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Is virtual planning an alternative for choosing the surgical approach?

¿Es la planificación virtual una alternativa para elegir el abordaje quirúrgico?

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ABSTRACT

The rationale for the development and use of virtual surgical planning (VSP) is to optimize the surgeon's ability to prepare for and mitigate potential struggles in the operating room. Relatively little evidence is found in the literature concerning the application of VSP in complex surgical procedures, even more scarce in the literature is reflected the goodness that the VSP offers in terms of the choice of the surgical approach. This study presents the approach for an extensive mandibular benign lesion, and its reconstruction with osteosynthesis material. All this assisted by a virtual surgical planning software that allowed the virtual execution of the surgery to be performed, the planning of the most convenient approach for the removal of the lesion using surgical guides and the subsequent reconstruction. Emphasizing the analysis of how the benefits of VSP include choosing the most ideal and least invasive surgical approach for the case.

RESUMEN

La razón fundamental para el desarrollo y el uso de la planificación quirúrgica virtual (PQV) es optimizar la capacidad del cirujano para prepararse y mitigar posibles contratiempos en el quirófano. En la literatura se encuentra relativamente poca evidencia sobre la aplicación de la PQV en procedimientos quirúrgicos complejos, aún más escasa en la literatura se refleja la bondad que ofrece la PQV en cuanto a la elección del abordaje quirúrgico. Este estudio presenta el abordaje de una lesión benigna mandibular extensa y su reconstrucción con material de osteosíntesis. Todo ello asistido por un software virtual de planificación quirúrgica que permitió realizar la ejecución virtual de la cirugía, la planificación del abordaje más conveniente para la extirpación de la lesión mediante guías quirúrgicas y la posterior reconstrucción. Enfatizando el análisis de los beneficios de la PQV y su influencia en la elección del abordaje quirúrgico más ideal y menos invasivo para el caso.

INTRODUCTION

Surgical correction of maxillofacial injuries presents many challenges. Care must be taken when designing surgical approaches to avoid damage to vital structures that could otherwise lead to function/sensory deficits. It is also imperative to optimize placement of incisions to avoid unfavorable scarring.¹ For this reason, several virtual surgical planning software's appear, which offer the possibility to create accurate anatomical models and allowed new approaches to planning surgical procedures. Digital models based on high-resolution polygonal meshes provide surgeons with the opportunity to design osteotomies preoperatively, simulate skeletal

movements, and visualize operative options in multistage approaches, such as complex maxillofacial procedures.²

The rationale for the development and use of virtual surgical planning (VSP) is to optimize the surgeon's ability to prepare for and mitigate potential struggles in the operating room. The proper use of VSP can help the surgeon to use his or her time in the operating room more safely and efficiently.³ However, relatively little evidence is found in the literature concerning the application of VSP in complex surgical procedures, such as the removal of tumors in the maxillofacial complex and its subsequent reconstruction.

Even more scarce in the literature is reflected the goodness that the VSP offers in terms of the

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choice of the surgical approach; that by allowing the surgeon to previously plan his surgery, leaning towards less invasive, smaller and less morbid techniques, this would lead to equally curative results, but more beneficial for the patient.

This study presents the approach for an extensive mandibular benign lesion, and its reconstruction with osteosynthesis material. All this assisted by a virtual surgical planning software that allowed the virtual execution of the surgery to be performed, the planning of the most convenient approach for the removal of the lesion using surgical guides and the subsequent reconstruction. Emphasizing the analysis of how the benefits of VSP include choosing the most ideal and least invasive surgical approach for the case.

CASE REPORT

A 17-year-old male was referred to the author's institution for evaluation of asymptomatic volume increase in the posterior mandibular sector on the right side, with two years of evolution without receiving treatment. The patient's past medical and dental histories were noncontributory. Physical examination revealed a volume increase in the lower third of the face on the right side. Intraoral examination revealed a volume increase in the right posterior mandibular region that caused expansion of bone tables. Asymptomatic on palpation with no signs of infection. A clinical absence of the right mandibular second molar was also observed. The imaging study (CT) revealed a hypodense lesion with hyperdense borders that extended from the right mandibular first molar to the ipsilateral mandibular ramus (Figure 1). The second and third right mandibular molars were also absent.

It was decided to perform an incisional biopsy of the lesion that it was reported as an ameloblastic fibroma in the histopathological study under local anesthesia. It was scheduled for a block resection of the lesion and reconstruction with osteosynthesis material. Based on the images in DICOM format through the surgical planning software *NemoScan V.2020* it proceeds to plan the removal of the lesion, demarcating the areas for osteotomies while respecting the safety margins for

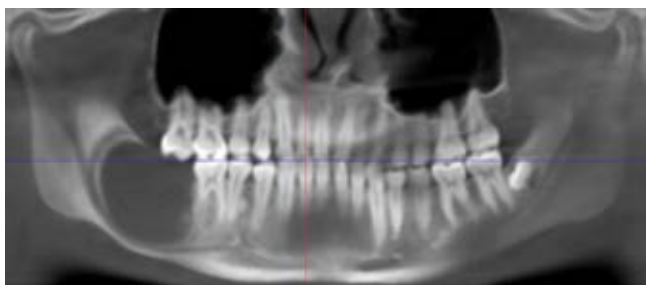


Figure 1: Computed tomography showing a hypodense lesion with hyperdense borders that extended from the right mandibular first molar to the ipsilateral mandibular ramus.

