reline resins (Tokuyama Rebase II, Mild Rebaron LC) to a thermoplastic acrylic resin (Acrytone) used for non metal clasp denture. The results were compared with those of a conventional heat polymerized acrylic resin (Paladent 20) and a thermoplastic polyamide resin (Bioton). The failure sites were examined by scanning electron microscopy to evaluate the mode of failure. As results, the bond strength of reline resins to a thermoplastic acrylic resin was similar to the value of a conventional heat polymerized acrylic resin. However, thermoplastic polyamide resin showed the lowest value. The results of this study indicated that a thermoplastic acrylic resin for non metal clasps denture allows chairside reline and repair. It was also found that the light-polymerized reline resin had better bond strength than the autopolymerizing reline resin in relining for a conventional heat polymerized acrylic resin and a thermoplastic acrylic resin.

Keywords: Non metal clasp denture, Thermoplastic acrylic resin, Chairside relining, Bond strength

INTRODUCTION

Increased esthetic expectations in dentistry have led to the need for removable partial dentures that expose little or none of the metal supporting structures or retentive clasps. For this reason, non-metal clasp dentures using thermoplastic resins have become alternative treatment options[1,2].

Various types of thermoplastic resin for non metal clasp denture have been introduced.

In the 1950s, the use of nylon polymer as a denture base material has been described in the literatures. Nylon is a generic name for certain types of thermoplastic polymer belonging to a class of polyamide[3,4]. These polyamide resins have advantages of higher elasticity and higher molding precision than conventional heat polymerizing resins[5-7]. Since they have inherent flexibility, these materials prevent prosthesis fractures and facilitate denture retention by utilizing the undercuts of abutment tooth in the denture base design without metal clasps[8].

However, some disadvantages reported in the early form of polyamide resins included high water sorption, discoloration and difficulties in reline and repair[1,2].

Existing removable partial denture often requires denture base relines to improve their fitness to the supporting tissue because of gradual changes in edentulous ridges[9,10]. Successful denture relining depends on the bonding strength between reline resin and denture base resin. Therefore, adequate bonding strength to reline resin is very important factor in the selection of denture base resin[11]. To compensate the relining problem with polyamide resin, new non-metal denture base materials are still being developed.

Acrytone (High-Dental-Japan, Osaka, Japan) is a newly introduced thermoplastic acrylic resin in order to maintain advantages, and overcome the shortcomings of conventional heat polymerized acrylic resins and existing thermoplastic resins. According to the manufacturer, it is available for non-metal clasp dentures due to the elastic characteristics, and relining is possible because it is composed of polymethyl methacrylate (PMMA).

The physical characteristics such as flexural strength and modulus of elasticity of Acrytone were reported[12], but the studies on the bond strength of reline resins to Acrytone are insufficient.

Even though the bonding strength between reline resins and Acrytone has never been clearly investigated, some practitioners have already begun using them based on their preference and clinical experiences.

The purpose of this *in vitro* study was to investigate the bond strength of two relining resins bonded to Acrytone, and the results were compared with those of a heat-polymerized acrylic resin and a thermoplastic polyamide resin. In addition, the nature of the fracture surfaces was evaluated. The hypotheses of this study were that the bond strength of reline resins to Acrytone would be different with those of a heat-polymerized acrylic resin and a thermoplastic polyamide resin, and that the type of reline resin may affect the bond strength.

MATERIALS AND METHODS

Three denture base resins and two chairside hard reline resins were selected for the study (Table 1). The denture base resins were a conventional heat-polymerized acrylic resin (Paladent 20; PAL20), a thermoplastic

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A Review: Flexible Removable Partial Dentures

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Abstract: *In an era of implants and fixed prosthesis, removable partial dentures are still a treatment of choice for a wide range of patients and clinicians. As every other treatment option, removable prosthesis also has some disadvantages. But with introduction of flexible partial dentures, many of the disadvantages of conventional acrylic and cast partial dentures are taken care of. This article discusses about the material used in fabrication, indications and compares the flexible partial dentures with other removable partial denture options along with design and insertion technique of the flexible removable partial dentures.*

I. Introduction:

The choice between several treatment options for replacing missing teeth is influenced by clinical, dentist- and patient-immanent factors. Replacement of missing teeth is one of the most important needs for patients attending clinics to restore esthetics and/or function. Many treatment modalities are available for replacing missing teeth; removable partial denture, fixed partial denture or dental implant. Each modality is a possible treatment option and has its own advantages and disadvantages.

