

# Perception of the applicability of CAD/CAM technology in craniofacial surgery in a plastic surgery postgraduate program

## Percepción de la aplicabilidad de la tecnología CAD/CAM en cirugía craneofacial en un posgrado de cirugía plástica

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### ABSTRACT

**Introduction:** Multiple technologies help the development of reconstructive surgical procedures in craniofacial surgery, Surgeon's perception of this type of diagnostic and treatment aids has not been widely studied. **Methods and Materials:** A workflow is proposed for the management of craniofacial bone defects; the results are showed to the staff in charge for the treatment of these patients. A survey was applied, evaluating the degree of satisfaction and the perception of the staff regarding applicability, usefulness, impact on different process factors of treatment. Descriptive analysis was performed. **Results:** 30 people were interviewed: specialists, residents of surgical specialties, and general practitioners. The majority did not have experience with CAD/CAM technology (77%), but considered useful (67%), the considered disadvantages were: technical difficulty, administrative procedures to access, costs, lack of information, need for specific training. The benefits were: Improvement in diagnosis and treatment accuracy, specificity, help in planning, innovation, and versatility. **Discussion:** Tools such as 3D printing, CAD/CAM technology, facilitate the process of anatomical understanding, planning and execution of surgery, the participants agrees with these data, where the impact and utility in the treatment of patients is evident, both for graduate surgeons and those in training. **Conclusions:** The application of technologies in the practice of medicine may be useful because facilitates the technical execution of the procedure precision, reduces surgical time and costs. Information and studies that evaluate the surgeon's perception regarding the applicability of CAD/CAM technology in the treatment of bone defects are not enough, which represents a novelty of our study.

**Keywords:** biomedical technologies; plastic surgery; reconstructive surgery procedure; medical devices; Computer-Aided Design

## I. INTRODUCTION

Actually has been recognize that de healthcare technologies have made important changes in the form of that medical treatments have been made. In fact, according to the orthopedics field multiple technologies help the development of reconstructive surgical procedures in craniofacial surgery, and it is becoming increasingly popular to implement these tools which facilitate the treatment of patients and also reduce the likelihood of complications. (1, 2, 3, 4) Surgeons' perception of this type of diagnostic and treatment aids has not been widely studied, because in developing countries these kind of treatment support by patient specific technologies is not yet broadly useful still.

Recently, through a research group at the University these patient specific technologies are successful applied for some cases such as plastic surgery. Hence according to the last, this study seeks to evaluate the perception of the different groups of surgeons in charge of the treatment of craniofacial bone defects as well as the perception of students regarding the application of CAD/CAM technology (Computer

Assisted Design, Computer Assisted Manufacturing) and 3D printing in the surgical management of complex craniofacial bone defects.

## II. METHODS AND MATERIALS

The first one stage was related with a workflow proposed for the management of craniofacial bone defects in conjunction with reconstructive plastic surgery and industrial design services through research group, which include cases of craniofacial bone reconstruction with autologous tissue and custom designed implants, oncological resections, reconstruction of bone defects secondary to congenital malformations.

In second one was defined of population. All participants 30 people were interviewed, of which 50% were specialists mainly in head and neck surgery and plastic surgery, the rest of the population corresponded to physician in training (residents of surgical specialties, general practitioners, medical students). Among the specializations interviewed were: plastic surgery, maxillofacial surgery, neurosurgery, otolaryngology and head and neck surgery. One of the inclusion criteria was about people specialist or residents without previous experience or knowledge about development patient specific technologies surgery treatment.

In the third stage was presented the experience of case studies made with interdisciplinary group. A record of the virtual surgical pre-planning, design of devices and tools used in the surgical procedure and the results were presented in medical rounds and socialization sessions, showing the surgical photographic record, videos and the stereolithographic biomodel and different devices designed and 3D printed. Each participant was able to evaluate the physical, ergonomic characteristics and surgical planning performed for the different cases of craniofacial reconstruction. A survey was subsequently applied, which evaluated the degree of satisfaction with the design of the instruments and the surgical planning for each patient, the perception of the staff regarding applicability, usefulness, impact on different process factors of treatment such as planning, surgical time, diagnostic objectivity and costs when implementing technology in the treatment of craniofacial bone defects in the institution.

