A new occlusal splint design for protection of anterior aesthetic rehabilitation in patients with sleep bruxism: technical note

Um novo design de placa oclusal para proteção da reabilitação estética anterior em pacientes com bruxismo do sono: nota técnica

Un nuevo diseño de placa oclusal para la protección de la rehabilitación estética anterior en pacientes con bruxismo del sueño: nota técnica

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Abstract

This dental technique note describes the manufacture of a new design of occlusal splint for protection of shear forces in anterior aesthetic restorations in patients with sleep bruxism, using the computer-aided design and computer-aided manufacturing (CAD/CAM) technique. Maxillary and mandibular arches were scanned and a Jig with polyvinyl siloxane material was made to maxillomandibular relationship record. For interocclusal device planning, the anterior limits must not cover the buccal surfaces of the anterior teeth, extending only on the incisal of these dental elements. The device is then virtually designed, and the CAD file of splint is sent to CAM milling process. The occlusal splint was tested for stability, insertion and removal, the distribution of occlusal contacts and care instructions were given to the patient. This device design avoids contact between splint and anterior aesthetic restorations during occlusal forces decreasing potential of failure, which increases the success rate of these previous aesthetic rehabilitations.

Keywords: Sleep bruxism; Temporomandibular joint disorders; Mouth rehabilitation.

Resumo

Esta nota técnica odontológica descreve a confecção de um novo desenho de dispositivo interoclusal para proteção das forças de cisalhamento as restaurações estéticas anteriores em pacientes com bruxismo do sono, utilizando a técnica de desenho e manufatura auxiliada por computador (CAD / CAM). Os arcos maxilar e mandibular foram digitalizados e um Jig com material de polivinil siloxano foi feito para registro da relação maxilomandibular. Para o planejamento de dispositivo interoclusal, os limites anteriores não devem cobrir as superfícies vestibulares dos dentes anteriores, se estendendo apenas na incisal destes elementos dentários. O dispositivo é então projetado virtualmente e o arquivo CAD é enviado para o processo de fresamento CAM. A placa oclusal foi testada quanto à estabilidade, inserção e remoção, a distribuição dos contatos oclusais e instruções de cuidados foram dadas ao paciente. Este projeto do dispositivo evita o contato entre a tala e as restaurações estéticas anteriores durante as forças oclusais que diminuem o potencial de falha, o que aumenta a taxa de sucesso dessas reabilitações estéticas anteriores.

Palavras-chave: Bruxismo do sono; Transtornos da articulação temporomandibular; Reabilitação bucal.

Resumen

Esta nota técnica dental describe la realización de un nuevo diseño de dispositivo interoclusal para proteger las fuerzas de cizallamiento de restauraciones estéticas previas en pacientes con bruxismo del sueño, utilizando la técnica de diseño y fabricación asistida por computadora (CAD / CAM). Se digitalizaron los arcos maxilar y mandibular y se realizó un Jig con material de polivinilsiloxano para registrar la relación maxilomandibular. Para la planificación del dispositivo interoclusal, los límites anteriores no deben cubrir las superficies bucales de los dientes anteriores, extendiéndose solo en el incisal de estos elementos dentales. Luego, el dispositivo se diseña virtualmente y el archivo CAD se envía al proceso de fresado CAM. Se probó la estabilidad de la placa oclusal, su inserción y extracción, la distribución de los contactos oclusales y se dieron instrucciones de cuidado al paciente. Este diseño del dispositivo evita el contacto entre la férula y las restauraciones estéticas previas durante las fuerzas oclusales que disminuyen el potencial de falla, lo que aumenta la tasa de éxito de estas rehabilitaciones estéticas anteriores.

Palabras clave: Bruxismo del sueño; Trastornos de la articulación temporomandibular; Rehabilitación bucal.

1. Introduction

Occlusal Splints (OS) are used to treat temporomandibular dysfunction and/or bruxism. The therapeutic mechanisms are not yet completely clarified, though many proposal were made: (1) modifications in the input feedback mechanism of peripheral oral receptors; (2) reduction in masseter and temporal EMG activity (Jokubauskas, Baltrušaitytė & Pileičikienė, 2018; Silva et al., 2020); (3) placebo; (4) changes in the condylar position; and (5) cognitive awareness (Carlsson, 2010; Sjoholm, Kauko, Kemppainen & Rauhala, 2014).