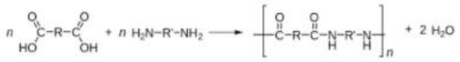
Removable partial dentures became popular many decades ago with the introduction of acrylic polymers and chrome cobalt alloys in dentistry. Many patients choose removable partial dentures due to factors ranging from cost to psychology.

Dr. Walter Wright (1937) introduced Polymethyl methacrylate as a denture base material which became the major polymer to be used. Since ages, polymethyl methacrylate (PMMA) has been used to fabricate the dentures. Metal cast / metal frame / metal base dentures are also fabricated to restore the defects. Some of the problems with acrylic are difficult to address, such as insertion in undercut areas, brittleness of methyl methacrylate which leads to fracture, and allergy to methyl methacrylate monomer. In the recent times flexible removable partial dentures have become quite popular. Though search for the ideal option is still on, here is a review of viable option for replacing missing teeth known as flexible dentures.

II. Material And Its Properties:

Thermoplastic resins are used for the fabrication of flexible dentures.A **thermoplastic** is a plastic which becomes pliable or moldable above a specific temperature and returns to a solid state upon cooling. There are different kind of thermoplastic resins available like-

- thermoplastic acetal
- thermoplastic polycarbonate
- thermoplastic acrylic
- thermoplastic nylon
- Because of inherent flexibility of thermoplastic nylon, it is used primarily for flexible tissue borne partial dentures. Chemically, nylons are condensation copolymers formed by reacting equal parts of a diamine and a dicarboxylic acid. Chemical elements included are carbon, hydrogen, nitrogen, and oxygen. The chemical polymerisation reaction is as below:



Nylon is a versatile material with characteristics like high physical strength, heat resistance and chemical resistance. It can be easily modified to increase stiffness and wear resistance. Because of its excellent balance of strength, ductility and heat resistance, nylon is the most suitable material available for flexible RPDs. The specific gravity of nylon is 1.14. The tensile strength is 11000 psi and the flexural strength is 16000 psi.[1] When compared with PMMA, valplast (the most commonly used thermoplastic nylon) has higher transverse strength (117.22 ± 37.80 MPa) as well as impact strength (0.76 ± 0.03 kN).[2]

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Original Article

Comparative clinical evaluation of removable partial dentures made of two different materials in Kennedy Applegate class II partially edentulous situation

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ABSTRACT

Background: Cast Chromium Cobalt alloy has been the material of choice for fabricating Removable Partial Dentures (RPDs) but has certain drawbacks. Newer materials like the flexible Nylon based Super Polyamide have been introduced to overcome these drawbacks. The present study has compared the above two materials for nine clinical parameters.

Method: The study was carried out on 30 patients presenting with a Kennedy Applegate class II partially edentulous situation who were divided into two equal groups and clinically assessed.

Result: Statistically significant results were obtained in favor of flexible RPDs, in the parameters of 'aesthetics' and 'overall patient satisfaction'. Both groups showed more or less similar values for 'frequency of fracture of the prosthesis during usage' with the incidence being slightly higher for patients wearing the cast RPDs. The clinical parameters of 'oral soft tissue tolerance', 'gingival health', 'periodontal health' and 'adaptability in areas with undercut' were statistically at par for all the 30 patients thus suggesting the comparable biocompatibility of the two materials. The highlight of this study was the relative ease in fabrication of the flexible RPDs as compared to the cast RPDs.

