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João Lucas Carvalho Paz

Avaliação do deslocamento do processo alveolar fraturado – efeito da rigidez da contenção dentária

Fractured Alveolar Process Displacement Evaluation – effect of rigidity of wire-composite splint

Dissertação apresentada à Faculdade de Odontologia da Universidade Federal de Uberlândia como requisito parcial para obtenção do Título de Mestre em Odontologia na área de Clínica Odontológica Integrada.

Uberlândia, 2020

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DEDICATÓRIA

Dedico este trabalho aos pacientes vítimas de traumatismos dentoalveolares.

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"Seremos ainda cientistas caso nos desliguemos da multidão?"

Berthold Brechet

SUMÁRIO

RESUMO

Objetivo: avaliar a movimentação da região vestibular do processo alveolar de um incisivo superior traumatizado comparado à região adjacente utilizando modelo artificial mimetizando a região maxilar anterior com o objetivo de identificar o efeito das diferentes rigidezes de contenções dentárias.

Material e Métodos: um modelo de incisivos centrais e laterais superiores foi criado utilizando resina e poliestireno, incisivos bovinos e com simulação do ligamento periodontal. O processo alveolar fraturado foi criado mantendo o osso vestibular em contato apenas com o ligamento periodontal simulado. 4 fios de espessuras diferentes (0,3; 0,6; 0,9 e 1,2 mm de diâmetro) foram criados e comparados a modelos sem contenção e a medição ocorreu na área fraturada e na área intacta (n=5). A movimentação do processo alveolar fraturado foi medida (3 vezes por modelo/por tipo de contenção) na região fratura e na região intacta adjacente utilizando um deflectômetro (Instron) sob a mimetização de um ciclo mastigatório (100N) na região palatinas dos incisivos. Os resultados da movimentação (μm) foram analisados pelo Teste Two-Way ANOVA seguido por teste de Tukey HSD (α=0.05).

Resultado: a movimentação do processo alveolar intacto não foi influenciada pelo tipo de contenção e se manteve constante durante todo ciclo de carga ($p>0,05$). O modelo sem contenção demonstrou um significante aumento da movimentação do processo alveolar fraturado quando comparado aos modelos com algum tipo de contenção ($p<0,001$). Aumentando o diâmetro do fio utilizado na contenção de 0,3mm para 0,9mm demostrou uma significativa diminuição da movimentação na região fraturada ($p<0,001$). Contudo, não houve diferença entre os modelos com os fios 0,9mm e 1,2mm. As contenções com o fio de 0,9mm ($p=0,123$) e 1,2mm ($p=0,123$) se mostraram similares em relação à movimentação na região de alvéolo intacto.

Conclusão: a rigidez da contenção influenciou significativamente a movimentação da região de alvéolo fraturado. O uso de contenções com fio de 0,9mm de diâmetro foi eficiente na redução da movimentação do processo alveolar fraturado, onde a movimentação foi próxima a do processo alveolar intacto.

Palavras-Chaves: traumatismo dentário, fixação de fratura, movimentação, ancoragem dentária, rigidez

Abstract

Aim: measure the displacement of the alveolar buccal bone of a fractured region when it is compared to an intact region using an *in vitro* model with four teeth aiming observe the effect of the rigidity of a dental trauma splint

Materials and Methods: to mimic a maxilla, four bovine incisors were placed in a plastic model made of polystyrene resin. To simulate the periodontal ligament (PDL), polyether was used. The fracture was designed in the model covering one tooth and the fractured bone was adhered to the model by the simulated PDL. The splints were created with four wires in different diameters (0.3, 0.6, 0.9 and 1.2mm). Models without splints were also tested. The measure of the displacement in the fractured region and in the intact region was made 3 times by a deflectometer (Instron) under a dynamic cycle with 100N on central incisor palatines. Data of the displacement were advised in micrometers and analyzed using Analyze of Variance followed by Tukey Test (α=0.05)

Results: in relation to the intact alveolar process, the displacement in all situations of dental trauma splint were not different between them ($P>0.05$). The higher displacement found was in the without splint model and it was different of all other situations ($P<0.001$). When the diameter was increased, the displacement had been decreased ($P<0.001$). Dental trauma splints made with 0.9 and 1.2mm showed no difference ($P=0.123$).

Conclusions: dental splint rigidity has shown influence on the fractured alveolar process mobility. The use of 0.9 mm and 1.2mm wire showed to be efficient to reduce the fractured alveolar process displacement when compared with the intact alveolar process.