While many studies confirm the effectiveness of OS treatment for Sleep Bruxism (SB), admitted evidence is incapable to reinforce its role in the long-term reduction of SB (Jokubauskas et al., 2018). The OS contributes to preserve natural teeth from excessive wear and can act to dissipate the extra stresses generated due to SB and create a biomechanical balance between the physiological loading and the created stress (Sjoholm et al., 2014; Gholampour, Gholampour & Khanmohammadi, 2019; Carvalho et al., 2020). It is the most popular management strategy to prevent the consequences of SB and tooth grinding (Singh et al., 2015).

The CAD/CAM technique has been used from OS fabrication (Lauren & McIntyre,

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2008; Waldecker, Leckel, Rammelsberg & Bömicke, 2019; Vasques, Mori & Laganá, 2020). For occlusal splint, a full-arch digital impressions are necessary, a specialized CAD software is used to design splints and a computerized milling device or 3-dimentional (3D) printing (Lauren & McIntyre, 2008; Ender & Mehl, 2015; Zimmermann, Koller, Rumetsch, Ender & Mehl, 2017; Prpic et al., 2019). The advantages of this technology is the capacity to store and reproduce the devices, accurate and consistent digital control over articulation, splint design and production and a quicker splint fabrication (Lauren & McIntyre, 2008; Waldecker et al., 2019; Vasques et al., 2020). Digital splints can be produced using many materials including cold-cure acrylic, hard/soft materials, heat-softening acrylics, and light-cure materials (Lauren & McIntyre, 2008). However, the mechanical properties of OS depend more on the material than on the manufacturing technology, but some materials as Polymethylmetacrylate (PMMA) can exhibit improved properties in comparison to the conventional heat-cured, and Polyamide and nonacrylic light-polymerizing resins for additive manufacturing (Huettig, Kustermann, Kuscu, Geis-Gerstorfer & Spintzyk, 2017; Prpic et al., 2019; Lutz et al., 2019; Al-Dwairi, Tahboub, Baba & Goodacre, 2020).

This dental technique describes a new design of occlusal device for protection of shear forces in anterior aesthetic restorations in patients with sleep bruxism, using a fully digital workflow.

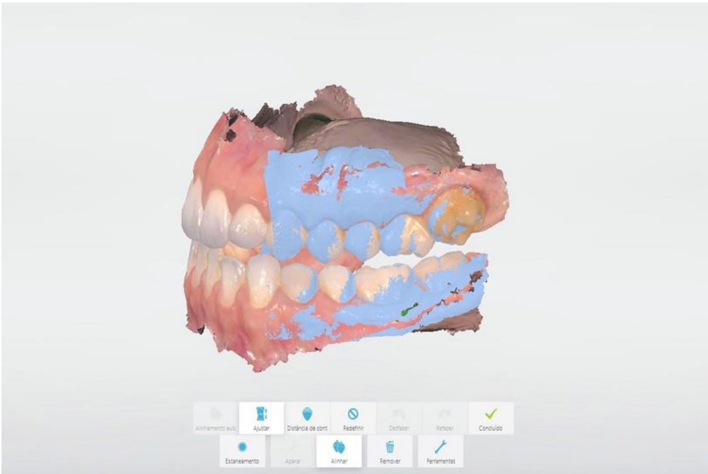
2. Technique

1. Execute a full-arch intraoral scan in accordance with the scanning procedure recommended by the manufacturer (TRIOS, 3shape). Use a jig with an incisal plateau from dense polyvinyl siloxane material (Elite HD, Zhermack) and insert between the central incisors to the interocclusal space registration and to digitally transfer. The distance create by jig must be no more than 3mm between mandibular and maxillary arches. This jig will stabilize the mandible during the scanning of maxillomandibular relationship record in the Figure 1. The buccal tooth surfaces are registered optically when performing the intraoral scan and the virtual models are already generated with occlusal splint space at Figure 2.

Figure 1 – “Jig” positioned to interocclusal record.

Source: Authors (2020).

Figure 2 – Virtual models with interocclusal space for splint design.



Source: Authors (2020).