Conclusion: Based on the favorable clinical results of this study, it can be summarized that the flexible RPDs is a viable alternative to cast RPDs in Kennedy Applegate class II partially edentulous situation in the short term.

Introduction

Removable Partial Dentures (RPDs) are provided to restore facial form and masticatory function after tooth loss. Chromium–Cobalt (Cr–Co) alloy has been traditionally used as the material of choice in the fabrication of definitive cast RPDs, since 1929.[1] However, in the Kennedy Applegate class II partially edentulous condition, the use of metal alloys together with the design considerations pose unique challenges to the esthetic and biological acceptance of the restoration.[2]

In this clinical situation, the conventional circumferential clasp design along with the distal occlusal rest, instead of transferring the forces along the long axis of the terminal abutment, causes torquing which intensifies as the ridge

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ORIGINAL ARTICLE

Shear bond strength of an autopolymerizing repair resin to injection-molded thermoplastic denture base resins

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Abstract

Objective. This study investigated the shear bond strength of an autopolymerizing repair resin to injection-molded thermoplastic denture base resins. ***Materials and methods.*** Four injection-molded thermoplastic resins (two polyamides, a polyethylene terephthalate copolymer and a polycarbonate) were used in this study. The specimens were divided into eight groups according to the type of surface treatment given: (1) no treatment, (2) air abrasion with alumina, (3) dichloromethane, (4) ethyl acetate, (5) 4-META/MMA-TBB resin, (6) alumina and 4-META/MMA-TBB resin, (7) tribochemical silica coating or (8) tribochemical silica coating and 4-META/MMA-TBB resin. Half of the specimens in groups 1, 5, 6 and 8 were thermocycled for 10,000 cycles in water between 5–55°C with a dwell time of 1 min at each temperature. The shear bond strengths were determined. ***Results.*** The shear bond strengths to the two polyamides treated with alumina, dichloromethane and ethyl acetate and no treatment were very low. The greatest post-thermocycling bond strengths to polyamides were recorded for the specimens treated with tribochemical silica coating and 4-META/MMA-TBB resin (PA12: 16.4 MPa, PACM12: 17.5 MPa). The greatest post-thermocycling bond strengths to polyethylene terephthalate copolymer and polycarbonate were recorded for the treatment with alumina and 4-META/MMA-TBB resin (22.7 MPa, 20.8 MPa). ***Conclusion.*** Polyamide was exceedingly difficult to bond to an autopolymerizing repair resin; the shear bond strength improved using tribochemical silica coating followed by the application of 4-META/MMA-TBB resin. Both polyethylene terephthalate copolymer and polycarbonate were originally easy to bond to an autopolymerizing repair resin. However, with 4-META/MMA-TBB resin, the bond was more secure.

Key Words: *injection-molded thermoplastic denture base resin, polyamide, polyethylene terephthalate copolymer, polycarbonate, shear bond strength*

Introduction

In recent years, removable partial dentures (RPDs) without metal clasps have been used in dental practice [1,2] because the metal clasps of conventional RPDs have poor esthetics and metal allergies can occur in some situations [3]. RPDs without metal clasps have been made with injection-molded thermoplastic resins (polyamides, polyethylene terephthalate copolymer and polycarbonate) [4–6]. It was proved in our previous studies [5,6] that one kind of polyamide and of polycarbonate had high impact strengths, but the impact strengths decreased after thermocycling. Injection-molded thermoplastic resins with low impact strength may fracture due to impact force. It appears that RPDs without metal clasps fracture easily and fail due to the debonding of the denture teeth.

