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Avaliação biomecânica de próteses unitárias sobre implantes de hexágono interno em maxila anterior com diferentes tipos de ancoragem óssea e comprimentos de implantes. Estudo pelo método dos elementos finitos 3-D.

Araçatuba – SP

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Orientador: Prof. Ass. Dr. Fellippo Ramos Verri

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Dedicatória

DEDICATÓRIA

Primeiramente gostaria de externar os meus sinceros agradecimentos às pessoas que mais me apoiaram na vida.

Á DEUS,

Por tudo que aconteceu e acontece na minha vida e por ele ter dado uma linda família e por todos os amigos que colocastes no meu caminho.

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"Sonda-me, Senhor e me conheces

Quebranta o meu coração

Transforma-me conforme a Tua palavra

E enche-me até que em mim

Se ache só a Ti, Então

Usa-me, Senhor

Como um farol que brilha à noite

Como ponte sobre as águas

Como abrigo no deserto.

Como flecha que acerta o alvo..."

(Aline Barros, Edson Feitosa e Ana Feitosa)

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"Mas eu só quero lembrar

Que de 10 vidas, 11 eu te daria

E foi vendo você

Que eu aprendi a lutar

Mas eu só quero lembrar

Antes que meu tempo acabe

Pra você não se esquecer

Que se Deus me desse uma chance de viver outra vez

Eu só queria se tivesse você"

(Lucas Lucco)

ESSES VERSOS RESUMEM O MEU AMOR POR VOCÊS!!!

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"Hoje eu acordei mais cedo e fiquei te olhando dormir,
Imaginei algum suposto medo para que tão logo pudesse te cobrir,
Tenho cuidado de você todo esse tempo,
Você está sob meu abraço, minha proteção,
Tenho visto você errar e crescer, amar e voar,
Você sabe onde pousar.
Ao acordar já terei partido,
Ficarei de longe escondido,
Mas sempre perto,
De certo, como se eu fosse humano, vivo,
Vivendo para te cuidar, te proteger,
Sem você me ver,
Sem saber quem sou,
Se sou anjo ou se sou seu amor"

(Saulo Fernandes)

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Epígrafe

"A maior prisão que podemos ter na vida é aquela quando

a gente descobre que estamos sendo não aquilo que somos,

mas o que o outro gostaria que fôssemos.

Geralmente quando a gente começa a viver muito em torno

do que o outro gostaria que a gente fosse,

é que a gente está muito mais preocupada com o que o outro

acha sobre nós, do que necessariamente nós sabemos sobre nós

mesmos. "

Padre Fábio de Melo

CRUZ, R. S. **Avaliação biomecânica de próteses unitárias sobre implantes de hexágono interno em maxila anterior com diferentes tipos de ancoragem óssea e comprimentos de implantes. Estudo pelo método dos elementos finitos 3-D.** 2017. Dissertação (Mestrado em Ciência Odontológica, área de concentração Biomateriais) – Faculdade de Odontologia de Araçatuba, Universidade Estadual Paulista, Araçatuba 2017.

Proposição: A proposta dessa pesquisa foi avaliar a distribuição de tensões em próteses unitárias implantossuportadas de hexágono interno (HI) na região maxilar anterior, variando a técnica de ancoragem óssea (Convencional (C), Bicorticalização (B) e Bicorticalização com elevação do assoalho nasal (BEAN) e as direções de carregamento (0°, 30° e 60°) por análise tridimensional (3D) de elementos finitos.

Material e métodos: Três modelos tridimensionais foram simulados com ajuda dos programas Invesalius, Rhinoceros 3D 4.0 e SolidWorks 2011. Cada modelo possuía um bloco ósseo da região anterior do maxilar (osso tipo III) com 10m de altura padrão com um implante (4×8,5 mm (C), 4x10mm (B) e 4x11,5mm (BEAN), suportando uma coroa cimentada metal free. Os modelos foram processados pelos programas FEMAP v.11.0 e NEiNastran 11, utilizando uma força de 178 N em diferentes inclinações (0°, 30°, 60°). Os resultados foram plotados em mapas de tensão de von Mises (TvM), tensão máxima principal (TMxP), Microstrain (με) e Tendência de deslocamento (TD).

Resultados: Análise de TvM mostrou aumento da concentração de tensão com o aumento da inclinação da força para os implantes, parafusos de fixação e abutments, com padrão similar de distribuição para os modelos testados. Sob análise de TMxP e με, o tecido ósseo apresentou maiores concentrações de tensões de tração sob cargas oblíquas (30° e 60°) ao redor do pescoço do implante na técnica convencional. Análise de deslocamento mostrou aumento da tendência de inclinação de forma similar para todos os modelos com o aumento da inclinação da força.

RESUMO

Conclusão: As técnicas bicorticais utilizando implantes mais longos mostraram menor concentração de tensões no tecido ósseo e aumento na inclinação de força mostrou padrão mais intenso de distribuição de tensões para todas as situações testadas.

Palavras chaves: Prótese dentária; Implante dentário; Análise de elementos finitos.

ABSTRACT

CRUZ, R. S. **Biomechanical evaluation of unitary prostheses on implants of internal hexagon in anterior maxilla with different types of bone anchorage and implant lengths. Study by the finite element method 3-D.** 2017. Dissertation (Masters in Dental Science, Biomaterials concentration area) - Faculty of Dentistry of Araçatuba, Paulista State University, Araçatuba 2017.

Proposition: The purpose of this research was to evaluate the stress distribution of single crowns supported by internal hexagon (HI) implants in the anterior region of the maxilla, varying the bone anchoring technique (conventional (C), bicorticalization (B) and bicorticalization with nasal floor elevation (BNFE) at loading directions (0° , 30° and 60°) by three-dimensional (3D) finite elemento analysis.

Material and methods: Three 3D models were designed with aid of Invesalius, Rhinoceros 3D 4.0 and SolidWorks 2011 software. Each model contained a bone block of the premaxillary área (type III bone) with 10m of standard height with one implant (4×8, 5mm (C), 4x10mm (B) and 4x11.5mm (BNFE)), supporting a cemented metal free crown. The models were processed by the FEMAP v.11.0 and NEiNastran 11 using load of 178 N at different inclinations (0°, 30°, 60°). Von Mises (TvM), maximum principal stress (TMxP), microstrain (με) and displacement maps (D) were plotted to results analysis.

Results: Analysis of TvM showed increased of stress concentration with increasing load inclination for implants, fixation screws and abtments, with similar pattern of distribution for the tested models. Under TMxP and με analysis, bone tissue showed higher traction stress concentrations under oblique loads (30 ° and 60 °) around the implant neck for the conventional technique. Displacement analysis showed increase of inclination tendency similar for all models as the load increased inclination.

ABSTRACT

Conclusion: Bicortical techniques using longer implants showed lower stress distribution to the bone tissue and increase of force inclination showed more concentrated pattern of stress distribution for all tested situations.

Keywords: Dental prosthesis; Dental implants; Finite element analysis.

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LISTA DE ABREVIATURAS E SIGLAS

MEF	-	Método dos Elementos Finitos
Mpa	-	Mega Pascal
3D	-	Tridimensional
mm	-	Milímetros
TD	-	Tendência de deslocamento
PM	-	Pré-molar
N	-	Nilton
TvM	-	Análise de variância
TMxP	-	Tensão máxima principal
HI	-	Hexágono interno
με	-	Microstrain
C	-	Convencional
B	-	Bicorticalização
BEAN	-	Bicorticalização com elevação do assoalho nasal

Sumário

SUMÁRIO

Avaliação biomecânica de próteses unitárias sobre implantes de hexágono interno em maxila anterior com diferentes tipos de ancoragem óssea e comprimentos de implantes. Estudo pelo método dos elementos finitos 3-D. 2017.

Avaliação biomecânica de próteses unitárias sobre implantes de hexágono interno em maxila anterior com diferentes tipos de ancoragem óssea e comprimentos de implantes. Estudo pelo método dos elementos finitos 3-D. 2017.

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Material e métodos: Três modelos tridimensionais foram simulados com ajuda dos programas Invesalius, Rhinoceros 3D 4.0 e SolidWorks 2011. Cada modelo possuía um bloco ósseo da região anterior do maxilar (osso tipo III) com 10m de altura padrão com um implante (4×8,5 mm (C), 4x10mm (B) e 4x11,5mm (BEAN)), suportando uma coroa cimentada metal free. Os modelos foram processados pelos programas FEMAP v.11.0 e NEiNastran 11, utilizando uma força de 178 N em diferentes inclinações (0°, 30°, 60°). Os resultados foram plotados em mapas de tensão de von Mises (TvM), tensão máxima principal (TMxP), Microstrain (με) e Tendência de deslocamento (TD).

