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Desenho de guia tridimensional (3D) para restauração de oclusão em paciente com fratura do condilo mandibular. Resultados preliminares e desafios da implementação da tecnologia digital no serviço público.

Design of a three dimensional guide (3D) guide for occlusion restoration in a patient with a mandibular condylar fracture. Preliminary results and challenges of implementing digital technology in the public service.

Diseño de guía tridimensional (3D) para la restauración de la oclusión en un paciente con fractura condylar mandibular. Resultados preliminares y retos de la implantación de la tecnología digital en el servicio público.

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RESUMO

As fraturas mandibulares são comuns quando as condições necessárias estão presentes. Caso seja indicado o tratamento cirúrgico aberto, com fixação dos segmentos ósseos fraturados com placas e parafusos, a restauração oclusal é obrigatória. O serviço público é responsável por resolver grande parte dessa demanda de pacientes cirúrgicos e a inserção da tecnologia tridimensional (3D) tornou-se imperativa, pois auxilia imensamente no planejamento cirúrgico, aumentando o grau de exatidão do reposicionamento ósseo e, consequentemente, reduzindo as taxas de insucesso do tratamento e a possível necessidade de reoperação do paciente. A instalação da Barra de Erich é o padrão ouro para se obter a oclusão original, e na sua instalação, devido ao manuseio de fios de aço, o risco de lesão e contaminação cruzada ainda representa perigo ocupacional para o cirurgião. No diagnóstico das fraturas mandibulares, a tomografia computadorizada tem se destacado como o exame complementar que mais agrega informações ao exame clínico, permitindo ao cirurgião a visualização da fratura, inclusive em três dimensões (3D), facilitando sobremaneira o planejamento e a tática cirúrgica. Este estudo descreve os passos envolvidos na concepção de guia de restauração oclusal virtual, impressão em impressora 3D e utilização no tratamento de paciente com fratura condilar para a qual está indicada cirurgia. Os resultados iniciais, necessidades futuras e desafios também serão discutidos.

Palavras Chave: Serviço público, Fraturas mandibulares, fixação de fraturas condilares, miniplacas, tecnologia 3D.

ABSTRACT

Mandibular fractures are common when the necessary conditions are present . If open surgical treatment is indicated, with fixation of the fractured bones with plates and screws, occlusal restoration is mandatory. The public service is the place for resolving a large part of this demand for surgical patients and the insertion of three-dimensional (3D) technology has become imperative, as it helps immensely in surgical planning, increasing the degree of bone repositioning and consequently reducing treatment failure rates and the potential need to reoperate the patient. The installation of the Erich Bar is the gold standard for achieving original occlusion, and in its installation, due to the handling of steel wires, the risk of injury and cross-contamination still represents a major occupational risk for the surgeon. In the diagnosis of mandibular fractures, computed tomography has stood out as the complementary exam that adds the most information to the clinical examination, allowing the surgeon to visualize the fracture, even in three dimensions (3D), greatly facilitating surgical planning and tactics. This study describes the steps involved in designing a virtual occlusal restoration guide, manufacturing it on a 3D printer and using it to treat a patient with a condylar fracture for which surgery is indicated. Initial results, future needs and challenges will also be discussed.

Keys Words: Public service, mandibular Fractures, condylar fracture fixation, miniplates, 3D technology

RESUMEN

Las fracturas mandibulares son frecuentes cuando se dan las condiciones necesarias. Si el tratamiento quirúrgico abierto es indicado, con fijación de los segmentos óseos fracturados con placas y tornillos, la restauración oclusal es obligatoria. El servicio público es responsable de resolver gran parte de esta demanda de pacientes quirúrgicos y la inserción de la tecnología tridimensional (3D) se ha convertido en un imperativo, ya que ayuda enormemente en la planificación quirúrgica, aumentando el grado de reposicionamiento óseo y, en consecuencia, reduciendo las tasas de fracaso del tratamiento y la posible necesidad de reoperación del paciente. La instalación de

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la barra de Erich es el patrón oro para obtener la oclusión original, y en su instalación, debido a la manipulación de alambres de acero, el riesgo de lesiones y contaminación cruzada sigue representando un riesgo laboral importante para el cirujano. En el diagnóstico de las fracturas mandibulares, la tomografía computarizada se ha destacado como la prueba complementaria que más información añade al examen clínico, permitiendo al cirujano visualizar la fractura, incluso en tres dimensiones (3D), facilitando enormemente la planificación y la táctica quirúrgica. Este estudio describe los pasos necesarios para diseñar una guía de restauración oclusal virtual, fabricarla en una impresora 3D y utilizarla para tratar a un paciente con una fractura condilar para la que está indicada la cirugía. También se discutirán los resultados iniciales, las necesidades futuras y los retos.