Autopolymerizing resin is often clinically used as a repair material for denture base resin made from PMMA. However, high bond strength between the denture base resin and autopolymerizing acrylic resin is not always predictable [7,8]. Surface treatments are necessary to enhance the bond between the denture base resin and the autopolymerizing repair resin. Many researchers have reported on the surface treatments used on acrylic resins [7–16], but little study has been done on bonding injection-molded thermoplastic resins to an autopolymerizing repair resin. Katsumata et al. [3] found that one kind of polyamide denture base polymer (PACM12) and an autopolymerizing repair resin did not bond to each other, but the surface treatment with a tribochemical silica coating system enhanced the bond strength. However, little attention has been focused on the effect of the

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Original article

Pressure transmission area and maximum pressure transmission of different thermoplastic resin denture base materials under impact load

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ABSTRACT

Purposes: The purposes of the present study were to examine the pressure transmission area and maximum pressure transmission of thermoplastic resin denture base materials under an impact load, and to evaluate the modulus of elasticity and nanohardness of thermoplastic resin denture base.

Methods: Three injection molded thermoplastic resin denture base materials [polycarbonate (Basis PC), ethylene propylene (Duraflex), and polyamide (Valplast)] and one conventional heat-polymerized acrylic resin (PMMA, SR Triplex Hot) denture base, all with a mandibular first molar acrylic resin denture tooth set in were evaluated (n = 6). Pressure transmission area and maximum pressure transmission of the specimens under an impact load were observed by using pressure-sensitive sheets. The modulus of elasticity and nanohardness of each denture base (n = 10) were measured on 15 × 15 × 15 × 3 mm³ specimen by using an ultramicroindentation system. The pressure transmission area, modulus of elasticity, and nanohardness data were statistically analyzed with 1-way ANOVA, followed by Tamhane or Tukey HSD post hoc test (α = .05). The maximum pressure transmission data were statistically analyzed with Kruskal–Wallis H test, followed by Mann–Whitney U test (α = .05).

Results: Polymethyl methacrylate showed significantly larger pressure transmission area and higher maximum pressure transmission than the other groups (P < .001). Significant differences were found in modulus of elasticity and nanohardness among the four types of denture bases (P < .001).

Conclusions: Pressure transmission area and maximum pressure transmission varied among the thermoplastic resin denture base materials. Differences in the modulus of elasticity and nanohardness of each type of denture base were demonstrated.

1. Introduction

The removable prosthesis is indicated to restore oral and masticatory function which leads to the improvement in the quality of life in edentulous patient [1]. The rate of being fully edentulous in several countries has declined but the reduction number expected from the anticipation will be offset by the increasing in adult population over than 55 years [2]. One of the significant aging problems found in most edentulous patients is residual ridge resorption, which contributes to the reduction in the height of alveolar bone and the size of the denture bearing area [3].

Residual ridge resorption is an irreversible, chronic, and progressive process that is observed in all edentulous patients [3]. The amount of bone resorption is subjected to interindividual and intraindividual variability. Prosthetic, metabolic, anatomic, and function are the possible factors responsible to the bone resorption [3,4]. Studies indicated that bone resorption increased when the high pressure was applied [5,6]. A 3.4 and 4.9 KPa continuous mechanical pressures exerted on molar region of hard palate via removable denture base was reported causing bone resorption in Wistar strain rats [5]. Moreover, it was also demonstrated that continuous compressive pressure ≥ 6.86 KPa or an intermittent compressive pressure ≥ 19.6 KPa caused the significant bone resorption in the same animal model [6]. Reducing the amount of force transferred to the residual ridges is considered as one of the goals in dental prosthesis fabrication. Appropriate denture tooth materials and cuspal angulation were demonstrated

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Case Report

FLEXIBLE DENTURE FOR PARTIALLY EDENTULOUS ARCHES - CASE REPORTS

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ABSTRACT

Conventional fixed partial dentures, implant supported Fixed Partial Dentures (FDPs) and removable partial dentures are the most common treatment modalities for the aesthetic and functional rehabilitation of partially edentulous patients. Hard and soft tissue undercuts are frequently encountered in the fabrication of prosthesis in partially as well as completely edentulous arches. Removable cast partial dentures are used as definitive removable prostheses when indicated, but location of clasps may affect aesthetics. So, when patient is concerned about aesthetics, flexible partial dentures which is aesthetically superior to flipper and cast partial dentures, may be considered. This article is an effort to review the various commercially available flexible denture base materials and highlights their indications and special instructions in wearing and maintenance of the same.