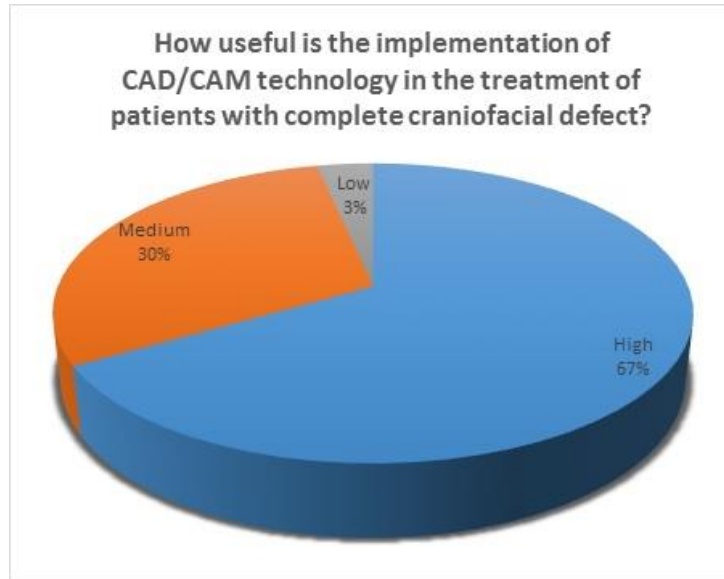
Finally, in fourth stage a descriptive analysis was performed, using means and standard deviation or median and interquartile ranges for quantitative variables as appropriate for their distribution. For qualitative variables, description was made using absolute and relative frequencies.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee: Ethics committee in scientific research of the Universidad Industrial de Santander, (CEINCI-UIS), N° 1. And with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

## III. RESULTS

The majority of the population did not have any experience in the use of CAD/CAM technology in the treatment of their patients 77%, only 23% of surgeons with master degree and residents have some experience using this kind of software. Those who had experience with the technology used it approximately 1 time per year. But they considered its implementation useful (67%) (Graph 1) and 80% of the population counts in their practice clinic with patients who could benefit from these technologies, in surgical branches such as: plastic surgery, orthopedics, neurosurgery, maxillofacial surgery, otolaryngology more frequently and less frequently: chest surgery, head and neck surgery and rehabilitation; and they could make use of this technology on a monthly basis.

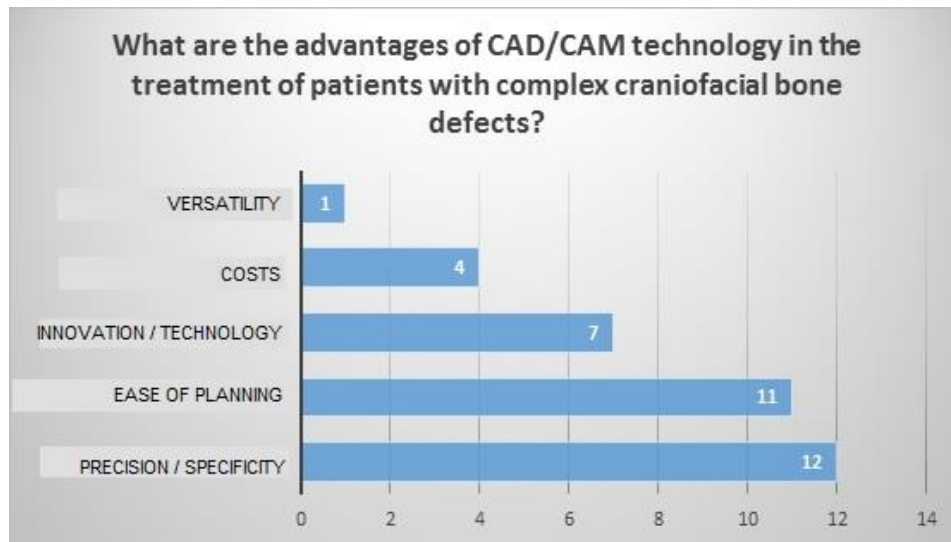
**Graph 1.** Usefulness of the implementation of CAD/CAM technology in the treatment of complex craniofacial bone defects



