

Use of stereophotogrammetry for evaluating craniofacial deformities: a systematic review

Uso da estereofotogrametria nas deformidades craniofaciais: revisão sistemática

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ABSTRACT

Three-dimensional digital models of the face were developed to circumvent the limitations of the traditional assessment of soft tissue. Currently, a method reported to have a high clinical applicability is digital stereophotogrammetry. This systematic review aims to address the use of this technique in evaluating craniofacial abnormalities, with a focus on its practical application. The subject was searched in the Medline, Cochrane Library, LILACS, and SciELO databases. From preestablished inclusion criteria, 19 articles were selected. The data extracted were as follows: systems used, year of publication, diseases addressed, reference points used for each disease, advantages and disadvantages of the stereophotogrammetry system used, and quality of articles. The 3dMD[®] system was used in 11 articles. The most common publication year was 2010, with 6 studies. Twelve studies addressed cleft lip and palate, and 17 studies used anthropometric landmarks. Noninvasiveness, fast image acquisition, and accuracy were the advantages mentioned in 70% of the articles that used the 3dMD[®] system. The most frequently mentioned disadvantage of such equipment was the high cost. Twelve items had good level of scientific evidence. Digital stereophotogrammetry is a technology aimed to improve the evaluation of treatments and quantification of craniofacial deformities. However, there is a need for more studies with long-term monitoring and on the association of a wider variety of systems.

Keywords: Photogrammetry. Craniofacial abnormalities. Imaging, three-dimensional. Photography. Review.

RESUMO

O desenvolvimento de modelos tridimensionais digitais da face foi uma das formas de contornar as limitações dos métodos tradicionais de avaliação de tecidos moles. Para tanto, o método com maior aplicabilidade clínica atualmente é a estereofotogrametria digital. Esta revisão sistemática objetiva abordar o uso dessa técnica em anormalidades craniofaciais, com foco em sua aplicação prática. Foram realizadas buscas sobre o tema nas bases de dados Medline, Cochrane Library, LILACS e SciELO. A partir de critérios de inclusão preestabelecidos, 19 artigos foram selecionados. Extraíram-se dados sobre: sistemas utilizados, ano de publicação, doenças abordadas, pontos de referência usados para cada doença, vantagens e desvantagens da estereofotogrametria por sistema utilizado e qualidade dos artigos. O sistema 3dMD[®] foi o equipamento empregado em 11 artigos. O ano de publicação mais frequente foi 2010, com 6 trabalhos. Doze estudos abordaram fissuras labiopalatinas

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e 17 trabalhos utilizaram pontos de referência antropométricos. O caráter não-invasivo, a rápida aquisição de imagens e a acurácia foram as vantagens referidas em 70% dos artigos que aplicaram o sistema 3dMD®. A desvantagem desse mesmo equipamento apontada com maior frequência foi o alto custo. Doze artigos possuíam bom nível de evidência científica. A estereofotogrametria digital é uma tecnologia capaz de aperfeiçoar o modo de avaliação dos tratamentos e quantificação das deformidades craniofaciais. Entretanto, há necessidade de realização de mais estudos com acompanhamento a longo prazo e associação de maior variedade de sistemas.

Descritores: Fotogrametria. Anormalidades craniofaciais. Imagem tridimensional. Fotografia. Revisão.

INTRODUCTION

The success of craniomaxillofacial surgery depends not only on the technical aspects of the operation but also on comprehensive surgical planning. Traditionally, this plan consists of 5 steps: data collection, diagnosis and quantification of the condition, establishing a preliminary surgical plan, surgical simulation, establishment of the final surgical plan, and transfer of the patient during the actual procedure¹.

To perform all these steps and evaluate the results of surgery, medical professionals commonly use methods such as physical examination, radiographs (cephalometric and panoramic radiographs), medical-dimensional photographs, gutters, clinical anthropometry, dental models, and predictive tracings from radiographic cephalometry. However, with these approaches, the three-dimensional visualization of the process is limited to the imagination of each person involved, causing communication problems. Moreover, as cephalometry and traditional photographs provide two-dimensional views, the management of patients with asymmetrical deformities (34% of teeth and facial deformities¹) is only grossly shown. Other obstacles are the planning for the transfer to the operating room for patients without dental abnormalities, and the use of different positioning of the patient in the evaluation methods cited, reducing the quality of the prediction¹⁻³.

One of the ways to improve the process described is the development of three-dimensional digital models of facial morphology². Systems with several different approaches were designed to generate a three-dimensional surface, and digital stereophotogrammetry is a method with a high clinical applicability reported^{4,5}. This technique consists in acquiring a three-dimensional image from 1 or more pairs of stereophotographs, with the term “photogrammetry” being related to the possibility of conducting measurements by using three-dimensional pictures⁶, and if associated with the CT scan of the patient, using the structure of the underlying bone⁴.