Resultados: Análise de TvM mostrou aumento da concentração de tensão com o aumento da inclinação da força para os implantes, parafusos de fixação e abutments, com padrão similar de distribuição para os modelos testados. Sob análise de TMxP e με, o tecido ósseo apresentou maiores concentrações de tensões de tração sob cargas oblíquas (30° e 60°) ao redor do pescoço do implante na técnica convencional. Análise de deslocamento mostrou aumento da tendência de inclinação de forma similar para todos os modelos com o aumento da inclinação da força.

Conclusão: As técnicas bicorticais utilizando implantes mais longos mostraram menor concentração de tensões no tecido ósseo e aumento na inclinação de força mostrou padrão mais intenso de distribuição de tensões para todas as situações testadas.

Palavras chaves: Prótese dentário; Implante dentário; Análise de elementos finitos.

As reabilitações com próteses implantossuportadas na região anterior atualmente apresentam elevados índices de sobrevivência e sucesso[12,18]. Entretanto, as instalações dos implantes podem estar limitadas a disponibilidade do tecido ósseo, e quando o volume ósseo é reduzido, isso pode comprometer a estabilidade primária dos implantes[4,19].

A instalação de implantes na maxila anterior muitas vezes é comprometida por apresentar esta área uma cortical óssea menos espessa quando comparada com o osso mandibular[11]. Esse fator contribui para reabsorção progressiva do rebordo alveolar após a perda do elemento dentário[6], causando a proximidade com o assoalho nasal e restrição na espessura de rebordo, restringindo assim a instalação de implantes de maior comprimento[19].

Assim, uma das alternativas para contornar essa limitação é a utilização de implantes curtos[12]. No entanto, os implantes curtos podem estar associados com taxas mais elevadas de insucesso[12], devido a redução do contato osso-implante[25], comprometendo a estabilidade primaria dos implantes[2] em comparação com implantes de maior comprimento. Além disto, os implantes curtos podem não atingir um travamento bicortical podendo apresentar portanto uma desvantagem biomecânica[29].

Além da utilização dos implantes curtos, diferentes abordagens podem ser utilizadas para o tratamento dessa região, como por exemplo o travamento bicortical e o levantamento de assoalho nasal com ou sem enxerto ósseo associado, no intuito de utilizar implantes de maiores comprimentos e diâmetros, melhorando a estabilidade primária, bem como favorecendo a distribuição das forças oclusais[7].

Estudos biomecânicos avaliando a influência de diferentes técnicas cirúrgicas sugerem que a utilização da técnica bicortical é mais vantajosa quando comparada com técnica convencional quando se mantém o comprimento dos implantes[14,29,30]. No entanto, dados da literatura ainda indicam controvérsia quanto a bicorticalização para melhorar o prognóstico dos implantes, pois esta poderia aumentar o estresse no osso cortical a um nível indesejável para a osseointegração. Estudo retrospectivo relata que a taxa de falha de implantes colocados em implantação bicortical foi de cerca de 4 vezes maior que implantes colocados de forma monocortical[8].

Clinicamente, existem situações para resolução cirúrgico-protética nesta região. O profissional poderá optar pela instalação de implantes curtos de maneira convencional, ou implantes de maior comprimento utilizando as técnicas de bicorticalização, com ou sem elevação de assoalho nasal. Porém, não existe comparação da técnica cirúrgica empregada em relação ao comprimento do implante utilizado.

Assim, o objetivo deste estudo foi avaliar, pela metodologia dos elementos finitos 3D, a distribuição de tensões em próteses unitárias implantossuportadas sobre implante de hexágono interno (HI) na área de pré-maxila, variando o tipo de ancoragem óssea (convencional, bicorticalização e bicorticalização associada à técnica de levantamento de assoalho nasal) e as direções de carregamento (0°, 30° e 60°).

A hipótese nula testada foi de que não existe influência do comprimento do implante na distribuição de tensões em relação a técnica cirúrgica empregada.

3.1 - DELINEAMENTO EXPERIMENTAL

Esta pesquisa foi desenvolvida considerando-se três fatores: técnicas cirúrgicas (Convencional, Bicorticalização e Bicorticalização associada à técnica de levantamento de assoalho nasal), comprimentos de implante (4,0 × 8,5 mm, 4,0 × 10.00 mm e 4,0 x 11,5 mm) e carregamento (0°, 30° e 60°). Dessa forma, foram confeccionados três modelos tridimensionais descritos na tabela 1.

Tabela 1. Descrição dos modelos utilizados no estudo

Modelos	**Ancoragem**	**Diâmetro e Comprimento (Implantes)**	**Angulação**
1	Convencional	4,0 x 8,5 mm	0º 30° 60º
2	Bicorticalização	4,0 x 10 mm	0º 30° 60º
3	Bicorticalização associada à técnica de levantamento de assoalho nasal	4,0 x 11,5 mm	0º 30° 60º

3.2 - MODELAGEM TRIDIMENSIONAL

Esse estudo seguiu a metodologia de estudos prévios[29,30]**.** Cada modelo representou uma secção óssea da região de pré-maxila, sendo simulado um implante do tipo hexágono interno (Conexão Sistemas de Prótese Ltda., São Paulo, Brasil), com 4,0 mm de diâmetro e com diferentes comprimentos, variando-se a disponibilidade óssea clínica: implantes de 8,5 mm de comprimento instalado com a técnica convencional; implantes de 10 mm de comprimento instalado com a técnica de bicorticalização; e implantes de 11,5 mm de comprimento utilizando a técnica de bicorticalização associada à técnica de levantamento de assoalho nasal, na região do elemento 21, suportando uma coroa metal free sobre UCLA preparado para prótese cimentada.

O bloco ósseo apresentou altura padrão de 10 mm para todos os modelos simulados, sendo simulando osso tipo III, composto por osso trabeculado envolto por 1 mm de tecido ósseo cortical[29,30]. Assim, o modelo com implantação convencional teve 1,5 mm de tecido ósseo remanescente apicalmente ao implante; já na implantação bicortical o implante teve o seu ápice travado na cortical superior óssea; e na bicorticalização associada ao levantamento de assoalho nasal uma projeção de 1,5 mm foi realizada para envolver o ápice do implante de 11,5 mm. A modelagem do tecido ósseo foi obtida através de uma recomposição tomográfica utilizando o software InVesalius (CTI, Campinas, São Paulo, Brasil). Em seguida, o modelo foi transferido para o software Rhinoceros 3D 4.0 (Seattle, WA, USA) onde foram realizadas as simplificações de superfícies.

Os desenhos dos implantes foram obtidos através do desenho original de um implante HI fornecido pelo fabricante (Conexão Sistemas de Prótese Ltda., Arujá, São Paulo, Brazil) no programa SolidWorks 14 (SolidWorks Corp, Waltham, MA, USA), sendo exportado posteriormente para o programa Rhinoceros 4.0 para simplificação do desenho do implante, sem que isso comprometesse o resultado final das análises[28].

A coroa foi desenhada diretamente no software Rhinoceros 4.0 a partir das fotografias diretas das várias faces dentarias e escalonada posteriormente no tamanho real da coroa fotografada, sendo a finalização do desenho semelhante aos trabalhos anteriores[29,30]. Após, o desenho da superfície foi utilizado para realizar a montagem com os demais componentes anteriormente citados, sendo simulada uma coroa protética de espessura média mínima de 0,7 mm, com incisal de 2 mm, e espessura de cimentação ao redor do UCLA de 0,8 mm, com inclinações de parede de preparo de 5 graus.

Em seguida, todas as estruturas simuladas (tecido ósseo cortical e trabeculado, implante, UCLA, parafuso de fixação e coroa) foram agrupadas no programa Rhinoceros 4.0 para exportação dos sólidos para análise de elementos finitos.

Os sólidos obtidos anteriormente foram exportados para pré-processamento no programa de elementos finitos FEMAP 11.1.2 (Siemens PLM Software Inc., Santa Ana, CA, USA). No pré-processamento foram definidas as propriedades mecânicas de cada material envolvido no estudo, atribuídas as propriedades a cada estrutura utilizada de acordo com trabalhos prévios (Tabela 2), para posterior geração das malhas tridimensionais (Figura 1), com elementos sólidos tetraédricos parabólicos, sendo todos os materiais considerados isotrópicos, homogêneos e linearmente elásticos, com contatos colados entre as estruturas simuladas à exceção do contato UCLA/implante que foi definido como contato justaposto para se assemelhar ao modelo real de contato clínico implante-coroa.