KEYWORDS: dental trauma, fractured alveolar process, alveolar displacement, dental trauma splint

Introdução e Referencial teórico

1. INTRODUÇÃO E REFERENCIAL TEÓRICO

De acordo com a Organização Mundial de Saúde, o traumatismo dentoalveolar está configurado entre os principais problemas de saúde pública em todo o mundo, assim como a doença cárie e o câncer bucal (Petersen *et al.*, 2005). De fato, alguns estudos apontam que na população infantil o traumatismo dental se apresenta como o problema de saúde oral mais severo, já que é observado um declínio na prevalência de cáries dentárias em vários países (Changing patterns of oral health and implications for oral health manpower: Part I. Report of a Working Group convened jointly by the Federation Dentaire Internationale and the World Health Organisation, 1985).

O traumatismo dentoalveolar (TDA) é bastante frequente na sociedade. Em escala mundial, cerca de 85% das emergências odontológicas estão relacionadas aos TDA (Petti *et al*, 2018). Cerca de 5% dos traumatismos afetam diretamente a região oral, mesmo que esta represente 1% da área total do corpo (Petersson *et al*, 1997). Os acidentes automobilísticos, juntamente com o aumento da violência e práticas desportivas são os maiores responsáveis pelos casos de traumatismo dentoalveolar, que hoje, é considerado um problema de saúde pública (Silva-Oliveira *et al*, 2017)

Há diversos tipos de traumatismos que afetam a cavidade bucal, dentre eles estão a fratura alveolar e a luxação lateral. Elas afetam cerca de 5,5% da população que sofre traumatismo dentoalveolar. Essas duas situações se assemelham no que diz respeito à fratura do osso alveolar, que ocorre nas duas situações (DiAngelis *et al*, 2012). Normalmente, são resultados de traumas graves na região da face, como acidentes automobilísticos, de motocicleta e, até mesmo por agressão (Toprak *et al*, 2014). A fratura do osso alveolar pode causar diversos prejuízos ao paciente, podendo levar à perda do elemento dentário. A instabilidade do osso fraturado gera dor, desconforto ao paciente, interferências oclusais, além da reabsorção da região fraturada (Gutmacher Z *et al*, 2017)

O guia para tratamento de traumatismos dentoalveolares escrito *pela International Academy of Dental Traumatology* (*IADT)* recomenda a utilização de contenções dentárias para ambas as situações. Para as fraturas alveolares propriamente ditas, o tratamento deve ser o uso de contenções por 3-4 semanas. Já para as luxações laterais, o recomendado é instalação de contenções semi-rígidas (Diangelis *et al*, 2016). Contudo, a utilização de contenções rígidas para tratamento de traumatismos que envolvem fraturas alveolares demonstra melhores resultados quando comparadas às contenções semi-rígidas (Kahler B *et al*, 2016).

Uma vez indicada a contenção rígida, para os casos que envolvam fraturas alveolares, não há consenso sobre quais materiais devem ser utilizados na construção desse aparelho (Berthold *et al,* 2012; Franz *et al*, 2013). Fios ortodônticos constituídos de diferentes ligas metálicas foram descritos como possibilidades para construção de contenção rígidas (Franz *et al* 2013; Berthold *et al* 2011; Berthold *et al*, 2009). Outros materiais como a fibra de quartzo também tem sido descrito como possibilidade na construção de uma contenção rígida (Berthold *et al*, 2012). Para ambos os materiais, o diâmetro da peça utilizada foi significativo para a rigidez.

A mastigação é um processo dinâmico, onde as forças oclusais se dissipam entre as estruturas de suporte dentário, tais como o ligamento periodontal e o osso alveolar (Lin *et al*, 2017), portanto é fundamental que a contenção se matenha estável frente a este desafio. Desta forma, o sistema adesivo e a resina composta a serem utilizados devem apresentar propriedades mecânicas adequadas a esta finalidade para que, assim, suportem os ciclos mastigatórios do paciente sem o colapso das regiões de adesão da resina ao esmalte dentário ou ao fio utilizado (Burcak *et al*, 2006).