2. Import the standard tessellation language (STL) files with the 3D images of the maxilla and mandible in their occlusal relationship into the CAD software (DentalCAD Valletta 2.2, Exocad). To design this type of occlusal device, the splint anterior limits must not cover the buccal surfaces of the anterior teeth at Figure 3.

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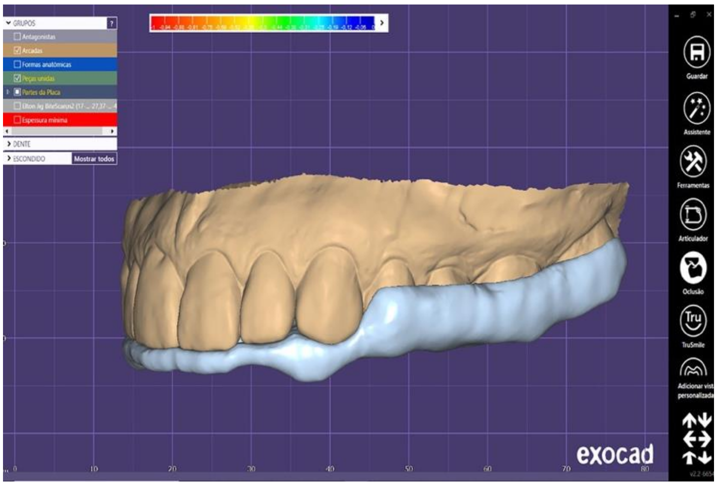
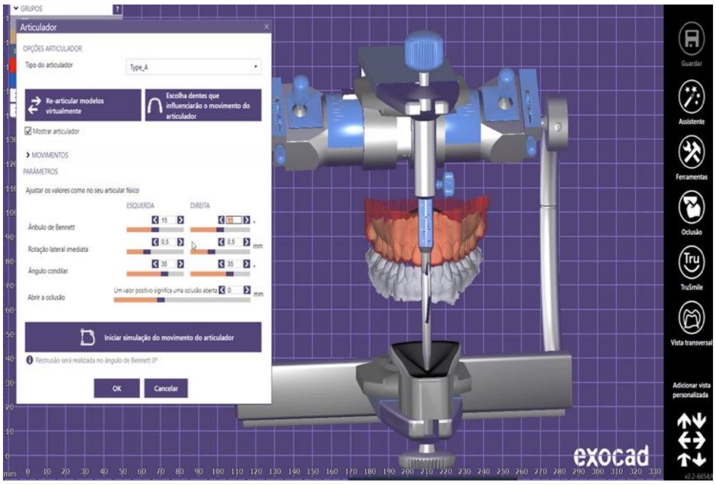
Figure 3 – Splint design without cover the buccal surfaces of anterior teeth.



Source: Authors (2020).

3. Evaluate the mandibular movements and the occlusal contacts in the virtual articulator. Can use a range of 30º to 35º for condylar angle and 15º for Bennet angle as illustrated in Figure 4.

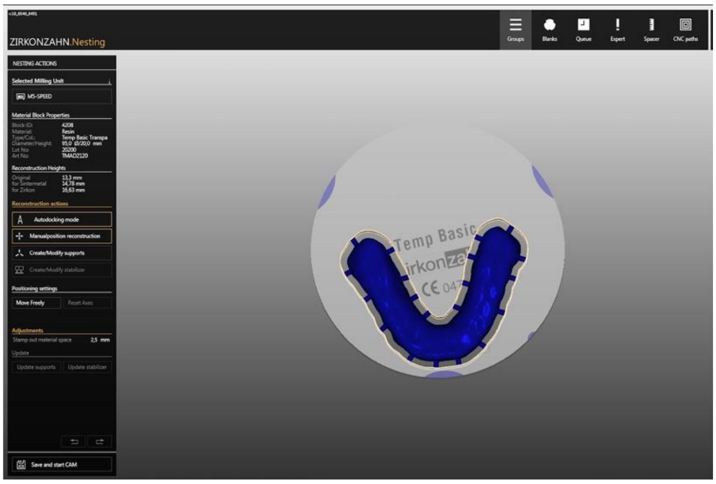
Figure 4 – Virtual models mounted in virtual articulator for adjusting occlusal contacts during anterior and lateral guidance.



Source: Authors (2020).