Tabela 2 - Propriedades mecânicas dos materiais

Estrutura	Módulo de Elasticidade (E) (GPa)	Coeficiente de Poisson (v)	Referência
Osso trabeculado baixa densidade (osso tipo III)	1,37	0,30	**Verri et al. (2014)[31]**
Osso Cortical	13,7	0,30	**Verri et al. (2014)[31]**
Titânio (UCLA, implante)	110,0	0,35	**Verri et al. (2014)[31]**
Porcelana de recobrimento (e.max CAD)	95,000	0,2	**Schmitter et al (2014)[22]**
Cimento resinoso	18,300	0,33	**Lazari et al. (2014)[10]**

Figura 1- Malha de Elementos Finitos (Osso Cortical, Osso trabecular, Implantes, UCLA, Parafuso de Fixação, Cimento resinoso e Coroa. 1) Técnica Convencional, 2) Técnica de Bicorticalização e 3) Técnica de Bicorticalização associada à técnica de levantamento de assoalho nasal.

Ainda no pré-processamento, as condições de contorno foram estabelecidas como fixa em todos os eixos (x, y e z) em linhas de construção do bloco ósseo na região superior relativa à parede do assoalho nasal, permanecendo outras partes do modelo sem quaisquer restrições. Foi realizada uma aplicação de carga linear, sendo toda a estrutura envolvida no estudo (coroa/componentes/implante/tecido ósseo) possível de se movimentar e sofrer intrusão, restando apenas a base do bloco ósseo fixada e sem movimentação. A força aplicada foi de 178 N a 0°, 30° e 60°, localizada cerca de 2 mm abaixo da superfície incisal do dente, de acordo com estudos prévios[30.]

Após pré-processamento foram gerada análises para processamento no programa Nei Nastran 11.1 (Noran Engineering, Inc., Westminster, California, USA) e exportação dos resultados. Desta forma, os resultados foram transferidos ao FEMAP 11.1.2 para o pós-processamento e visualização gráfica. A Tensão Máxima Principal (TMxP) foi utilizada como critério de análise das tensões no tecido ósseo por ser esta estrutura friável, uma vez que tal análise fornece valores de compressão (valores negativos) e tração (valores positivos)[29]. Os mapas de von Mises (TvM) foram utilizados para avaliar componentes protéticos/implantes/parafusos[30,31], materiais dúcteis. Os mapas de Microstrain (με) foram utilizados para análise do tecido ósseo e os mapas de deslocamento foram utilizados para análise de todo conjunto (osso/implante/componentes protéticos/cora)[29,30]. A unidade de medida usada para mensurar a TMxP e TvM foi Mega-Pascal (Mpa) e para mensurar o deslocamento foi o milímetro (mm).

4.1 - TENSÃO MÁXIMA PRINCIPAL

Na análise do mapa de tensão máxima principal para o tecido ósseo cortical (vista oclusal) e cortical e trabecular (vista lateral) sob carregamento 0°, foi observada menor magnitude e área de concentração de tensões de compressão próximas à interface osso/implante, com padrão semelhante de distribuição para todos os modelos. Menores magnitudes de tensões de tração foram observadas (Figura 2).

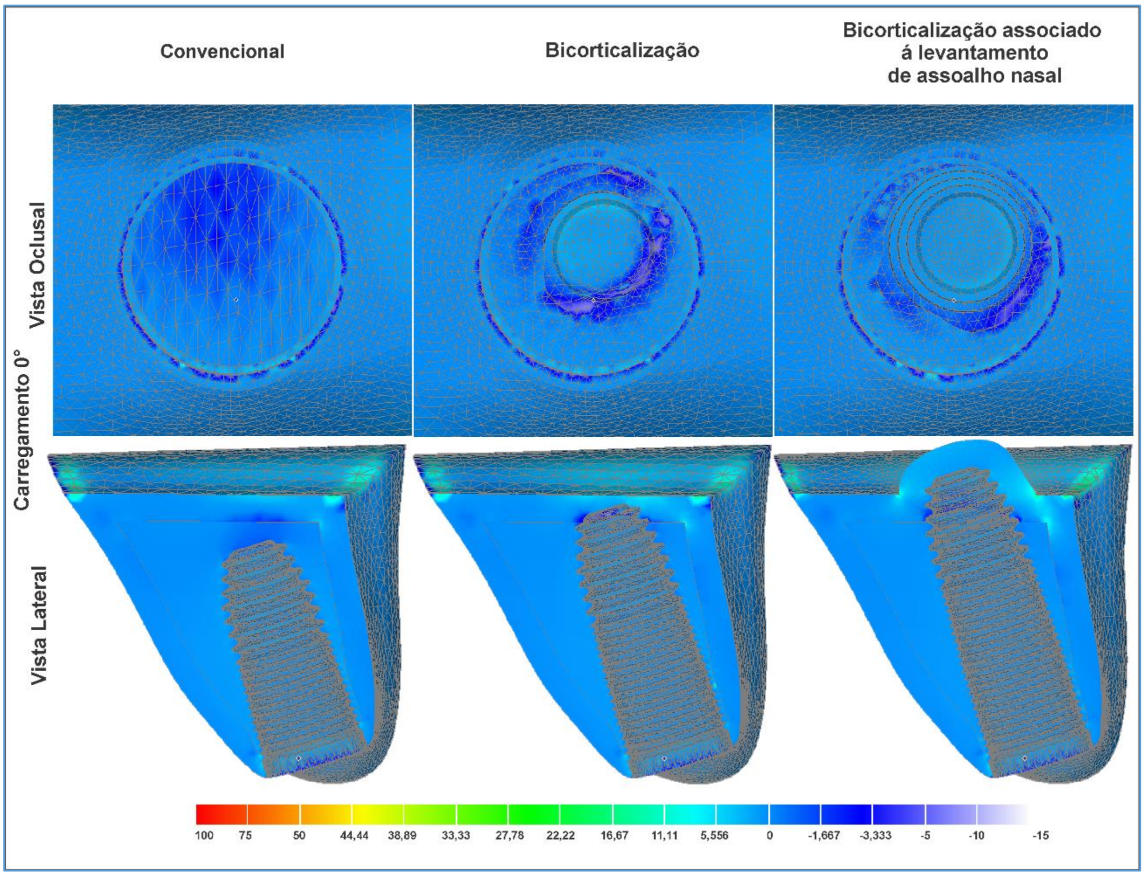

Figura 2- Mapas de Tensão Máxima Principal para o carregamento 0°, vista oclusal (osso cortical) e vista lateral (osso trabecular).

Sob carregamento 30° e 60° em vista oclusal, observou-se maiores concentrações de tensões de tração para o modelo de técnica convencional na região peri-implantar (interface osso/implante) quando comparado com as técnicas bicorticais. A tensão de compressão revelou padrão semelhante para todos os modelos estudados.

Em vista lateral foram observadas concentrações de tensão de tração em região platina e vestibular de todos os modelos, com padrão de distribuição similar para todas as técnicas testadas. Além disso, a análise mostrou que quando há um aumento na inclinação da carga há um aumento da concentração de tensão no tecido ósseo (Figura 3 e 4).

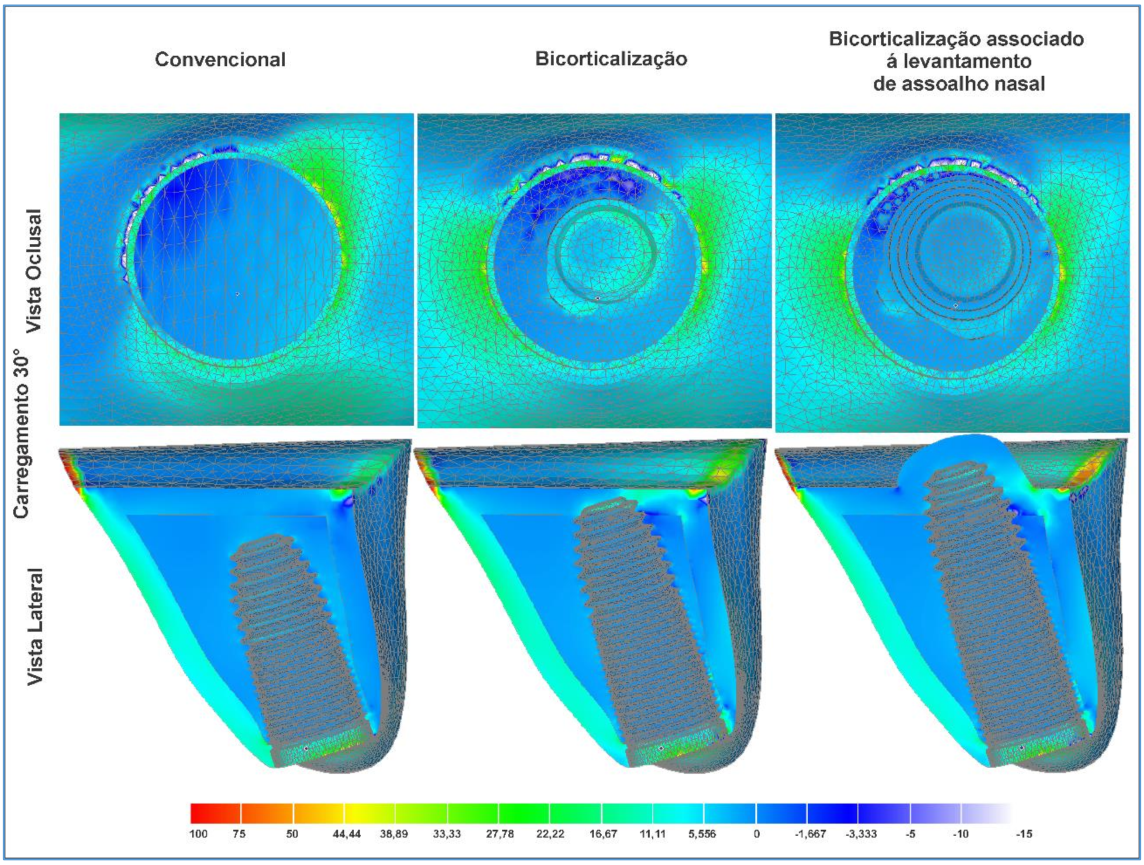

Figura 3- Mapas de Tensão Máxima Principal para o carregamento 30°, vista oclusal (osso cortical) e vista lateral (osso trabecular).