Baseado na dificuldade clínica da qual apresenta o estudo dos traumatismos dentoalveolares quem envolvem fraturas ósseas, a utilização de modelos artificiais em estudo *in vitro* se mostram como um meio eficiente nestes casos (Berthold *et al*, 2012; Franz *et al*, 2013; Clark *et al*, 2019). Estudos *in vitro* possibilitam a mensuração de propriedade mecânicas dos materiais envolvidos, pois é possível controlar as variáveis aplicadas ao sistema testado. Em testes que avaliam a rigidez de contenções, a medição desta propriedade pode ser realizada pelo deslocamento do próprio fragmento fraturado ou pelo deslocamento do(s) dente(s) envolvidos na fratura (Franz *et al*, 2013) e também em ensaios estáticos ou dinâmicos (Berthold *et al*, 2011), sendo os testes dinâmicos mais fidedignos às situações clínicas, uma vez que a mastigação é um processo dinâmico (Lin *et al*, 2017).

Portanto, o objetivo deste estudo é testar a influência de diferentes espessuras de fios ortodônticos na rigidez da contenção dentária utilizadas em traumas que envolvam fraturas alveolares, comparando o deslocamento de um osso alveolar fraturado com um osso alveolar intacto adjascente, frente a um desafio mastigatório dinâmico e cíclico.

Capítulo 1

1. CAPÍTULO 1

ARTIGO

Fractured alveolar process displacement evaluation – effect of rigidity of wire-composite splints

***Artigo a ser enviado para o periódico Dental Traumatology**

Fractured alveolar process displacement evaluation – effect of rigidity of wire-composite splints

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Running title: Effect of rigidity of wire-composite splints

Keywords: dental trauma, Fractured alveolar process, displacement, wire-composite splint, rigidity.

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Aim: evaluate the alveolar buccal bone displacement at region of traumatized incisor compared with region of the adjacent central incisor using simulated model of anterior maxilla in order to identify the effect of different rigidity of wire-composite splints.

Materials and Methods: a model of the maxillary central and lateral incisors was created using polystyrene resin and bovine incisors simulating periodontal ligament (PDL). The alveolar process fracture was created maintaining the buccal bone connected only by simulated PDL. Four wire-composite splints (0.3, 0.6, 0.9 and 1.2mm in diameter) were created and compared with models without splint and also with no fracture area (n=5). The fractured alveolar process displacement was measured (3 times per model/per each splint type) at fractured and adjacent central incisors regions using deflectometer (Instron) under a functional chewing cycling fatigue (100N) on central incisor palatines. Data of displacement (μm) were analyzed using two-way ANOVA followed by Tukey HSD test ($\alpha=0.05$).

Results The alveolar process displacement at region of the adjacent incisor was not influenced by splint and maintained stable during all cycle loading ($P>0.05$). Model without splint had significant higher alveolar process displacement at traumatized tooth than all other models with splint ($P<0.001$). Increasing the wire diameter from 0.3 to 0.9 the alveolar process displacement reduced significantly ($P<0.001$). However, no difference was observed between 0.9 and 1.2mm wire-composite splint. Splint using 0.9mm ($P=0.123$) and 1.2mm ($P=0.219$) wire resulted in similar alveolar process displacement measured at adjacent tooth region.

Conclusions Wire-composite rigidity influenced significantly on the fractured alveolar process mobility. The use at least 0.9 mm wire-composite splint was efficient to reduce the fractured alveolar process displacement at similar level to adjacent no traumatized teeth.

Introduction

Although the face area represents just 1% of all body area, 5% traumatic lesions are on the face (1). More than one billion of living people have had traumatic dental injurie (TDI) around the world (2), making the dental trauma considered an important public health problem worldwide (3). There are several types of traumas on the face that can affect the tooth structures and all support tissues (4). Lateral luxation is a dental trauma injury that invariably causes the fracture of alveolar process bone (5). This occurs after severe trauma events as motorcycle, bike or car traffic accident and violence (6). The prevalence of alveolar bone fracture involve around 5.5% of dental injury (7) and can causes many complications to the patient who suffered dental trauma injury (5).

The recommended treatment by International Association of Dental Traumatology (IADT) for alveolar bone fracture involves reposition the fragment and splint for 4 weeks. When the TDI is a lateral luxation, the recommended is use flexible splint for 4 weeks and if have had a bone breakdown, splint for 3-4 weeks (4). In the IADT guideline (4) there is no consensus about the material that should be used to achieve the right rigidity adequate for different types of TDI. The movement of fractured fragment can result in pain, function interference, delayed fracture healing, and lead to bone resorption (5). There is not enough scientific data to support the flexible splint stabilize the bone and the rigid stabilization is fundamental to bone fracture healing (8). The indication of a rigid splint has been indicated as the better approach to the management of alveolar bone fracture (9,10).