Palabras clave: Servicio público, fracturas mandibulares, fijación de fracturas condilares, miniplacas, tecnología 3D.

INTRODUCTION

Mandibular fractures are frequent in large cities, where the necessary conditions for it to happen are found, such as crowding, high speed urban displacement and violence[1]. If open surgical treatment is indicated, with fixation of the fractured bones with plates and screws, occlusal reestablishment is mandatory. Erich Bar installation is the gold standard to reach original occlusion, and in its installation, due to the handling of steel wires, the risk of injury and cross-contamination still poses great occupational risk to the surgeon.

In the diagnosis of mandibular fractures, computed tomography has stood out as the complementary exam that adds more information to the clinical examination, allowing the surgeon to visualize the fracture, including three-dimensional (3D), greatly facilitating surgical planning and tactics.

The improvement of three-dimensional (3D) techniques is a natural evolution in many areas of health sciences. The 3D technology is already used in dentistry in various clinical situations, and several softwares are available, each indicated to perform specific tasks, either in the diagnostic, pre-clinical or clinical use, such as tray design, veneers and dental crowns, design of platforms and guides for implant installation surgeries; and in this article, in the design and manufacture of an occlusal guide, which replaces the Erich bar as a tool in intraoperative occlusal restoration. In the public service, the demand for patients who need this type of treatment is growing exponentially, in line with the increase in fast delivery services, carried out here in the city of São Paulo by motorcycle. It has even become common to see motorcyclists who have been in an accident and have fractured their facial bones and who have already had a plate installed to treat a previous facial fracture. In addition, many patients treated by the public service do not have the number of teeth and/or the quality of periodontal insertion that would allow the *erich bar* to be installed, so that we have another reference for occlusal restoration. In this type of patient, 3D technology would have a precise indication. The demand for three-dimensional digital technology has grown and has become an integral part of surgeons' arsenal in reverse planning. And the public service would not be left out of this technological revolution.

We are currently implementing a total quality program in oral and maxillofacial surgery department in Hospital Regional de Osasco SUS/SP, named as “ColosSUS Bucal”. This program aims to increase the treatment of patients who need dental care, especially in the area of oral and maxillofacial surgery. Doing more with the same resources.

This paper describes the steps, in the quest to make virtual occlusal restoration guide and its fabrication in 3D printer and use in the care of patient with condylar fracture with surgical indication[2]. Early results,

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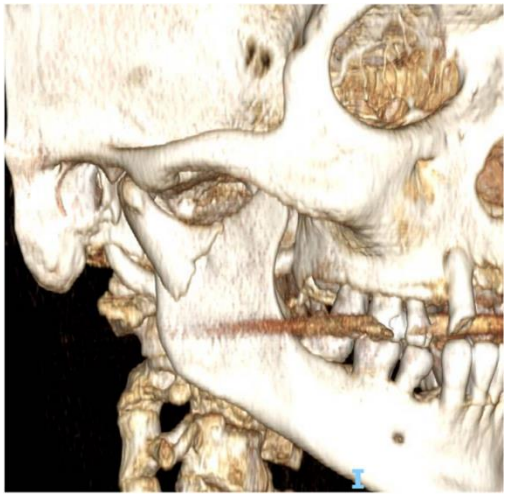
needs and future challenges, will also be discussed.

CASE STUDY

Male patient was referred to hospital Regional de Osasco SUS/SP with a history of beating, which occurred during assault. He was oriented, with normal vital signs, initially evaluated and released by the trauma team. He complained of pain in the right mandible region and presented occlusal deviation when opening his mouth. With presumptive diagnosis of condylar fracture, the patient underwent a facial computed tomography scan, which confirmed the diagnostic hypothesis (Fig 1).

Figure 1 - 3D tomographic image showing low condylar fracture.



After preoperative exams and patient consent, surgery was scheduled for fixation of the right condylar fracture. In the surgical planning, it was planned to restore the occlusion by means of a 3D guide, which would be made from the CT scan that was performed on the patient. The tomography DICOM (Digital Imaging and Communications in Medicine) data was converted into stl (Standard Triangle Language- file used for 3D impressions, created by the 3D systems-Rock Hill-South Carolina Laboratory-USA) in the software invesalius© (Renato Archer Information Technology Center-Campinas-Brazil) and then the ImplantViewer© software (Anne Solutions-São Paulo-Brazil) was used for condylar fracture reduction and occlusal alignment. The 3D guide was printed with a Formlabs© 2 3D Printer (Sommerville-Massachusetts-USA), printed in 0.5 microns.