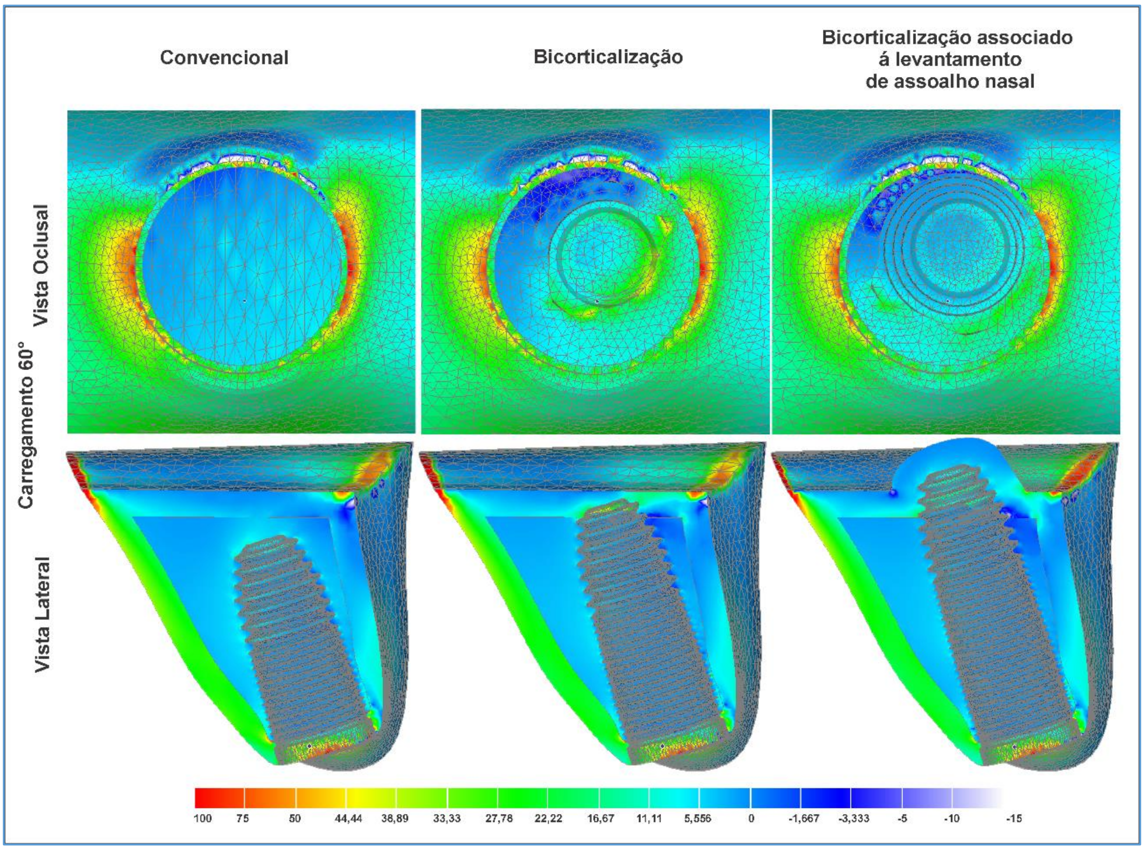

Figura 4 - Mapas de Tensão Máxima Principal para o carregamento 60°, vista oclusal (osso cortical) e vista lateral (osso trabecular).

4.2 - TENSÃO DE VON MISES

Na análise da distribuição de tensões de von Mises sob carregamento 0° foi possível observar um padrão de distribuição semelhante entre os modelos avaliados, com uma ligeira sobrecarga na região palatina dos implantes e menor concentração no ápice para todos os comprimentos testados (Figura 5). Maiores concentrações de tensão foram observadas no carregamento de 30° e 60°, sendo possível verificar também distribuição das tensões similares entre os modelos para as cargas oblíquas. Leve aumento de concentração foi observada para os implantes bicorticalizados na região vestibular, mais visível sob inclinação de força de 30º. (Figura 6) Além disso, com o aumento do ângulo de carregamento houve maior sobrecarga das paredes dos UCLAS, implantes e parafusos de fixação para todos os modelos. (Figura 6 e Figura 7).

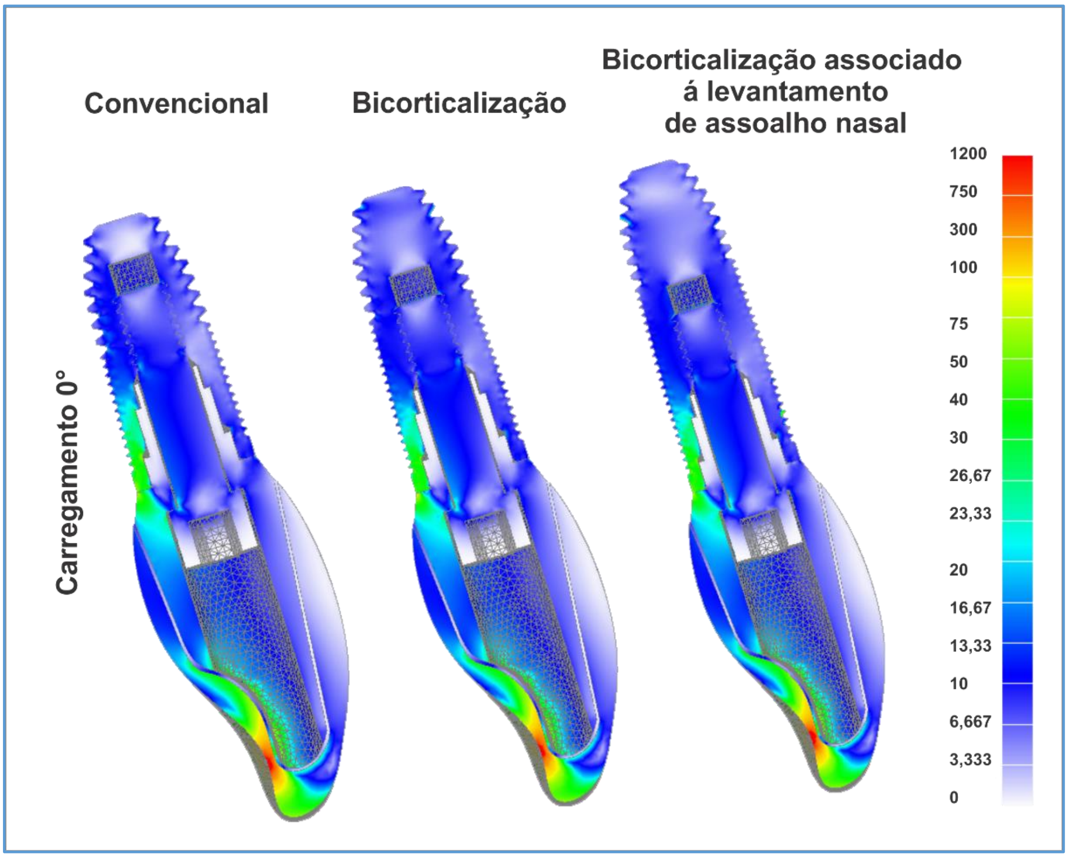

Figura 5- Mapas de tensão von Mises para o carregamento 0° (implantes/componentes/coroa).