INTRODUCTION

Unilateral or bilateral undercuts are frequently encountered and may complicate successful fabrication of denture prosthesis. Management of these situations conventionally includes alteration of the denture prosthesis bearing area, adaptation of the denture base, careful planning of the path of insertion and the use of resilient lining material. An alternative denture prosthesis design in which optimal flange height and thickness can be achieved is by using flexible denture base material. It is nylon based thermoplastic material that does not sacrifice function and preserves aesthetics. Soft dentures are an excellent alternative to traditional hard-fitted dentures. Traditionally relining dentures with a soft base increases comfort at the cost of chewing efficiency. To make up for the loss of chewing efficiency, denture wearers would use dentures adhesive which causes its own problems. A flexible material is now an option that does not trade off the ability to eat (Maurice, 1964; Parvizi, 2004)

Flexible Dentures

Soft dentures are generally used when traditional dentures cause discomfort to the patient that cannot be solved through relining. Soft dentures are not the same as a soft reline for traditional dentures.

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Soft relines use a soft putty-like substance to separate gums from the hard acrylic in dentures. Flexible dentures use a special flexible resin that prevents them from chafing the gums, allows the wearer to chew properly. It also provides a soft base that prevents the gums from being rubbed. Some of the commercially available products are Valplast, Sunflex, Duraflex, Flexite, Proflex, Lucitone, Impak where as valplast, Sunflex and lucitone are monomer free.

VALPLAST

Valplast is a flexible denture base resin that is ideal for partial dentures and unilateral restorations. The resin is a biocompatible nylon thermoplastic with unique physical and aesthetic properties that provides unlimited design versatility and eliminates the concern about acrylic allergies. The Valplast Flexible Partial allows the restoration to adapt to the constant movement and flexibility in the mouth. The flexibility, combined with strength and light weight, provides total comfort and great looks. The preparation is relatively simple. The Valplast partial is virtually invisible because there are no metal clasps and the material itself blends with the tissue in mouth. While the cost is often higher than a partial made with visible metal clasps. The Valplast flexible partial involves only non-invasive procedures (Parvizi, 2004 and Stafford *et al.*, 1986).

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ORIGINAL ARTICLE

Effect of thermal shock on mechanical properties of injection-molded thermoplastic denture base resins

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Abstract
Objective. This study investigated the effect of thermal shock on the mechanical properties of injection-molded thermoplastic denture base resins. ***Materials and methods.*** Four thermoplastic resins (two polyamides, one polyethylene terephthalate, one polycarbonate) and, as a control, a conventional heat-polymerized polymethyl methacrylate (PMMA), were tested. Specimens of each denture base material were fabricated according to ISO 1567 and were either thermocycled or not thermocycled ($n = 10$). The flexural strength at the proportional limit (FS-PL), the elastic modulus and the Charpy impact strength of the denture base materials were estimated. ***Results.*** Thermocycling significantly decreased the FS-PL of one of the polyamides and the PMMA and it significantly increased the FS-PL of one of the polyamides. In addition, thermocycling significantly decreased the elastic modulus of one of the polyamides and significantly increased the elastic moduli of one of the polyamides, the polyethylene terephthalate, polycarbonate and PMMA. Thermocycling significantly decreased the impact strength of one of the polyamides and the polycarbonate. ***Conclusions.*** The mechanical properties of injection-molded thermoplastic denture base resins changed after thermocycling.

Key Words: *thermal shock, mechanical properties, thermoplastic denture base resin, thermocycling*

Introduction

Removable partial dentures (RPD) are retained at the undercuts of the abutment teeth using metal clasps. The retentive arm of the metal clasp is deflected during the insertion and removal of an RPD, but it is preferable for the denture base to remain stiff and undergo little deflection during chewing as the denture base is placed on the soft tissue. However, the metal clasps of anterior RPDs are not esthetic, nor can they be used for patients with allergies to metal. Recently, an RPD without metal clasps has been used in dental practice [1,2]; this type of RPD is retained at the undercuts of the abutment teeth using denture base resin. Injection-molded thermoplastic resins (polyamide, polyethylene terephthalate and polycarbonate) are used for RPD denture bases without metal clasps because these thermoplastic resins have a higher elasticity than heat-polymerizing base resin (PMMA). The flexibility of the injection-molded thermoplastic resin is important because it affects the ease of insertion and removal of the RPD, as well as its retention and the stress to the abutment teeth.