Preoperatively, the occlusal guide was tested (Fig 2), it fit the maxilla initially, and later, only the mandible, as this was displaced by the condylar fracture.

Figure 2 - 3D printed occlusal guide under test. this guide fit the maxilla, but because the mandibular occlusion was misaligned by the condylar fracture, it did not fit the mandible.

The patient was intubated via nasotracheal tube, the fracture was accessed via the retromandibular approach, the occlusal guide was positioned, an attempt was made to reestablish occlusion, but the 3D guide was thicker on one side and required diamond bur wear, so it was decided to segment it. The fracture was fixed with a robust 4-hole 2.0-mm plate with locking system (Fig 3). (OrtomixSP, Santo André-SP)

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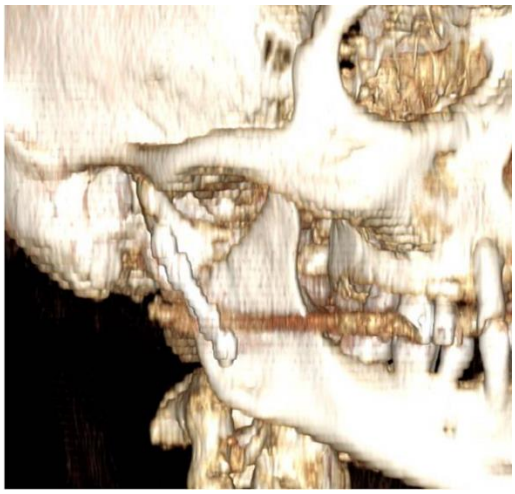
Figure 3 - Retromandibular approach. Robust miniplate fixed with locking screw, correcting the condylar fracture.

The post operative proceeded normally and the patient was discharged the next day. Occlusal function was restored, he had no motor loss of the VII cranial nerve, and he was discharged permanently after 2 months postoperatively (Fig 4).

Figure 4 - 3D tomography 2 months post operatively, showing condylar fracture repair.



DISCUSSION

The use of 3D printing technology is not new; however, this was our first experience in making occlusal guide for condylar fracture treatment. Initially, the production of the guide requires specific software, mastery in the handling of high-tech equipment such as 3D printers, as well as all the digital flow that originates from it[3]. In this specific case, the guide was made with a different thickness than we wanted, probably due to our error in obtaining the inter-cuspidation, since due to the condylar fracture, the mandibular occlusal plane had its Z axis tilted. As this guide is obtained by milling on a 3D printer, it needs to receive an individualized finish (customization), especially when removing resin, to allow visualization of occlusion and inter cuspidation in the anterior teeth. Another problem detected was the fragility of the guides, as some had very thin areas, which favored fragmentation during repeated occlusal checks.

We believe that these three-dimensional guide models were created to facilitate occlusal restoration and are now widely used in orthognathic surgery. The main limiting factor is the high cost of access to these technologies and the need to dominate these programs and milling machines. In our view, the application of this technology in patients with facial fractures still requires a long learning curve, since restoring tooth alignment requires manipulation of the fractured fragments, which, even today, is best achieved with the installation of Erich Bar. As a learning experience, we noted the need for future research to use intraoral scanning, since tomography does not provide good definition of the tooth surface, which may compromise the guide fitting. (Fig 5).

The importance of using this technology, which has recently been incorporated into the arsenal of dentistry and especially in the public service, would be to increase the accuracy of the surgical repositioning of fractured segments, thus reducing the potential need to reoperate on the patient,

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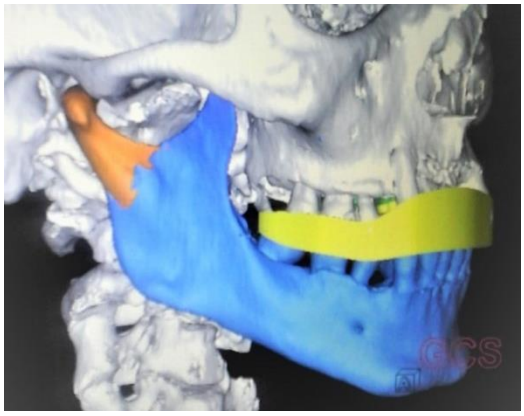
which would increase the treatment costs. Specifically in Brazil, where mandibular fractures caused by motorcycle accidents represent a public health problem and require surgical treatment[4].

Figure 5 - Virtual planning of condylar fracture reduction (Orange) and construction of a virtual bite guide (yellow). This file was transferred to a 3D printer and made in resin.



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