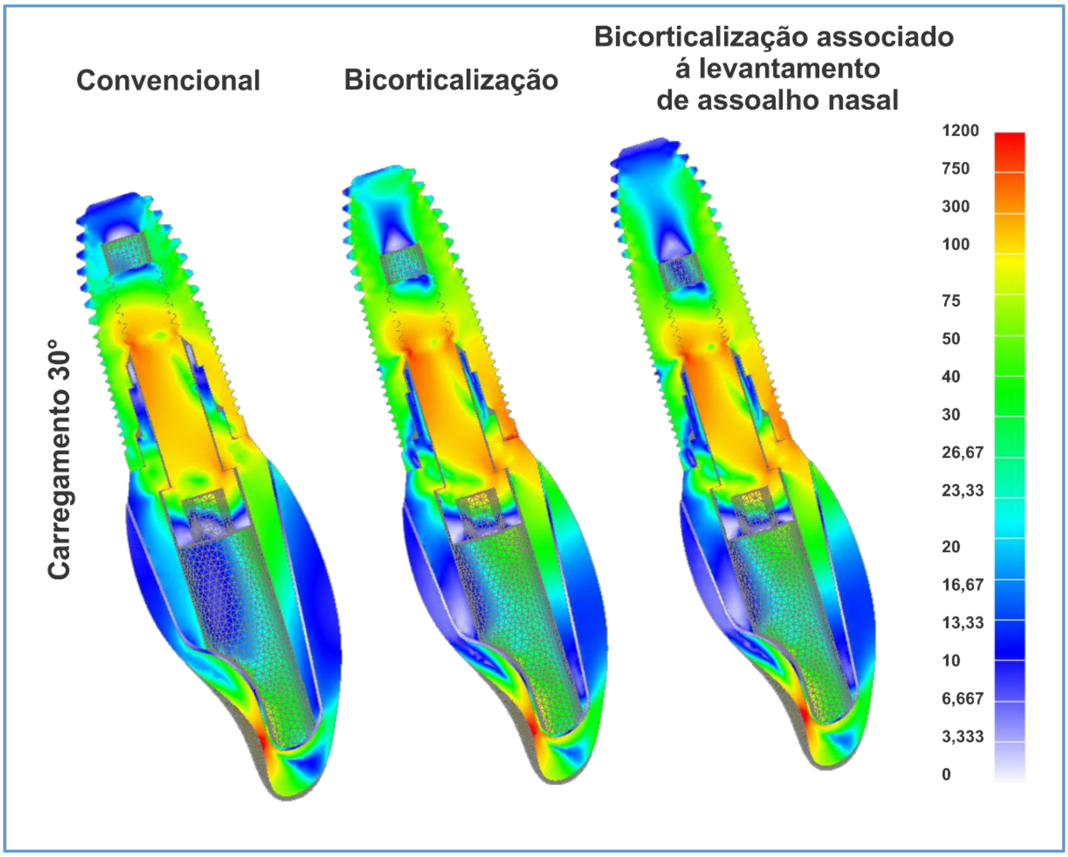

Figura 6- Mapas de tensão von Mises para o carregamento 30° (implantes/componentes/coroa).

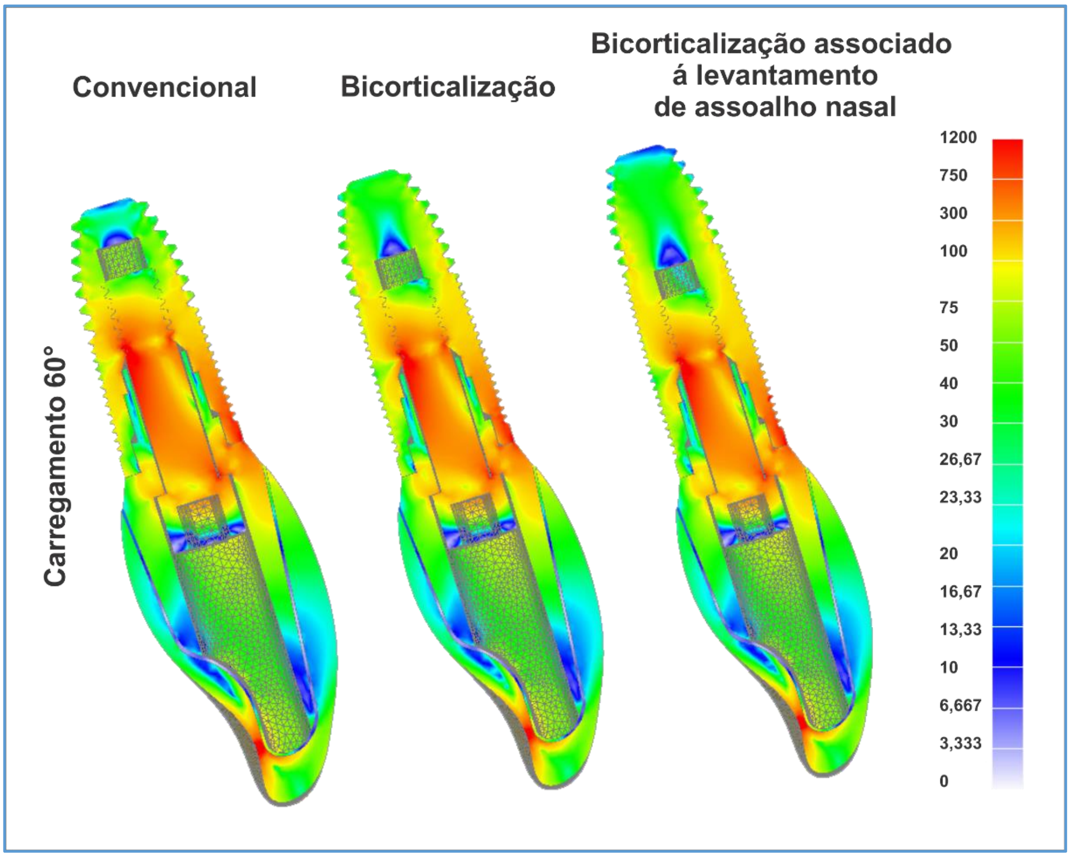

Figura 7- Mapas de tensão von Mises para o carregamento 60° (implantes/componentes/coroa).

4.3 - MAPAS DE MICROSTRAIN

A análise de με no tecido ósseo cortical mostrou padrões de microdeformação semelhantes para todos os modelos. Aumentando a direção da carga aumentaram as deformações na região vestibular, próximo ao contato osso implante. Entretanto, sob análise dos carregamentos de 30° e 60°, a técnica convencional teve uma maior concentração de deformação quando comparada com as outras técnicas (Figura 8).

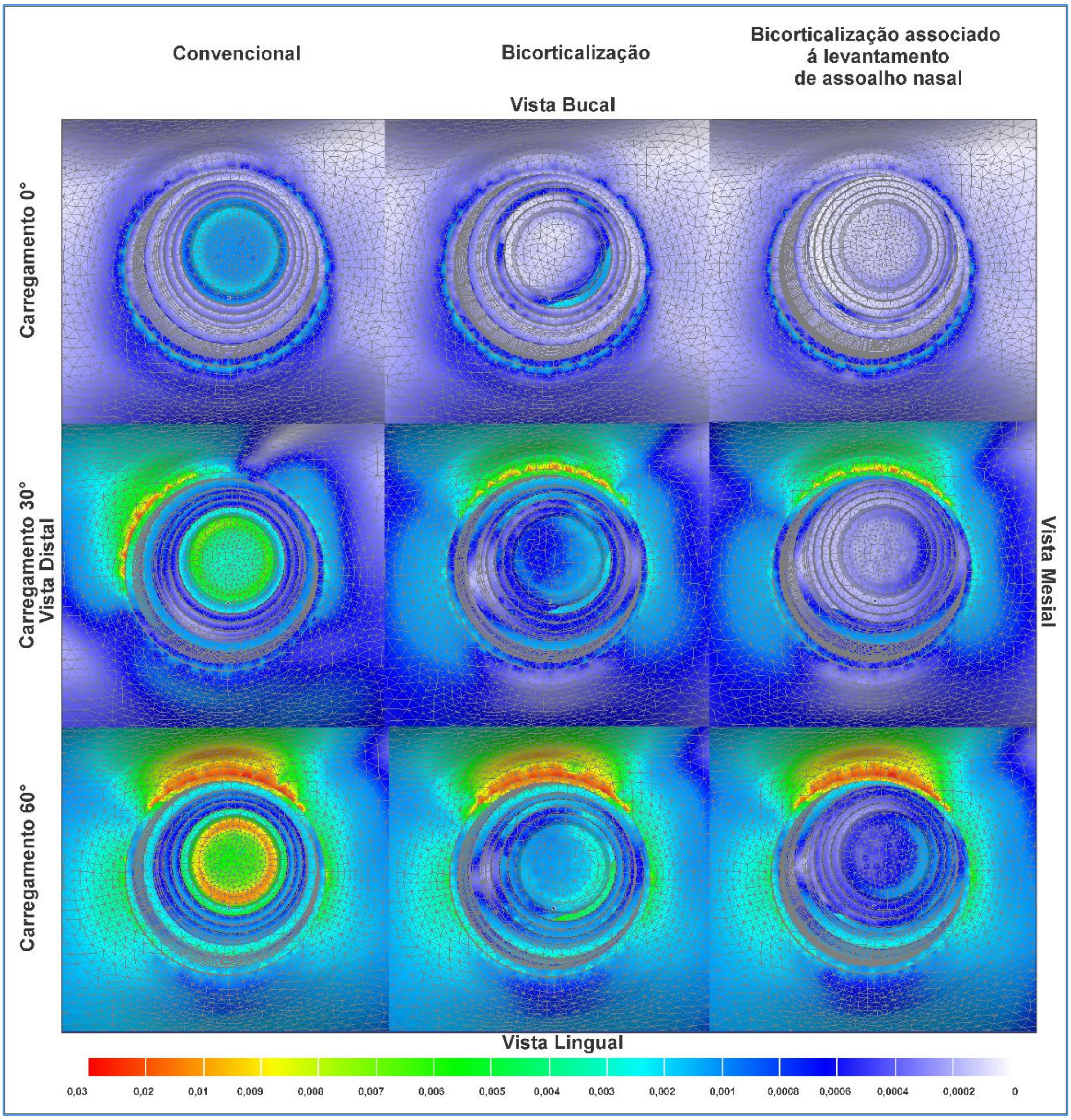

Figura 8 - Mapas de Microstrain para o carregamento 0°, 30° e 60° do osso cortical e trabecular.