Although injection-molded thermoplastic resins for denture base material have been investigated [3–11], the mechanical properties of polyamide, polyethylene terephthalate and polycarbonate for denture base material have not been compared. In a previous study [12], the mechanical properties of injection-molded thermoplastic denture base resins (polyamides, polyethylene terephthalate and polycarbonate) were estimated. It was found that (1) all of the injection-molded thermoplastic resins had significantly lower flexural strength at the proportional limit (FS-PL), lower elastic modulus and higher or similar impact strength than the conventional heat-polymerized acrylic resin, (2) the polyamide thermoplastic resins had low FS-PL and low elastic modulus; one of them possessed very high impact strength and the other one had low impact strength, (3) the thermoplastic resin composed of polyethylene terephthalate had moderately high FS-PL, moderate elastic modulus and low impact strength and (4) the thermoplastic resin

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TEMPORARY FLEXIBLE REMOVABLE PARTIAL DENTURE: A CLINICAL REPORT

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ABSTRACT

Missing tooth replacement is a must and it becomes best if a denture patient wearing is comfortable. Innovation of flexible dentures, flexibility combined with strength and light weight provides total comfort and great looks. Features of these prostheses are good retention, aesthetically superb and virtually invisible, excellent strength, easy in handling, no involvement of metal, noninvasive procedures, comfort. All of these factors become important when producing long-term provisional prostheses during implant or complex restorative cases, or when used for permanent removable appliances. This case study presents that the patient with long missing dentition in upper anterior region can be temporary treated esthetically and comfortably with flexible removable partial dentures.

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Research Article

Physical Properties of Polyamide-12 versus PMMA Denture Base Material

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Objectives. Polyamide-12 (PA) is a flexible material suited for denture bases and clasping. This study investigated its potential aging effects with a focus on surface roughness, color stability, and elasticity. *Methods.* PA specimens (Valplast) of $40 \times 10 \times 2$ mm and equally measuring PMMA specimens (Palapress) as control were fabricated. Color changes after storage in air, water, coffee, and red wine ($n = 10$) were measured using the CIE $L^*a^*b^*$ color specification. Elasticity after thermocycling (1000, 3000, and 7000 cycles, $n = 15$) was measured by three-point bending testing. Mean surface roughness (Ra) was determined after storage in the liquids mentioned above and thermocycling ($n = 10$). *Results.* Tukey's HSD test ($P < 0.05$) revealed statistically significant color changes of PA in red wine ($\Delta E = 4.27$ after 12 days, $\Delta E = 6.90$ after 12 days) and coffee ($\Delta E = 3.93$ after 36 days) but no color changes in PMMA. Elastic modulus of PA was 845 MPa and not affected by thermocycling (Tukey's HSD test, $P > 0.81$). Dry specimens showed significantly decreased elasticity ($P < 0.001$). Mean surface roughness (PA 0.20 µm, PMMA 0.28 µm) did not change significantly after thermocycling or storage (Mann-Whitney U-test, $0.16 < P < 0.65$). *Significance.* PA exhibited a higher susceptibility to discoloration than PMMA. Neither surface roughness nor elasticity of PA was altered by artificial aging.

1. Introduction

Despite the progress in dental implant treatment, there is still need for conventional removable partial dentures. Edentalism in the developed countries is in decline, but the number of patients suffering from partial tooth loss continues to rise [1–4]. On the other hand, in countries ranked lower in economic development and welfare index the rates of edentulism remain high [5–9]. Thus it has to be expected that the need for cost effective removable partial dentures will remain substantial.