Once defined the indication of rigid splint, there is no consensus about the correct material should be used to produce this effect (10,11). Some studies indicate the use of orthodontics wires (11–13), quartz-fiber (10) that are evaluable in different thickness, determining the range of rigidity level. Other important factor that should be accessed for maintaining the stabilization of the splint and consequently the alveolar bone fracture is the mastication process. The dynamic movement and loading in different intensity can generate fatigue on the splint, determining the challenge on the adhesive process and resin composite orthodontic wire integration (11,14).

Based on the impossibility to make clinical studies with patients whose suffered TDI, *in vitro* are a good option to study this condition (15). In i*n vitro* tests this rigidity can be measured by the bone displacement or the tooth movements using some different methodologies. Measure stress, stress and displacement can collaborate with better biomechanical performance of splint for dental trauma. However, the calculation experimentally the performance of the resin composite/ orthodontic wire splint using artificial model created with materials that have mechanics properties, such as elastic modulus, similar to the natural dental and bone seems to be the better option to perform this study.

Therefore, the aim of this study was to evaluate the displacement of fractured alveolar process during functional bite loading compared with alveolar process adjacent central incisor influenced by wire-composite splint with different rigidity. The null hypothesis tested was that the displacement of fractured alveolar process would not be affected by rigidity of wire-composite splint.

Materials and Methods

Models confection

This study used an experimental model made with polystyrene resin used to simulate the bone structure, bovine incisor teeth and periodontal ligament simulated using polyether impression material (n=5). Polystyrene resin material has the elastic modulus similar to the alveolar bone and has been used for tooth embedment for tooth fracture and tooth mobility for creating the bone structure, at first, one model was carved out in red wax (Lysanda, São Paulo, Brazil) with four bovine teeth, mimicking four alveolus. To standardize the height and width of the crowns, they were worn with sandpapers (3M, Sumaré, São Paulo, Brazil). This model was copied using polyvinylsiloxane impression laboratory material (Aerojet blue, Brazilian Aerojet of Fiberglass, São Paulo, Brazil). The replica made in silicon, was poured with polystyrene resin (Cristal, Piracicaba, São Paulo, Brazil), mixed with the proportion of 100g of resin and 5 g of catalysator. After 24 hours, the time for polymerization of polystyrene resin, this process was repeated five times to produce 5 standardized models. This methodology is described by Soares et al, 2011 (16).

Teeth Selection and Individualization of the model

The bovine incisor teeth were collected, cleaned removing soft tissue and conserved in distilled water at 4ºC. Collected teeth with similar shape and size and that present straight root were selected and divided in 4 groups. Then, the alveoli of the artificial model were individualized using bur #1516 (Edenta, São Paulo, Brazil) for handpiece, until the teeth could be inserted easily into the alveolus. After this, the roots of selected teeth were covered with layer of melted wax with 0.3 mm of thickness to get the space of periodontal ligament. These teeth were covered with petroleum gel (Farmax, Divinópolis, Brazil) and all the alveolus were individualized with polystyrene resin.

Periodontal Ligament simulation

The periodontal ligament simulation was performed as recommended by Soares et al, 2005 (17). The wax was removed of the teeth roots were cleaned pumice paste (Coltene, Rio de Janeiro, Brazil) and rubber cup. The alveolus was filled with polyether impression material (Impregum Soft, 3M-ESPE, Seefeld, Germany) and the teeth were inserted into the alveolar space. After polymerization, the excesses were trimmed with LeCron spatula (S.S. White Duflex, Rio de Janeiro, Brazil).

Splinting

Orthodontics NiCr wires in four different diameters were used in this study: 0.3mm, 0.6mm, 0.9mm (Morelli, Sorocaba, SP, Brazil) and 1.2mm (Orthometric, Marília, SP, Brazil). All the wires were trimmed and designed individually, for fitting passively at each model to. The buccal enamel was conditioned with phosphoric acid 37% (Condac 37, FGM, Joinvile, SC, Brazil) for 40 second, then rinsed and dried. The adhesive system (Ambar APS, FGM, Joinvile, SC, Brazil) was applied actively using microbrush (FGM, Joinvile, SC, Brazil) for 20s, air dried to remove the excess, and then light-cured for 40 seconds using the Radii Plus light curing unit (SDI, São Paulo, Brazil) that emitted 1.500 mW/cm^2, checked in MARC Resin Calibrator (BlueLight Analytics, Halifax, Canada). The nanohybrid resin composite (Vittra APS, FGM, Joinvile, SC, Brazil) increments of approximately 2mm were standardized in round corners square shape and were positioned at the center of conditioned enamel surface. The wire was positioned over the first resin composite layer and was light-cured for 40s. A second resin composite layer was inserted over the wire and was light-cured for 40s. The splints were positioned at medium third of the tooth crowns.