4.4 - MAPAS DE DESLOCAMENTO

Na análise do mapa de deslocamento para o conjunto osso/implante/parafuso/coroa, observamos que quando há um aumento da inclinação da carga há uma maior a tendência de deslocamento nas estruturas analisadas. Os modelos apresentaram um padrão similar de distribuição de deslocamento, com o modelo de técnica de elevação do soalho nasal com menores níveis de deslocamento quando comparado às outras técnicas. O centro de rotação do conjunto implante/coroa nos modelos convencional e de bicorticalização localizou-se na área apical, diferente da técnica de elevação do soalho nasal que se localizou na área de travamento do implante na cortical óssea superior com tendência de rotação e movimentação para a direção cervical, principalmente quando associado a direção da carga de 30° e 60° (Figura 9).

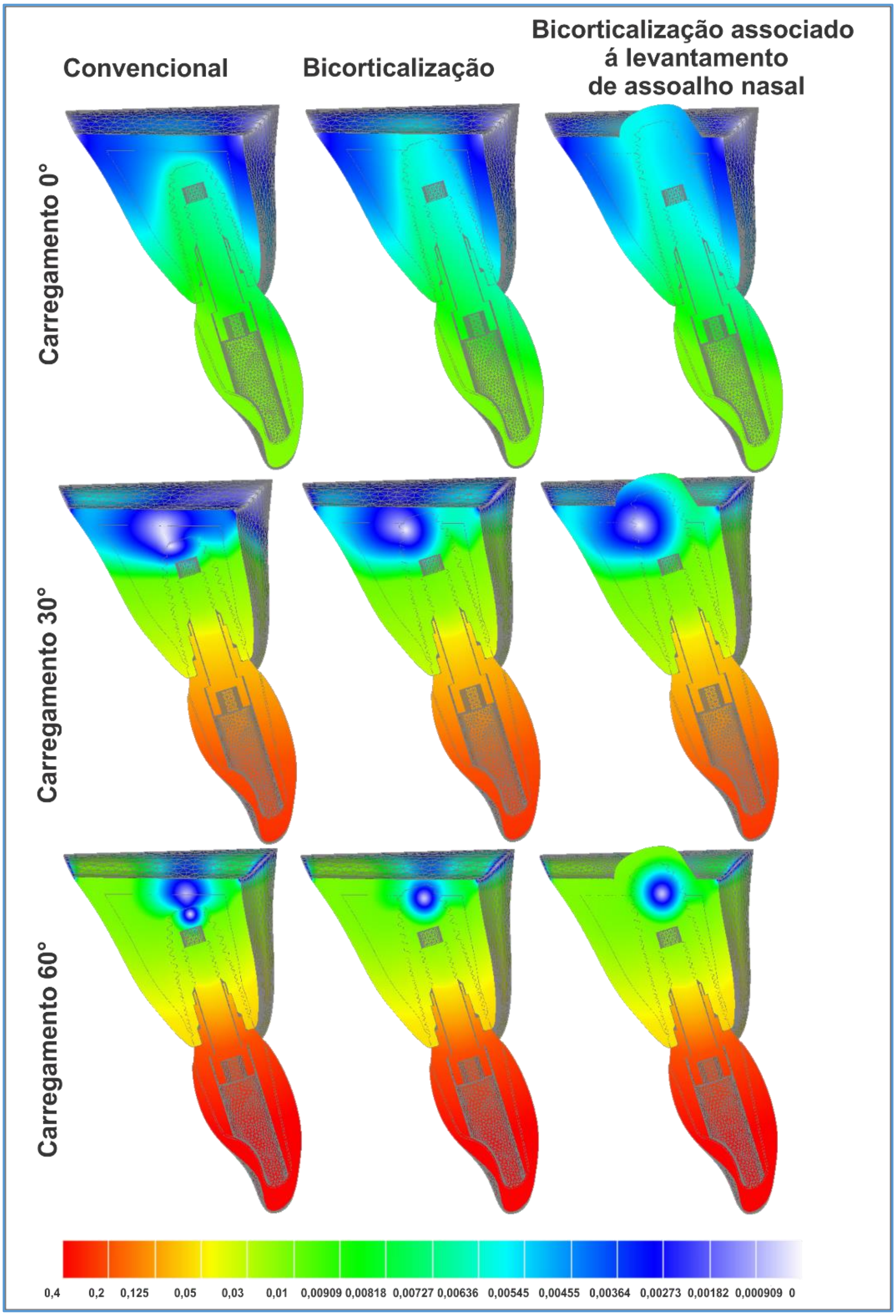

Figura 9- Mapas de deslocamento das estruturas, carregamento de 0°, 30° e 60°.

Este estudo mostrou que a escolha do comprimento do implante e técnicas cirúrgicas influenciam a distribuição de tensões nas situações testadas e, portanto, a hipótese nula deste estudo foi negada, visto que técnicas de bicorticalização mostraram melhor distribuição das tensões no tecido ósseo em comparação a técnica convencional. Este achado está em acordo com estudos que afirmam que comprimentos e técnicas de implantação podem influenciar no sucesso dos tratamentos reabilitadores com próteses implanto suportas[7,8,12,15]. Esses resultados também corroboram com estudos anteriores que verificaram que a técnica de bicorticalização é mais vantajosa para a distribuição das tensões no tecido ósseo variando-se apenas a técnica cirúrgica e não o comprimento dos implantes[29,30].

Além das vantagens observadas na distribuição de tensões, a técnica de bicorticalização pode ser recomendada por influenciar no aumento da estabilidade primária, otimizando a osseointegração dos implantes por disponibilizar uma maior superfície de contato osso-implante[1]. Esse aumento da estabilidade pode ser favorável, principalmente na região de maxila anterior por se tratar de uma região com exigência estética, sendo possível a instalação imediata do implante com carregamento imediato ou até mesmo por técnica de provisionalização imediata[24].

Em estudos biomecânicos com implantes com comprimento convencional (10 mm) foi observada vantagem biomecânica das técnicas de bicortilização para os implantes de conexão externa[30] e interna[31]. Entretanto, clinicamente a técnica e/ou comprimento do implante muitas vezes é baseada na quantidade de tecido ósseo remanescente[12]. De acordo com esse estudo, a utilização de implantes de maiores comprimentos associados às técnicas de bicorticalização é biomecanicamente mais favorável do que a utilização de implantes curtos com técnica convencional. Entretanto, essa técnica cirúrgica necessita de uma curva de aprendizagem devido a sua complexidade, pois é passível de intercorrências que podem ocasionar complicações como inchaço, dor, hematoma, infecção, deslocamento do implante, rinite[16,21], principalmente quando se realiza a elevação do assoalho nasal.

Estudos que avaliaram o comportamento biomecânico de implantes verificaram que os implantes mais longos apresentam uma tendência de acumular a tensões ao longo do seu comprimento, reduzindo as tensões na região tecido ósseo[17]. Implantes de 10mm e 11,5mm que são considerados pela literatura como implantes de comprimento longo[23]. Porém, não demostram diferença em relação a distribuição de tensão, inclusive para o tecido ósseo. Entretanto, o de 8,5mm, considerado implante de menor comprimento por alguns autores[26], sobrecarregou mais o tecido ósseo que os demais implantes analisados. Clinicamente, implantes de maior comprimento (10 e 11,5 mm) apresentam maior taxa de sobrevivência em comparação aos implantes curtos[12] e, por este motivo, são preferíveis. Os achados biomecânicos deste estudo corroboram com esta afirmação.