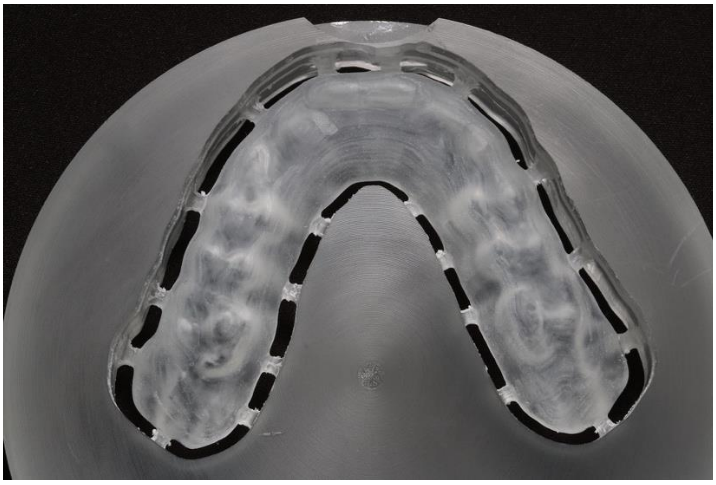
4. The splint CAD must be positioned in the virtual block like Figure 5 and sent to CAM machine (Zirkonzahn Milling M5, Zirkonzahn) for milling process, using a Polymethylmetacrylate disc for Zirkonzahn (EVOLUX PMMA, Blue Dent). After milling in Figure 6, finalize and polish the OS manually.

Figure 5 – The splint CAD positioned in the virtual block previously milling process.



Source: Authors (2020).

Figure 6 – Oclusal splint after milling process.



Source: Authors (2020).

5. Install the OS like Figure 7. Clinically, evaluate the stability and the distribution of occlusal contacts and if necessary, refine. Check the insertion and removal and give the care instructions for patient. The anterior region of OS must not be in contact with anterior teeth as illustrated in Figures 8A and 8B.

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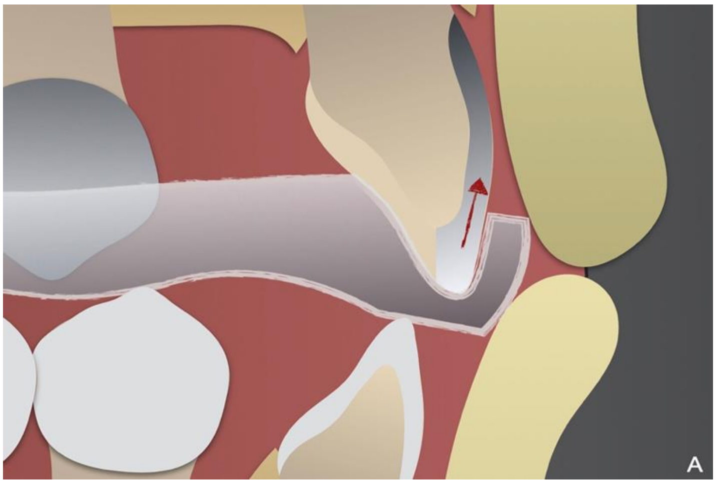
Figure 7 – Occlusal splint installed in patient with anterior upper rehabilitation.

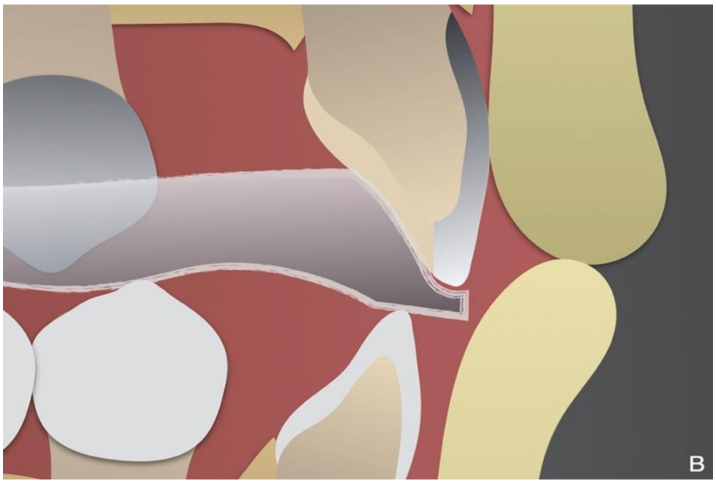
Source: Authors (2020).