Fracture Design

The simulation of bone alveolar process fracture was performed in just one alveolus per each model, always located in the central incisor. The fracture was designed in all models with the same shape: 10 mm of height and 12mm of width. The polystyrene resin was cut using diamond bur nº 330 (KG Sorensen, Barueri, SP, Brazil) over the delimitated area, ensuring that the buccal surface of alveolar process was not connected with the base of the model. The fractured part of the alveolar process was stabilized only by interaction with simulated PDL, representing the total fracture occurred clinically.

Mechanic Test and measurement of fracture alveolar process displacement

Masticatory forces were simulated using a closed-loop artificial mouth electrodynamic machine (ElectroPlus E3000, Instron, Norwood, MA, US)). The mastication load was applied through a flat metalic antagonist palatal angle of 30º with the flat surface contacting of the incisal edge (Fig.1). For this purpose, the metallic device was created to stablish the base model maintaining the angulation of anterior teeth. A total of 200 cyclic load was applied at a frequency of 1 Hz, starting with a load of 100 N (20N - 100N). A displacement strain deflectometer with magnetic base for mounting (W-E401-J, Intsron) was placed touching the tip in the center of the fracture alveolar process to measure de simulated bone displacement. The displacement was measured at real time during the 100N fatigue cycling. When the fatigue cycling finalized, the deflectometer was placed at the same location on the adjacent alveolus, an intact alveolus (control), and the fatigue cycling was performed again using the same parameters. It was repeated three times to each wire-composite splint sample and location of measurement.

When a sample was tested, the wire and resin composite were removed using diamond bur #2200FF (KG Sorensen, Barueri, SP, Brazil) and the enamel surface was cleaned with pumice paste and rubber cup. Then the new splint was made with the thinner wire or the model was tested with no splint. During the model changing, it was performed the tuning wizard of the fatigue machine to calibrate the load. The deflectometer was also calibrated, as recommended by the fabricant for all tests.

Statistical analysis

The alveolar process displacement data were tested for normal distribution (Shapiro–Wilk test) and equality of variances (Levene's test), followed by parametric statistical tests. Two-way analysis of variance (ANOVA) was performed to analyze the displacement data followed by Tukey's test. All tests were performed using a significance level of $\alpha = 0.05$, and all analyses were performed using the Sigma Plot version 13.1 statistical package (Systat Software Inc., San Jose, CA, USA).

Results

The values of alveolar process displacement during the simulation at 100 N fatigue bite cycling are shown in Figure 1. Two-way ANOVA showed significant differences in the alveolar process displacement for the location of measurement factor ($P < 0.001$), the splint type ($P < 0.001$) and for the interaction between both factors ($P < 0.001$). The displacement of alveolar process of adjacent incisor was similar for all tested groups ($P > 0.05$). The displacement measured at fractured alveolar process was higher for models without splint, followed by 0.3mm, 0.6mm wire-composite resin splints. The displacement values of fractured alveolar process were similar for 0.9 and 1.2 wire-composite splint and lower than other groups. The displacement values measured at fractured alveolar process region was significantly higher than at intact alveolar process adjacent tooth area for model without splint, and models with 0.3 and 0.6mm wire-composite splints ($P <0.001$). However, 0.9mm ($P=0.123$) and 1.2mm ($P=0.219$) wire-composite splints resulted in similar displacement values between fractured and intact alveolar processes.

The curves of alveolar process displacement values recorded during functional bite of 200 cycles loading measured at fractured alveolar process and intact alveolar process at adjacent tooth are shown in Figure 2. The models without splint showed curve of fractured alveolar process with crescent values when increasing the number of cycles. The use of splint tended to stabilize the values of displacement measured at fractured alveolar process, irrespective of rigidity level of the wire-composite resin splint. The 0.9 and 1.2mm the wire-composite resin splint showed very similar curves of displacement measured at intact and fractured alveolar process.

Discussion

The displacement of fractured alveolar process was influenced by rigidity of wire-composite splint, the use of 0.3 and 0.6mm did not stabilize the fractured portion of the alveolar process as 0.9 and 1.2mm did at similar level of intact alveolar process with no fracture. Therefore, the null hypothesis was rejected.