Fuente: Elaboration propel

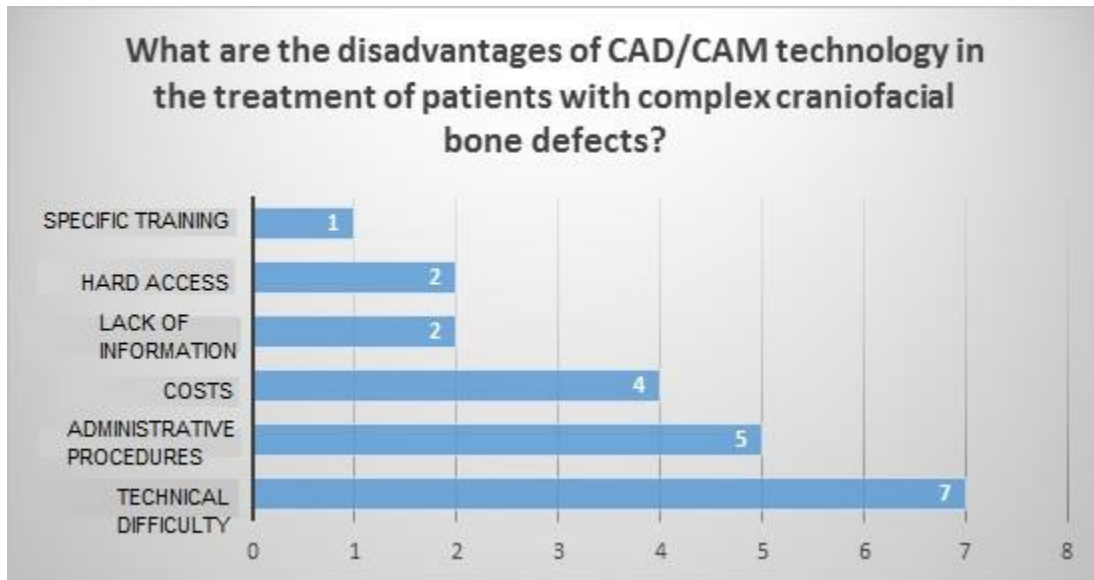
We were questioning about the advantages and disadvantages of the application of CAD/CAM technology from the personal perspective, the main aspects they disliked were: The technical difficulty to carry out the procedures, the administrative procedures to have access to technology, costs about the process or service, lack of information about these and the need for specific training. The benefits mentioned were: Improvement in diagnosis and treatment accuracy, specificity for the treatment of each patient, help in planning the procedure, innovation, costs and versatility for application in different areas of medicine. (Graphs 2, 3).

**Graph 2.** Advantages of CAD/CAM technology in the treatment of complex craniofacial bone defects



Source: authors' elaboration

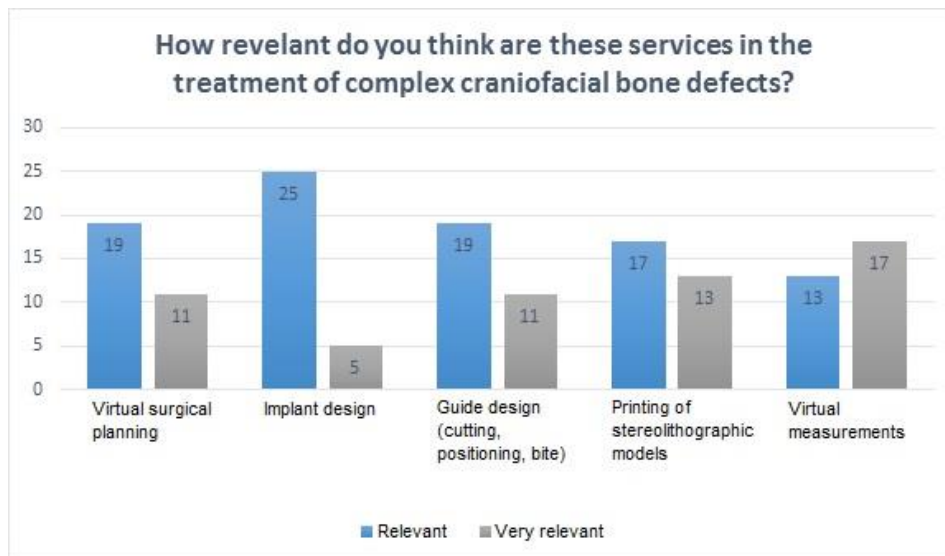
**Graph 3.** Disadvantages of CAD/CAM technology in the treatment of complex craniofacial bone defects