Figure 8A – In conventional, the buccal region of device touches in restorations, during insertion, removal and occlusion, generating shear forces.



Source: Authors (2020).

Figure 8B – The new design avoids contacts and touches in restorations.



Source: Authors (2020).

3. Discussion

The scientific evidence is insufficient to confirm the OS role in the long-term reduction of SB activity (Jokubauskas et al., 2018). A study that investigated the effects of an OS on sleep and the masticatory muscle EMG activity after 8 weeks, concluded that OS does not have significant inhibition on muscle motor activity during sleep (Sjoholm et al., 2014). In contrast, another study observed that two different OS types significantly improved the sleep quality and decreased SB episodes in participants after 3 months (Singh et al., 2015). Although, the therapeutic mechanisms are not yet entirely clarified, it is consensus in literature that OS can protect the teeth from excessive wear in patients with SB (Carlsson, 2010; Sjoholm et al., 2014; Jokubauskas et al., 2018).

The OS production using the CAD/CAM technology has some requirements as: data acquired directly through intraoral scanners or indirectly through a dental stone cast, software to design a virtual splint, and an additive manufacturing by 3-dimensional (3D) printing or a computerized milling device (Prpic et al., 2019). A full-arch dental impression using intraoral scanners has been shown to be quickly, and to increase treatment comfort and precision when compared to the irreversible hydrocolloid material (Ender & Mehl, 2015; Zimmermann et al., 2017). The accuracy of this process is sufficiently for the fabrication of an occlusal device (Waldecker et al., 2019). To maxillomandibular relationship record, a benefit for the "Lucia jig" that one can control the posterior interocclusal space and create a stable bite position (Lauren & McIntyre, 2008; Vasques et al., 2020). The design of the splint should consider the dental anatomy to provide good seating and rely on the posterior teeth for retention (Lauren &

McIntyre, 2008). In this technique was only the posterior teeth are used for splint retention, releasing the anterior teeth of any forces.

The CAD/CAM technology allows the subtractive fabrication of OS by milling them from a polymer blanks and an additive manufacturing by 3-dimensional (3D) printing. However, 3D-printed OS can show lower wear and fracture resistance than those milled or conventionally fabricated. A study observed that CAD/CAM PMMA specimens exhibited improved flexural and impact strength in comparison to the conventional groups. The milled OS may have a better fit because of the lack of polymerization shrinkage (Huettig et al., 2017; Lutz et al., 2019; Al-Dwairi et al., 2020). Regardless of technology, the mechanical properties of OS depend more on the fabrication material (Prpic et al., 2019). For patients with bruxism, rigid splints are considered the better option.

The fully digital workflow can be a successful method for occlusal splints fabrication. In this technique, interferences, nodules, or distortions on the device were not observed, and the device fitted properly and with a few corrections with a finishing burs, occlusal contact was obtained for all posterior teeth and canine guidance. Limited access to intraoral scanners, and high cost of milling machines and 3D-printers are disadvantages of this technique (Szymor, Kozakiewicz & Olszewski, 2016; Vasques et al., 2020).

This new device design avoids contact between OS and anterior aesthetic restorations during insertion and removal and occlusal forces, thus the shear forces on restorations are eliminated, decreasing potential of failure. Clinical studies with this new design and its influence on the occlusal forces are necessary.

Final Considerations

This dental technique describes a new occlusal splint design for protection of anterior aesthetic rehabilitation in patients with sleep bruxism. The OS was manufactured using a fully digital workflow. This method can be a successful for occlusal splints fabrication and protect the anterior aesthetic restorations of shear forces in patients with sleep bruxism.

References

Al-Dwairi, Z. N., Tahboub, K. Y., Baba, N. Z., & Goodacre, C. J. (2020). A comparison of the flexural and impact strengths and flexural modulus of CAD/CAM and conventional heat-cured polymethyl methacrylate (PMMA). *Journal of Prosthodontics*, *29*(4), 341-349.

Carlsson, G. E. (2010). Some dogmas related to prosthodontics, temporomandibular disorders and occlusion. *Acta Odontologica Scandinavica*, *68*(6), 313-322.