The complexity to study real traumatic dental injuries situations in large scale justify the use of artificial models, although the simulation should be most close to the oral environment as possible. *In vivo* studies have been conducted and have the advantage of a natural PDL (18,19) and the disadvantage of do not have a pathological mobility (18). However, *in vitro* studies allow the models to be optimized and replicated creating more reliable for the results. The artificial models used for simulating dental trauma can be made in plastic resins (20) or metal (21). The model created in this study considered the similarity of elastic modulus of polystyrene resin used to the alveolar bone (16) and the simulation of periodontal ligament (16,17). Another limitation of the artificial models is the use artificial teeth, limiting the adhesive interaction between the resinous materials with the enamel structure. Using bovine incisor teeth allowed the adhesive integration between natural enamel, adhesive system and wire- resin composite stabilization. Several studies have used bovine teeth in replacing human teeth by the facility of obtention and ethics reasons (12,14,22). In this study, the teeth were standardized in shape and size to better simulate the human teeth. However, no modification was performed at buccal surface of anterior teeth where the splints were fixed.

The performance and indication of splint indicated for dental trauma depends on its severity (23,24). The rigidity of splint is related to the extension (13), material used (12) and dimension the of adhesive/resin composite point of fixation (11). Other studies have investigated the rigidity of dental trauma splint, although, none testing the displacement of alveolar bone, only the teeth displacement (10,13,25). For bone fracture healing, it has been recommended as fundamental that the fractured bone be maintained with no movement (8). The rigid splints are recommended for treating the alveolar process fractures to prevent its movement and promote the bone repair (7). According to the results of this study, the splint made with the 1.2mm and 0.9mm-diameter wires showed similar mechanical behavior when comparing the fractured alveolus and the intact alveolus (control), not permitting a big displacement of the fractured alveolus, therefore they can be used as a rigid splint. The 0.6mm and 0.3mm permitted a bigger movement of the fracture when compared to the intact alveolus, so they should be considered as not-rigid splint and not indicated to alveolar fracture (5,13).

The resistance of the splint is also an important clinical aspect that should be considered. Increasing the rigidity is possible to increase the possibility of the resin composite fracture or debonding (11), compromising the stability of fracture. No debonding or composite resin fracture was observed for all tested group. It is necessary to emphases the use of materials with adequate mechanics properties for making dental trauma splint. None of our models had fractures the composite resin or had the adhesive process failed. The use of nanohybrid resin composite with high fluorescence that facilitate the splint remove should be indicated. The selective etching on enamel should be prioritized to better interaction with enamel structure (26).

The alveolar bone and periodontal ligament form the dentoalveolar joint. It is responsible to absorb physiological or pathological forces (27). Thus, it is expected this complex joint be displaced during physiologic force application. What can be saw at our study, that is the results of all teeth adjacent to the alveolar fracture were not influenced by the material of the splinting.

Non-stabilized bone fractures show a marked delay in bone healing compared to stabilized fractures (28). This delay may be caused by molecular gene expression with more pronounced indian hedgehog expression in non-stabilized fractures, which was associated with a delay in chondrocyte differentiation (29). Stabilization helps also the periodontal ligament to have better repair conditions, however those devices should be the least traumatic as possible (30).

Dental splint rigidity should be adapted to the type of dento-alveolar trauma (11). When treating dental trauma that result in alveolar process fracture the use of rigid splint is recommended to stabilize the bone fracture favoring the bone healing. However, the definition of the rigidity must be defined by the balance between fracture stability and ease of preparation. Although the splints made with 1.2mm and 0.9mm wires showed similar mechanics results, but it is hard to adapt this first one on teeth crowns because of its rigidity. Beyond the mechanic properties, 0.9mm wire is easier to manipulate than the 1.2mm wire facilitating the adaptation made manually by clinicians. In addition to clinical parameters such as stability, physiologic mobility of splinted teeth as well as ease of use, splints in dental trauma should not interfere with the comfort of the patient (30). Increasing the volume of the splinting more impairment on the patient comfort can be observed, this justify the preference for 0.9mm in comparison with 1.2mm. Higher volume of the wire-resin composite splint can create more difficult to clean and therefore leads to greater irritation of the gingival margin and also discomfort to the lip (30). Therefore, the wire-composite splint using 0.9mm wire can be considered the best option for treatment of alveolar process fracture.

Conclusion

Within the limitations of this *in vitro* study, the following conclusion can be draw:

- The 0.3 and 0.6mm wire-resin composite reduced the fracture mobility however no at the level of adjacent non-fractured alveolar process;
- 0.9mm and 1.2mm wire-composite have a rigid-splint behavior to result in stability similar to non-fractured alveolar process.