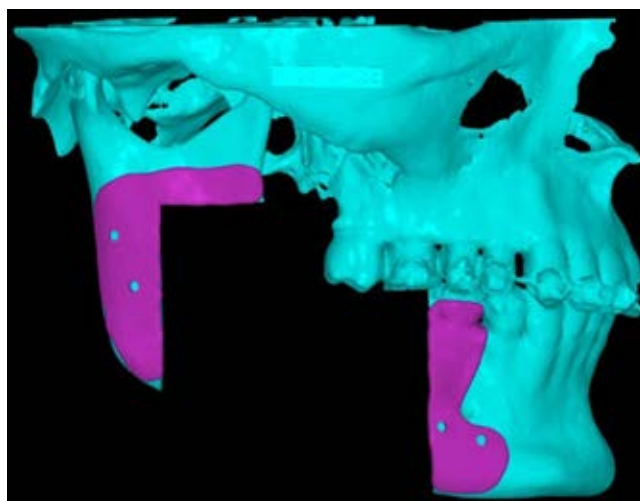


Figure 2: Design of the cutting guides for excision of the mandibular lesion.

this type of benign lesion. Surgical guides were made and allowed to conduct the excision of the lesion as planned (Figure 2), through a minimal retromandibular extraoral incision, in conjunction with an intraoral approach. The pre-bending of the osteosynthesis material was also carried out through the planning software, by the impression of the contralateral hemimandible in an inverted way through the «Mirror tool» of the planning software (Figure 3). During the surgery there was no need to alter the previously planned surgical plan, the cutting guides were used correctly for resection of the lesion and subsequently the fixation of the preformed mandibular reconstruction plate. The procedure was completed without complications. And simple postsurgical images were indicated where the removal of the lesion was appreciated as planned and the osteosynthesis material in the correct position and fulfilling its function (Figure 4). The excisional biopsy confirms the first diagnosis and the margins of the surgical specimen were found free of lesion.

DISCUSSION

VSP is a process that begins at the collection of imaging data. The digital manipulation of large-scale imaging data in 3 dimensions, specifically VSP, provides the ability to reproduce detailed anatomic models, and to fabricate surgical guides. These advancements have become an invaluable tool for oral and maxillofacial surgeons.⁴

The foundation of successful surgical planning depends on the ability of the acquired dataset to replicate anatomic detail and translate into virtual modeling and editing software to permit surgical planning. VSP is used extensively in the management of maxillofacial pathology for its ability to virtually visualize pathology and to provide guidance on the location of resection margins. The application of guided osteotomies is most beneficial in surgical

resections of the midface and for large tumors that have deformed anatomic landmarks.^{5,6} Ricotta et al.⁷ demonstrate the benefits of VSP and navigation by reporting a statistically significant difference in 91% of patients in obtaining a clear margin along deep tumor margins with an accuracy of less than 5 mm difference of the actual resection margin compared with the planned margin. In our case, the histopathological study reported the margins of the surgical specimen free of the lesion. Demonstrating the precision of the previously planned executed cut.

Parallel to the extirpation of tumors is the reconstruction of said defect. VSP has made a significant impact on all aspects of reconstruction. It has made reconstruction a streamline process.⁸ In the case presented, the pre-molding of the reconstruction plate on the contralateral hemi-mandibula printed through the «Mirror tool» of the planning software, resulted in a reduction in the time in the operating room as well as in an adequate plate coupling at the time of reconstruction. There are, however, some disadvantages with VSP. Firstly, the additional cost for the service. Secondly, the time needed for the planning session, obtaining the material, the production and shipping of guides/plates and sterilization before surgery, can in all be time consuming.⁹ It is also worth mentioning that thanks to the use of VSP, a reduction in the size of the extraoral incision was led, due to the fact that the orientation of the cut was made through the cutting guides based on virtual planning. This translates into smaller approaches and consequently less postoperative discomfort and scars. However, this advantage, which was made evident in the present case report, has not been studied in the literature. Future studies would then be needed to analyze in depth whether VSP offers the advantage of leading the surgeon to choose a less invasive surgical approach for each particular case.

For the surgeon who wishes to incorporate these tools into their practice, it is important to become familiarized with the nuances and logistics of accessing these tools in their local hospital system in order to efficiently use such resources. VSP has shifted towards advanced anatomical reconstruction, with the possibility of reproducing accurate models of disease and planning osteotomies in relation to



Figure 3: Reconstruction plate molded with the contralateral hemimandibula inverted with the «Mirror tool» of the planning software.



Figure 4: Postoperative panoramic X-ray: where the correct excision of the lesion and positioning of the osteosynthesis material can be seen as previously planned.

vulnerable structures. Bioengineering software provides enhanced capabilities to perform comparative analyses and gives surgeons immediate control over their work. Maxillofacial resection is a complex surgical approach, which has taken advantage of modern technology at a later time than traditional maxillofacial surgical procedures. However, the benefits might be considerable.

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