Forças oblíquas são mais donosas para o tecido ósseo peri-implantar[3,9]. Neste estudo, carregamento de 60° apresentaram maiores concentrações de tensões para os implantes e tecido ósseo. Entretanto, é necessário ressaltar que os implantes analisado foi de hexágono interno, que quando comparado com implantes de hexágono externo tem como vantagem menor tendência de afrouxamento ou fratura no parafuso de fixação, devido à menor concentração de tensões no pescoço do implante[3].

A análise de elementos finitos tem sido considerada uma ferramenta útil para avaliação de situações pré-clínicas[13], determinando as tensões e deformações em estruturas de maneira individualizada[3,29,30]. Desta forma, estes estudos já têm sido indicados para melhor compreensão do comportamento biomecânico e, em seguida, cuidadosamente terem seus resultados extrapolados para a clínica diária[27].

Como trata-se de uma análise computacional, este estudo apresenta algumas limitações, como fatores como restrições de modelos, as propriedades dos materiais, os valores de carga e tipo de aplicação que podem mudar os resultados e são limitados em comparação com avaliações clínicas. No entanto, esta técnica permite estudo comparativo biomecânico das regiões de interface osso/implante em situações diferentes sugerindo a melhor opção clínica sob ponto de vista biomecânico[3,9].

Dentro das limitações do presente estudo foi possível concluir que:

- Cargas oblíquas apresentaram maior estresse para implante e tecido ósseo.

- Técnicas bicorticais mostraram menor tensão para o tecido ósseo.

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Anexo A

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AUTHOR INFORMATION PACK

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Article Types

Articles are classified as one of the following: research/clinical science article, clinical report, technique article, systematic review, or tip from our readers. Required sections for each type of article are listed in the order in which they should be presented.

Research and Education/Clinical Research

The research report should be no longer than 10-12 double-spaced, typed pages and be accompanied by no more than 12 high-quality illustrations. Avoid the use of outline form (numbered and/or bulleted sentences or paragraphs). The text should be written in complete sentences and paragraph form.

Abstract (approximately 400 words): Create a structured abstract with the following subsections: Statement of Problem, Purpose, Material and Methods, Results, and Conclusions. The abstract should contain enough detail to describe the experimental design and variables. Sample size, controls, method of measurement, standardization, examiner reliability, and statistical method used with associated level of significance should be described in the Material and Methods section. Actual values should be provided in the Results section.

Clinical Implications: In 2-4 sentences, describe the impact of the study results on clinical practice.

Introduction: Explain the problem completely and accurately. Summarize relevant literature, and identify any bias in previous studies. Clearly state the objective of the study and the research hypothesis at the end of the Introduction. Please note that, for a thorough review of the literature, most (if not all references) should first be cited in the Introduction and/or Material and Methods section.

Material and Methods: In the initial paragraph, provide an overview of the experiment. Provide complete manufacturing information for all products and instruments used, either in parentheses or in a table. Describe what was measured, how it was measured, and the units of measure. List criteria for quantitative judgment. Describe the experimental design and variables, including defined criteria to control variables, standardization of testing, allocation of specimens/subjects to groups (specify method of randomization), total sample size, controls, calibration of examiners, and reliability of instruments and examiners. State how sample sizes were determined (such as with power analysis). Avoid the use of group numbers to indicate groups. Instead, use codes or abbreviations that will more clearly indicate the characteristics of the groups and will therefore be more meaningful for the reader. Statistical tests and associated significance levels should be described at the end of this section.

Results: Report the results accurately and briefly, in the same order as the testing was described in the Material and Methods section. For extensive listings, present data in tabular or graphic form to help the reader. For a 1-way ANOVA report of, F and P values in the appropriate location in the text. For all other ANOVAs, per guidelines, provide the ANOVA table(s). Describe the most significant findings and trends. Text, tables, and figures should not repeat each other. Results noted as significant must be validated by actual data and P values.

Discussion: Discuss the results of the study in relation to the hypothesis and to relevant literature. The Discussion section should begin by stating whether or not the data support rejecting the stated null hypothesis. If the results do not agree with other studies and/or with accepted opinions, state how and why the results differ. Agreement with other studies should also be stated. Identify the limitations of the present study and suggest areas for future research.

Conclusions: Concisely list conclusions that may be drawn from the research; do not simply restate the results. The conclusions must be pertinent to the objectives and justified by the data. In most situations, the conclusions are true for only the population of the experiment. All statements reported as conclusions should be accompanied by statistical analyses.

References0: See Reference Guidelines and Sample References page.

Tables: See Table Guidelines.

Illustrations: See Figure Submission and Sample Figures page.

Clinical Report

The clinical report describes the author's methods for meeting a patient treatment challenge. It should be no longer than 4 to 5 double-spaced, pages and be accompanied by no more than 8 high-quality illustrations. In some situations, the Editor may approve the publication of additional figures if they contribute significantly to the manuscript.

Abstract: Provide a short, nonstructured, 1-paragraph abstract that briefly summarizes the problem encountered and treatment administered.

Introduction: Summarize literature relevant to the problem encountered. Include references to standard treatments and protocols. Please note that most, if not all, references should first be cited in the Introduction and/or Clinical Report section.

Clinical Report: Describe the patient, the problem with which he/she presented, and any relevant medical or dental background. Describe the various treatment options and the reasons for selection of the chosen treatment. Fully describe the treatment rendered, the length of the follow-up period, and any improvements noted as a result of treatment. This section should be written in past tense and in paragraph form.

Discussion: Comment on the advantages and disadvantages of the chosen treatment and describe any contraindications for it. If the text will only be repetitive of previous sections, omit the Discussion.

Summary: Briefly summarize the patient treatment.

References: See Reference Guidelines and Sample References page.

Illustrations: See Figure Submission and Sample Figures page.

Dental Technique

The dental technique article presents, in a step-by-step format, a unique procedure helpful to dental professionals. It should be no longer than 4 to 5 double-spaced, typed pages and be accompanied by no more than 8 high-quality illustrations. In some situations, the Editor may approve the publication of additional figures if they contribute significantly to the manuscript.

Abstract: Provide a short, nonstructured, 1-paragraph abstract that briefly summarizes the technique.

Introduction: Summarize relevant literature. Include references to standard methods and protocols. Please note that most, if not all, references should first be cited in the Introduction and/or Technique section.

Technique: In a numbered, step-by-step format, describe each step of the technique. The text should be written in command rather than descriptive form ("Survey the diagnostic cast" rather than "The diagnostic cast is surveyed.") Include citations for the accompanying illustrations.

Discussion: Comment on the advantages and disadvantages of the technique, indicate the situations to which it may be applied, and describe any contraindications for its use. Avoid excessive claims of effectiveness. If the text will only be repetitive of previous sections, omit the Discussion.

Summary: Briefly summarize the technique presented and its chief advantages.

References: See Reference Guidelines and Sample References page

Illustrations: See Figure Submission and Sample Figures page.

Systematic Review

The author is advised to develop a systematic review in the Cochrane style and format. The Journal has transitioned away from literature reviews to systematic reviews. For more information on systematic reviews, please see www.cochrane.org. An example of a Journal systematic review: Torabinejad M, Anderson P, Bader J, Brown LJ, Chen LH, Goodacre CJ, Kattadiyil MT, Kutsenko D, Lozada J, Patel R, Petersen F, Puterman I, White SN. Outcomes of root canal treatment and restoration, implant-supported single crowns, fixed partial dentures, and extraction without replacement: a systematic review. J Prosthet Dent 2007;98:285-311.

The systematic review consists of:

An Abstract using a structured format (Statement of Problem, Purpose, Material and Methods, Results, Conclusions).

Text of the review consisting of an introduction (background and objective), methods (selection criteria, search methods, data collection and data analysis), results (description of studies, methodological quality, and results of analyses), discussion, authors' conclusions, acknowledgments, and conflicts of interest. References should be peer reviewed and follow JPD format.

Tables and figures, if necessary, showing characteristics of the included studies, specification of the interventions that were compared, the results of the included studies, a log of the studies that were excluded, and additional tables and figures relevant to the review.

Tips From Our Readers

Tips are brief reports on helpful or timesaving procedures. They should be limited to 2 authors, no longer than 250 words, and include no more than 2 high quality illustrations. Describe the procedure in a numbered, step-by-step format; write the text in command rather than descriptive or passive form ("Survey the diagnostic cast" rather than "The diagnostic cast is surveyed").

Contact Information

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- Double-spaced
- Left-justified
- No space between paragraphs
- 1-inch margins on all sides
- Half-inch paragraph indents
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The figures should be of professional quality and high resolution. The following are resolution requirements:

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If text is to appear within the figure, labeled and unlabeled versions of the figures must be provided. Text appearing within the labeled versions of the figures should be in **Arial font and a minimum of 10 pt.** The text should be sized for readability if the figure is reduced for production in the Journal. Lettering should be in proportion to the drawing, graph, or photograph. A consistent font size should be used throughout each figure, and for all figures, Please note: Titles and captions should not appear within the figure file, but should be provided in the manuscript text (see Figure Legends).