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Figures

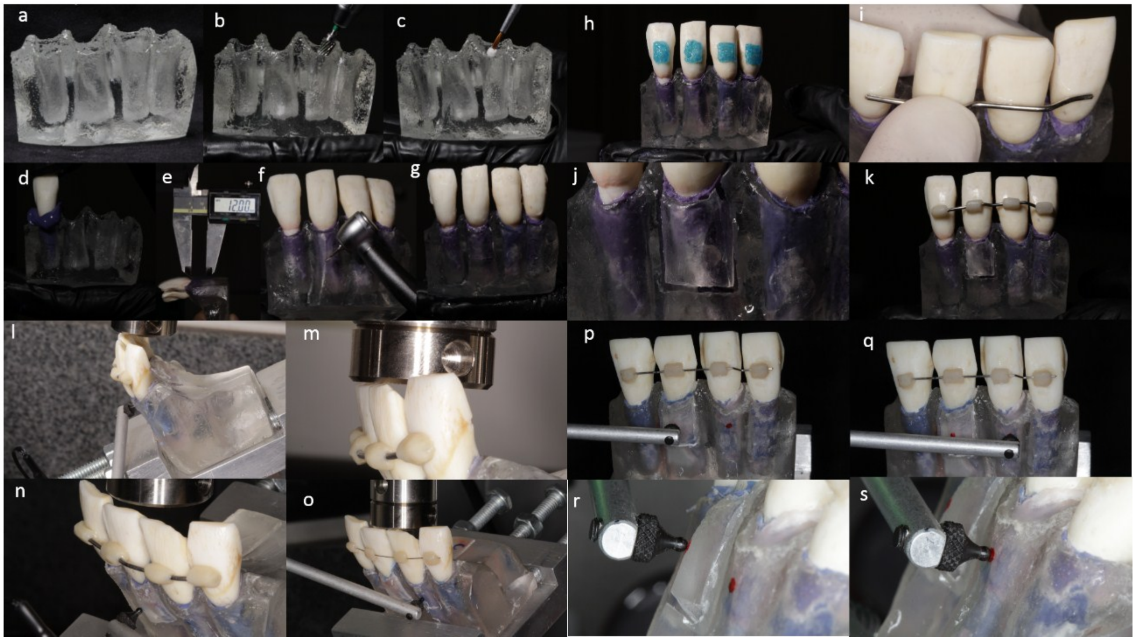

Figure 1. Model confection, fracture design and wire-composite splint building (a-k). Positioning the model in the Instron Machine and test performance, the contact of the teeth with de machine was always in just 2 teeth and the model was positioned in a 30º in relation to the piston of loading (l-o) and the deflectometer was positioned in the fractured alveolar process and in the intact alveolar process (p-s).