Polymethyl methacrylate (PMMA) is commonly used to fabricate removable dentures. PMMA shows sufficient material properties and ease of application [10]. However, an increasing rate of intolerance to monomers present in acrylic materials among patients and medical staff has been reported [11, 12]. Furthermore, the aesthetic appearance of removable partial dentures with PMMA bases may be compromised by the visibility of metal clasps. A feasible alternative to PMMA-based removable partial dentures may be the use of polyamide-12 [13]. The flexibility of polyamide-12 allows retentive elements that match the color of the gums or teeth. Partial dentures might be pressed in one piece including clasps, minor and major connectors, and denture bases [14]. However, these nonrigid denture designs are discussed controversially since flexible bases may cause higher displacement of soft tissue and their influence on ridge resorption is not yet fully understood [15]. A solution could be the integration of a metal framework providing rigid major connectors and occlusal rests (Figures 1, 2, and 3).

Shortcomings of polyamide-12 discussed comprise a more complex process of polishing and inferior color stability [16, 17]. Particularly early nylon dentures exhibited high water sorption leading to rapid discoloration, loss of surface finish, Review Article

Flexible Partial Dentures - A hope for the Challenged Mouth

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Abstract:

The strong, flexible nature of flexible denture material is perfectly suited to the variety of natural conditions in the mouth, simplifying design and enabling the flexible nylon resin to act as a built-in stress-breaker that provides superior function and stress distribution. Partially edentulous patients with challenging conditions like abused ridges, allergy to denture resins, undercuts due to angulated remaining teeth, cancerous lesions and cleft palate pose a great challenge for the fabrication of a successful removable partial denture.

Flexible denture offers a simpler and cost effective treatment for the oral rehabilitation of such cases. Flexible nature of the material allows shifting of the burden of force control from the design features of the appliance to the material properties of the base material. The clinical procedures are simple not requiring any expertise. A cast model prepared from a conventional alginate impression is sent to the laboratory that fabricates the desired prosthesis.

The stress distribution of the partial denture is accomplished by flexibility of the major connector, behaving as a stress-breaker. The tissue-supported saddles float on the edentulous ridge independently, without placing a stress load on the abutment teeth. In the long term, the flexibility of the complete or partial denture also appears to act as a tissue conditioner. Flexible partial dentures certainly offer advantages over conventional partials by way of superior aesthetics, better function, durable material and longevity of the prosthesis.

Key Words: Flexible dentures, Removable Partial Denture (RPD), Undercuts, Acrylic clasps

Introduction:

Modern dentistry offers many options for the restoration of partially edentulous mouth, like removable partial dentures (RPD), fixed bridges and dental implants. Removable partial dentures became very popular many decades ago with the introduction of acrylic polymers and chrome cobalt alloys in dentistry. Many patients choose removable partial dentures due to factors ranging from cost to physiology. Today, more dentists are advising flexible partial dentures because they make better and stronger appliances that are comfortable and long lasting (Naylor & Manor, 1983). The strong and flexible nature of the material is perfectly suited to the variety of natural conditions in the mouth, simplifying design and enabling the flexible nylon resin to act as a built-in stress-breaker in order to provide superior function and stress distribution in a removable partial denture.

Prevailing Materials:

Acrylic partial dentures offer a relative ease of fabrication as compared to the metal frame fabrication. The cast partials require accurate tooth preparations for guide planes and placement of occlusal rest. Very accurate surveying is required on the diagnostic cast to help inform about the tooth preparation (Lowe, 2004). However, the main limitations from these materials come from a steady loss of function as the edentulous ridge undergoes a natural process of resorption and the obvious non-aesthetic visible metal clasps (Shamnur et al, 2005). The patient needs to maintain the partial dentures routinely in terms of clasp adjustment and relines, and if any of the requirements are slightly compromised, the design will fail to work as intended. Irrespective of the accuracy with which the metal partial denture is designed for its fit, this perfection is gradually lost after the partial denture is placed for the reasons cited above.