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All microscopic photographs must have a measurement bar and unit of measurement on the image.

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Generally, a maximum of 8 figures will be accepted for clinical report and dental technique articles, and 2 figures will be accepted for tips from our reader articles. However, the Editor may approve the publication of additional figures if they contribute significantly to the manuscript.

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Writing Guidelines

General Policies and Suggestions

- Authors whose native language is not English should obtain the assistance of an expert in English and scientific writing before submitting their manuscripts. Manuscripts that do not meet basic language standards will be returned before review.
- The Journal does not use first person (I, we, us, our, etc.). “We conducted the study” can be changed easily to “The study was conducted.”
- Avoid the use of subjective terms such as “extremely”, “innovative” etc.
- The JPD uses the serial comma which is the comma that precedes the conjunction before the final item in a list of three or more items: The tooth was prepared with a diamond rotary instrument, carbide bur, and carbide finishing bur.
- We prefer the nonpossessive form for eponyms: the Tukey HSD test rather than Tukey’s HSD test, Down syndrome rather than Down’s syndrome and so on.
- Describe experimental procedures, treatments, and results in passive tense. All else should be written in an active voice.
- Describe teeth by name (eg, maxillary right first molar), not number.

- Hyphens are not used for common suffixes and prefixes, unless their use is critical to understanding the word. Some prefixes with which we do not use hyphens include: pre-, non-, anti-, multi-, auto-, inter-, intra-, peri-.
- Eliminate the use of i.e. and e.g. as they are not consistent with Journal style.
- Spell out seconds, minutes, hours, etc.
- Only use abbreviations in the Tables.
- Avoid the repeated use of Product names in the manuscript. Please initially identify all the products used in the experiment and subsequently refer to them by generic terms.
- It is generally better to paraphrase information from a published source than to use direct quotations. Paraphrasing saves space. The exception is a direct quotation that is unusually pointed and concise.
- When long terms with standard abbreviations (as in TMJ for *temporomandibular joint*) are used frequently, spell out the full term upon first use and provide the abbreviation in parentheses. Use only the abbreviation thereafter. Even very common acronyms should still be defined at first mention.
- We do not italicize foreign words such as “in vivo”, “in vitro.”
- Abbreviate units of measurement without a period in the text and tables (9 mm). Insert a nonbreaking space between all numbers and their units (100 mm, 25 MPa) except before % and °C. There should never be a hyphen between the number and the abbreviation or symbol except when in adjectival form (100-mm span).
- Spell out “degrees” for angles. Use the degree symbol only for temperature.
- Contractions such as don’t, it’s, wouldn’t, etc are not used in scientific writing.
- Avoid using the words ""respectively"" or ""former/latter."" Both force the reader to stop and backtrack.
- For the common statistical outcomes P, a, ß omit the zero before the decimal point as these cannot be greater than 1.
- Proprietary names function as adjectives. Nouns must be supplied after their use, as in *Vaseline petroleum jelly*. Wherever possible, use only the generic term.
- Do not use trademark symbols as they are not consistent with Journal style.

Some Elements of Effective Style

- Short words. Short words are preferable to long ones if shorter word is equally precise.
- Familiar words. Readers want information that they can grasp easily and quickly. Simple, familiar words provide clarity and impact.
- Specific rather than general words. Specific terms pinpoint meaning and create word pictures; general terms may be fuzzy and open to varied interpretations.
- Brisk opening. Plunge into your subject in the first paragraph of the article.
- Limited use of modifying words and phrases. Check your adjectives, adverbs, and prepositional phrases. If they are not needed, strike them out.
- No unnecessary repetition. An idea may be repeated for emphasis—so long as that repetition is effective.
- Short sentence length. Twenty words or less is recommended. Rambling sentences cluttered with subordinate clauses and other modifiers are hard to read and may cause readers to lose their train of thought. Short sentences should, however, be balanced with somewhat longer ones to avoid monotony.
- Paragraphs. Break up long sections into paragraphs but avoid the use of single sentence paragraphs.
- Restraint. Writers who use flamboyant words or overstate their proposition or conclusions discredit themselves. Facts speak for themselves.
- Clearly stated conclusions. Don’t hedge. If you don’t know something, say so.

Objectionable Terms

The following are selected objectionable terms and their proper substitutes. For a complete list of approved prosthodontic terminology, consult the eighth edition of the *Glossary of Prosthodontic Terms* (J Prosthet Dent 2005;94:10-92).

Or visit JPD http://www.prosdent.org and click on Collections/Glossary of Prosthodontic Terms.

- Alginate *use* Irreversible hydrocolloid
- Bite *use* Occlusion
- Bridge *use* Partial fixed dental prosthesis
- Case *use* Patient, situation, or treatment as appropriate
- Cure *use* Polymerize
- Final *use* Definitive
- Freeway space *use* Interocclusal distance
- Full denture *use* Complete denture
- Lower (teeth, arch) *use* Mandibular
- Model *use* Cast
- Modeling compound *use* Modeling plastic impression compound
- Muscle trimming *use* Border molding
- Overbite, overjet *use* Vertical overlap, horizontal overlap
- Periphery *use* Border
- Post dam, postpalatal seal *use* Posterior palatal seal
- Prematurity *use* Interceptive occlusal contact

- Saddle *use* Denture base
- Study model *use* Diagnostic cast
- Take impressions, photographs, radiographs *use* Make
- Upper (teeth, arch) *use* Maxillary
- X-ray, roentgenogram *use* Radiograph

In addition, *specimen* should be used rather than *sample* when referring to an example regarded as typical of its class.

Additional Terminology Guidelines

Acrylic
An adjective form that requires a noun, as in acrylic resin.

Affect, effect

Affect is a verb; effect is a noun.

African American

Spelled thus and preferred over Negro and black in both adjective (African American patients) and noun (… of whom 20% were African Americans) forms.

Average, mean, median

Mean and average are synonyms. Median refers to the midpoint in a range of items; the midpoint has many items above as below it.

Basic
Like fundamental, this word is often unnecessary. An example of unnecessary use: Dental implants consist of two basic types: subperiosteal and endosteal.

Between, among

Use between when 2 things are involved and among when there are more than 2.

Biopsy
This noun should NOT be used as a verb. A biopsy was performed on the Tissue, rather than: The tissue was biopsied.

Centric
An adjective that requires a noun, as in centric relation.

Currently, now, at present, etc.

These expressions are often unnecessary, as in: This technique is currently being used…

Data
Use as a plural, as in: The data were…

Employ
Should not become an elegant variation of use, as in This method is employed …

Ensure
Preferred over insure in the sense of to make certain.

Fewer, less

Use fewer with nouns that can be counted (fewer patients were seen) and less with nouns that cannot be counted (less material was used).

Following
After is preferred.

Imply, infer

The speaker implies; the listener infers.

Incidence
The rate at which a disease occurs in a given time; sometimes confused with prevalence (the total number of cases of a disease in a given region).

Majority
Means more than half; use most when you mean almost all.

Male, female
For adult humans, use men and women. For children, use boys and girls.

Must, should

Must means that the course of action is essential. Should is less strong and means that the course of action is recommended.

Numbers
Spell out numbers used in titles or headings and numbers at the beginning of a sentence. The spelled version may also be preferable in a series of consecutive numbers that may confuse the reader (eg, 2 3.5-inch disks should be written two 3.5-inch disks). In all other cases, use Arabic numerals.

Orient
Proper form; avoid orientate.

Pathologic
Use instead of pathological. Other words in which the suffix -al has been dropped include biologic, histologic, and physiologic.

Pathology
The study of disease; often mistaken for pathosis (the condition of disease)

Percent
Use the percent sign in the text, as in The distribution of scores was as follows: adequate, 8%; oversized, 23%; and undersized, 69%. But spell out when the percent opens a sentence, as in Twenty percent of the castings …

Prior to

Before is preferred.

Rare, infrequent, often not, etc.

Whenever possible, these vague terms should be backed up with a specific number.

Rather
Like very, this word should be avoided.

Regimen
A planned program for taking medication, dieting, exercising, etc. Not to be confused with regime, meaning a system of government or management.

Sex
Use “sex” rather than “gender” unless you are referring to the socially constructed roles, behaviors, activities, and attributes that a given society considers appropriate for men and women.

Symptomatology
The science or study of symptoms; this word is not a synonym for the word symptoms

Technique
Preferred over technic.

Using
Avoid the dangling modifier in sentences such as "The impression was made using vinyl polysiloxane impression material." Write "with" or "by using" instead.

Utilize
Use is preferred.

Vertical
An adjective that needs a noun, as in vertical relation.

Via
Use through, with, or by means of.

White
Preferred over Caucasian. This is true only if the patient is from the Caucasus region of Eastern Europe. If not, use the term, white to describe the patien

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