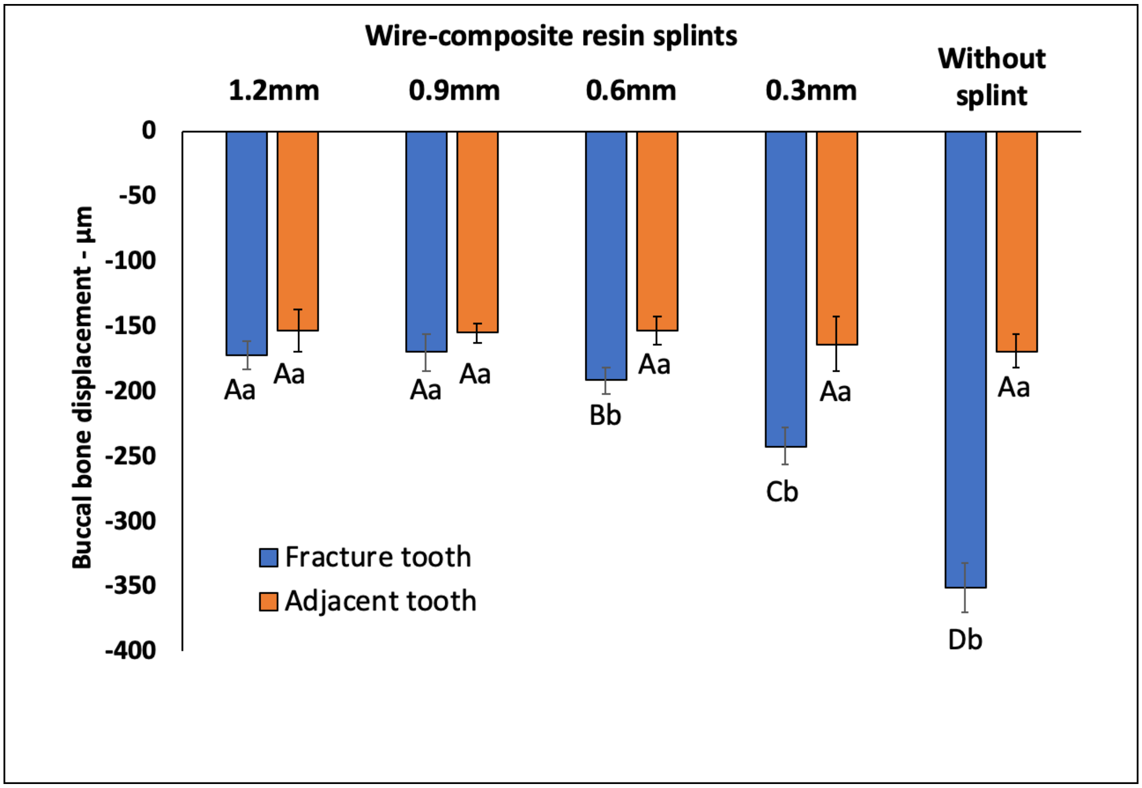

Figure 2. Mean and standard deviation of alveolar process displacement values during the simulation at 100 N with different wire-resin composite. Different capital letters demonstrate significant differences among the splint conditions; different lower caser letters tested demonstrate significant differences between the location measured (P<0.05).

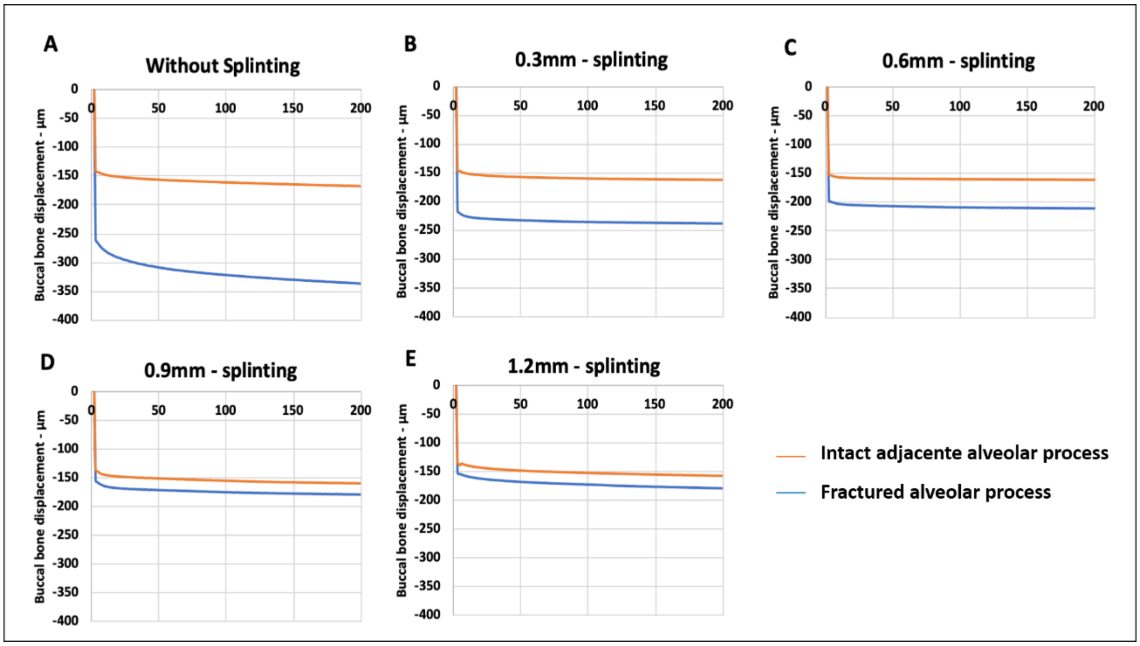

Figure 3. Curves of alveolar process displacement values recorded during functional bite of 200 cycles loading measured at fractured alveolar process (orange lines) and intact alveolar process at adjacent tooth (blue lines); A. without splint; B. 0.3mm wire-resin composite splint; C. 0.6mm wire-resin composite splint; D. 0.9mm wire-resin composite splint; and E. 1.2mm wire-resin composite splint.

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Anexos

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Corporate Author

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Journal Articles

Lam R, Abbott PV, Lloyd C, Lloyd CA, Kruger E, Tennant M. Dental trauma in an Australian Rural Centre. Dent Traumatol 2008; 24: 663-70.

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