Source: authors' elaboration

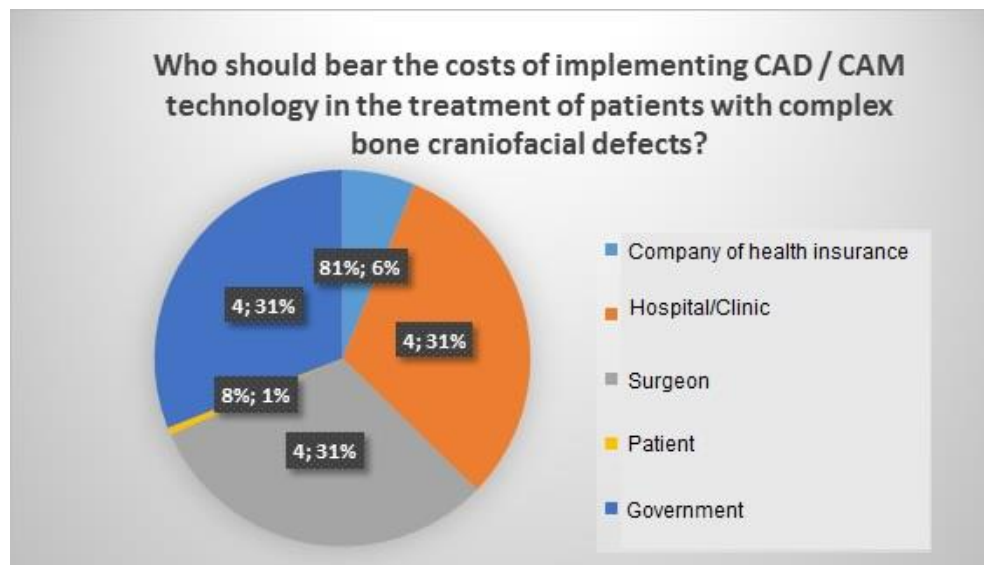
When showing the different applications of the technology in the treatment of craniofacial bone defects, all the items were considered of relevance: virtual surgical planning, biomodels printing, design and manufacture of cutting, positioning, bite guides and custom implants. Regarding the quality of the device designed and printed, the majority of the population was satisfied (97%). Regarding the perception of who should bear the costs of implementing CAD/CAM technology in the treatment of patients (Graph 4.), also 80% of the population considered that the expenses should be borne by the company of health insurance. (Graph 5.)

**Graph. 4** Perception of the relevance of the services offered for the treatment of complex craniofacial bone defects



Source: authors' elaboration

**Graph. 5** Responsibility of costs of implementing CAD/CAM technology in the treatment of patients with complex bone craniofacial defects



Source: authors' elaboration

#### IV. DISCUSIÓN

Surgeons generally base their surgical decision on their learning, experience, using diagnostic aids such as tomography and nuclear magnetic resonance, to be able to perform a surgical planning of the procedure they are going to perform, it happens in this way with reconstruction at the level of the craniofacial complex, characterized by great anatomical and functional complexity, requires an ideal and precise treatment to obtain the best results. (5) However, their decisions about planning has been made mainly without CAD/CAM technologies; despite of this, whatever it is a great opportunity to introduce CAD/CAM technologies in their treatments. According to the last, tools such as 3D printing, CAD/CAM technology, facilitate the process of anatomical understanding, planning of the surgical procedure and execution of surgery, since they allow a personalized way to reconstruct, recreate and simulate both skull-facial bone defects and their reconstruction, either with autologous tissue or by creating implants, devices tailored to the patient. And even within the applications there are software that facilitates access to diagnostic images and assessment of the patient.(1)(4)(5)(6)