The need to make improvements in the lives of people using removable partial dentures, inspired further research in this particular field of dentistry. Limitations of function and cosmetics of framework supported removable part of RPDs, which created a need to fundamentally change the technique of designing and fabrication of RPD. This is what led to the introduction of Flexible Dentures in the late 1940s. Two young brothers, Arpad and Tibor Nagy, had the vision to experiment with the new polymers of the day

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Case Report

Flexible Thermoplastic Denture Base Materials for Aesthetical Removable Partial Denture Framework

ABSTRACT

Conventional fixed partial dentures, implant supported Fixed Partial Dentures (FDPs) and removable partial dentures are the most common treatment modalities for the aesthetic and functional rehabilitation of partially edentulous patients. Although implants and FDP have certain advantages over removable partial dentures, in some cases, removable partial dentures may be the only choice which is available. Removable cast partial dentures are used as definitive removable prostheses when indicated, but location of clasps may affect aesthetics. So, when patient is concerned about aesthetics, flexible partial dentures which is aesthetically superior to flipper and cast partial dentures, may be considered. But for the success of flexible removable partial denture, proper diagnosis, treatment planning and insertion technique of this prosthesis is very important, which have been thoroughly described in this article.

Key words: Flexible partial dentures, Valplast, Flexiplast, Nylon, Retento-grip tissue bearing technique and flipper

CASE REPORT

A 55-year-old female patient reported to the Department of Prosthodontics, Institute of Dental Studies and Technologies, Modinagar, Ghaziabad, Uttar Pradesh, India, with chief complaint of bad aesthetics due to missing teeth. The patient presented with partially edentulous arches with bilaterally missing posterior teeth in maxilla (Kennedy class I) and premolars and first molars in mandible (Kennedy class III), as shown in [Table/Fig-1]. Some of the remaining teeth had carious lesions, cervical abrasions and carious exposures. Carious and cervically abraded teeth were restored and root canal treatment of carious, exposed teeth was done. We planned removable cast partial dentures for replacing the mandibular missing teeth, because aesthetics was not a problem and as it was a totally tooth supported prosthesis. Flexible partial denture was fabricated for replacing maxillary posterior teeth, because clasps placed on canines with flexible material are aesthetically good and more retentive because of their extensions into undercuts which present lateral to maxillary tuberosity.

Acrylic resin teeth do not bond chemically with flexible denture base resin. They are mechanically retained by making 'T' shape holes (Diatorics), shown in [Table/Fig-2] into which denture base resin flows to retain teeth mechanically. This retention technique is known as Retento-Grip tissue bearing technique. The clasps of flexible removable partial dentures [Table/Fig-3 and 4] are extensions of denture base into undercut areas, which can be adjusted by dipping the clasp area in boiling water and then bending with the plier in or out to increase or decrease the retention. [Table/Fig-4] shows the flexibility of the prosthesis and [Table/Fig-5] shows a final horse shoe shape designed flexible removable prosthesis in patient's mouth.

The second patient presented with bilaterally missing, mandibular, posterior teeth [Table/Fig-6]. She was very much apprehensive about the appearance of metal clasp and did not want any metal prosthesis in her mouth. Mandibular missing teeth were restored with flexible partial dentures [Table/Fig-7, 8 and 9] and she was very much satisfied with aesthetics as well as with function of the prosthesis. The two years follow up of both the patients showed generalized yellow staining of the prostheses due to improper care of the prostheses.

[Table/Fig-1]: Pre operative. [Table/Fig-2]: Wire inserted to check the orientation of the holes (Diatorics). [Table/Fig-3]: Flexible removable partial denture. [Table/Fig-4]: Checking flexibility of RPD. [Table/Fig-5]: Prosthesis in patient's mouth

[Table/Fig-6]: Pre operative
[Table/Fig-7]: Flexible Removable partial denture
[Table/Fig-8]: Checking flexibility of RPD
[Table/Fig-9]: Prosthesis in patient's mouth