Carvalho, G. A. O., Sousa, G. P. de, Pierote, J. J. A., Caetano, V. da silva, Lima, D. E. O. de, Costa, I. V. S., Silva, F. A. de J. C., & Lima, L. F. C. (2020). Anxiety as an ethological factor of bruxism - literature. *Research, Society and Development*, 9(7), e95973925. https://doi.org/10.33448/rsd-v9i7.3925

Ender, A., & Mehl, A. (2015). In-vitro evaluation of the accuracy of conventional and digital methods of obtaining full-arch dental impressions. *Quintessence International*, *46*(1), 9-17.

Gholampour, S., Gholampour, H., & Khanmohammadi, H. (2019). Finite element analysis of occlusal splint therapy in patients with bruxism. *BMC oral health*, *19*(1), 205.

Huettig, F., Kustermann, A., Kuscu, E., Geis-Gerstorfer, J., & Spintzyk, S. (2017). Polishability and wear resistance of splint material for oral appliances produced with conventional, subtractive, and additive manufacturing. *Journal of the Mechanical Behavior of Biomedical Materials*, *75*, 175-179.

Jokubauskas, L., Baltrušaitytė, A., & Pileičikienė, G. (2018). Oral appliances for managing sleep bruxism in adults: a systematic review from 2007 to 2017. *Journal of Oral Rehabilitation*, *45*(1), 81-95.

Lauren, M., & McIntyre, F. (2008). A new computer-assisted method for design and fabrication of occlusal splints. *American journal of orthodontics and dentofacial orthopedics*, *133*(4), S130-S135.

Lutz, A. M., Hampe, R., Roos, M., Lümkemann, N., Eichberger, M., & Stawarczyk, B. (2019). Fracture resistance and 2-body wear of 3-dimensional–printed occlusal devices. *The Journal of Prosthetic Dentistry*, *121*(1), 166-172.

Prpic, V., Slacanin, I., Schauperl, Z., Catic, A., Dulcic, N., & Cimic, S. (2019). A study of the flexural strength and surface hardness of different materials and technologies for occlusal device fabrication. *The Journal of prosthetic dentistry*, *121*(6), 955-959.

Silva, M. C. P. da, Rodrigues, C. M. de C., Figueiredo, C. E., Reis , D. C. S. dos, Almeida, V. L. de, Cardoso, S. V. ., Machado, A. C., Soares, P. V., & Paranhos, L. R. (2020). Effect of botulinum toxin treatment in patients with bruxism and orofacial pain - randomized double-blind clinical trial. *Research, Society and Development*, *9*(9), e917998206. https://doi.org/10.33448/rsd-v9i9.8206

Singh, P. K., Alvi, H. A., Singh, B. P., Singh, R. D., Kant, S., Jurel, S., ... & Dubey, A. (2015). Evaluation of various treatment modalities in sleep bruxism. *The Journal of prosthetic dentistry*, *114*(3), 426-431.

Sjoholm, T., Kauko, T., Kemppainen, P., & Rauhala, E. (2014). Long-term use of occlusal appliance has impact on sleep structure. *Journal of oral rehabilitation*, *41*(11), 795-800.

Szymor, P., Kozakiewicz, M., & Olszewski, R. (2016). Accuracy of open-source software segmentation and paper-based printed three-dimensional models. *Journal of Cranio-Maxillofacial Surgery*, *44*(2), 202-209.

Vasques, M. T., Mori, M., & Laganá, D. C. (2020). Three-dimensional printing of occlusal devices for temporomandibular disorders by using a free CAD software program: A technical report. *The Journal of Prosthetic Dentistry*, *123*(2), 232-235.

Waldecker, M., Leckel, M., Rammelsberg, P., & Bömicke, W. (2019). Fully digital fabrication of an occlusal device using an intraoral scanner and 3D printing: A dental technique. *The Journal of prosthetic dentistry*, *121*(4), 576-580.

Zimmermann, M., Koller, C., Rumetsch, M., Ender, A., & Mehl, A. (2017). Precision of guided scanning procedures for full-arch digital impressions in vivo. *Journal of Orofacial Orthopedics/Fortschritte der Kieferorthopädie*, *78*(6), 466-471.

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