In addition, technology facilitates learning for training surgeons giving the possibility to analyze, study the Craniofacial bone defect with different software, print the segment and simulate the surgical procedure in a way that is easier and more reliable when performed on the patient. (4) Another useful aspect is the compression of the surgical anatomy, even for less experienced students and surgeons, representing a benefit in learning. Useful in preoperative planning, intra-operative navigation, surgical training by accurately transferring complex anatomical information. (7)(8) Facilitates the understanding of form, scale, anatomy, more easily than with other ways. (9)

Among the various areas that would likely benefit from the application of emerging technologies for the treatment of patients are reported in the literature: urology, cardiovascular surgery, anesthesiology, orthopedics, plastic surgery, craniofacial surgery, among others. (2)(3)(10)(11)(12)

In the field of reconstructive plastic surgery, a study demonstrated the usefulness of 3D printing, CAD/CAM technology in the treatment of patients not only at the craniofacial level but also in the training

of residents and surgeons, patient education, design and manufacture of hand and upper limb prostheses, cranio-maxillo-facial reconstruction, breast reconstruction, etc., in total 1092 articles, 3D printing provides the ability and ease of complex reconstructions with implants tailored to the patient, improving not only the results but the cost effectiveness, with acceptable level of accessibility in the different populations, with great impact in the treatment of traumatic reconstructions, at the facial, limb level, and advances in the design of biological and synthetic implants(4) when implementing the Survey in our service we could show that the perception of the majority of the participants agrees with the data, where the impact and utility of the application of this technology in the treatment of patients is evident, both for graduate surgeons and those in training. Our study did not include the aspect of education for residents or the patient, data that would be interesting to evaluate and compare with the world literature.

There is always fear in terms of safety and precision, confidence in the application of new technologies in the treatment of patients, requires knowledge of technology, software and devices, in addition to a learning curve, studies report up to 70 % reserve and fear towards the implementation of this type of new techniques due to learning laxity, and short learning curve time(13) and risk of complications and adverse effects(14), the perception of the cranio-facial surgeon versus to the use of this type of technology has not been widely characterized, in our study we found that the aspects that most concerned the interviewees regarding the application of technology were the technical difficulty, the difficult access to this technology, the costs and others less frequent as the required training necessary to be able to implement it. However, we found that the majority of the population would implement and recommend the use of it in the treatment of their patients.

Studies that have evaluated the perception of the application of these technologies such as the printing of anatomical segments, simulation of the surgical procedure by surgeons and residents, in addition to the use of biomodels for patient education has shown adequate adherence and positive feedback(9)(10) both of the patient and the surgeon. Specifically in the area of reconstructive plastic surgery demonstrated the perception of utility of these technologies as tools for improvement of resident training, accuracy, decrease in surgical time, in addition to patient education, (11)(12)(17-22) data that are compatible with the results produced by our survey.

## V. CONCLUSIONES

The application of different technologies in the practice of medicine is very useful since it facilitates not only the technical execution of the procedure, but also in reducing surgical time, cost reduction, precision in results, being an important tool in the training of surgeons. Information and studies that evaluate the surgeon's perception regarding the applicability of CAD/CAM technology in the treatment of craniofacial bone defects are not enough, which represents a novelty of our study, demonstrating the perception of It is very useful in terms of diagnosis and treatment of patients, training for surgeons.

**Author Contributions:** the contributions were made by the authors are cited below: design research GLM and CIL and DCN; conceptual background GLM and survey design CIL and DCN; methodology DCN; software, DCN and CIL; validation DCN; data analysis, DCN and CIL; first manuscript DCN and CIL; write of paper DCN, GLM and CIL the authors are agreeing with the manuscript.

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