The analysis of three-dimensional models of stereophotogrammetry can be made by means of linear, volume, angular, or area measurements, and/or by comparison of

pattern reference points or whole faces. The more relevant the issues addressed in a model, the better the quality of the study results^{7,8}.

This systematic review aims to address the use of stereophotogrammetry in evaluating craniofacial deformities, focusing on its practical application.

METHODS

We searched for articles and possible systematic reviews on the use of stereophotogrammetry in craniofacial deformities, on December 17, 2011, in the Medline, Cochrane Library, LILACS, and SciELO databases. In Medline, the keywords used were “photogrammetry” and “craniofacial abnormalities” (search details: “Photogrammetry” [MeSH] AND “Craniofacial Abnormalities” [MeSH]). In Cochrane Library, the MeSH term “photogrammetry” was used in the search. In searching LILACS and SciELO, we used the word “photogrammetry” in the simple search.

From the abstracts of the articles found, we manually selected those that met the following inclusion criteria: used digital stereophotogrammetry in craniomaxillofacial surgery and/or orthodontics; published in English, Spanish, or Portuguese; with trial, full version available online through the portal of CAPES journals (www.periodicos.capes.gov.br), or have free access.

From Medline, 70 articles were initially retrieved. After the selection using the criteria described, 17 articles were identified for further analysis. The Cochrane Library provided 68 clinical trials and 1 technical note (classified as “economic evaluation”), which, after exclusion, resulted in 3 articles, one of which was already among the 17 recovered from Medline. No articles that met the established criteria were found in LILACS and SciELO, which showed 60 and 26 initial results, respectively. We found no systematic review of digital stereophotogrammetry.

In the 19 selected articles, the following data were collected: systems used, year of publication, diseases

addressed, reference points used for each disease, advantages and disadvantages of stereophotogrammetry according to the system used, and the quality of the studies. This review aims to understand the advances, applicability, and limitations of using this technology in craniofacial abnormalities.

RESULTS

Systems Used

In the 19 articles selected, the following systems were used:

- 3dMD® system[I] – used in 11 articles (3 articles: 3dMD Cranial®[II]; 5 articles: 3dMD Face®[III]; 2 articles: 3dMD DSP 400®[IV]; 1 article: 3dMD® not specified)^{3,7-16};
- C3D® system[V] – used in 3 articles¹⁷⁻¹⁹;
- 2 semimetric cameras (Rollei 6006 Réseau®[VI]) – used in 3 articles²⁰⁻²²;
- 2 professional photo cameras (Nikon FM2®[VII]) – used in 2 articles^{23,24};
- Genex FaceCam 250®[VIII] – used in 1 article that additionally used the 3dMD® system¹³.
- The C3D® system is not commercially available and originates from the University of Glasgow (UK)²⁵.

Publication Year

The selected articles were published from 1994 to 2011:

- 2011: 1 article published⁹;
- 2010: 6 articles published^{3,7,8,10-12};
- 2009: 2 articles published^{13,14};
- 2007: 2 articles published^{15,17};
- 2006: 1 article published¹⁶;
- 2004: 1 article published¹⁸;
- 2003: 1 article published¹⁹;
- 1997: 1 article published²³;
- 1996: 1 article published²⁴;
- 1995: 1 article published²⁰;
- 1994: 2 articles published^{21,22}.

Figure 1 shows the article distribution according to publication year.

Diseases Approached

Figure 2 shows the disease distribution according to the number of articles that addressed each condition, as follows:

- Cleft lip and palate – addressed by 12 articles^{3,9,12,13,15-22};

- Nonsynostotic cranial deformity – addressed by 3 articles^{7,8,10};
- Extraction of the third lower molar – addressed by 2 articles^{23,24};
- 22q11.2 deletion syndrome – addressed by 1 article¹⁴;

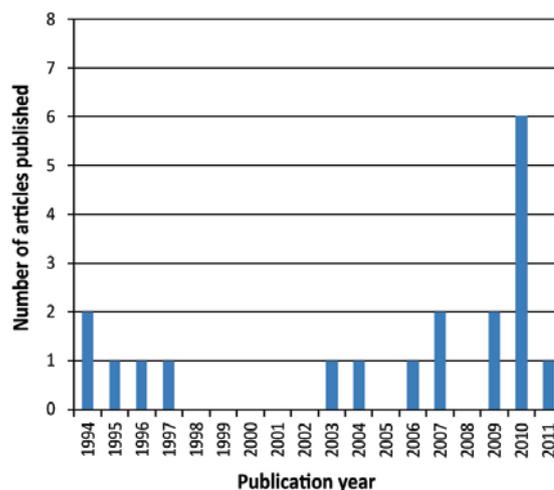


Figure 1 – Distribution of the articles according to publication year.

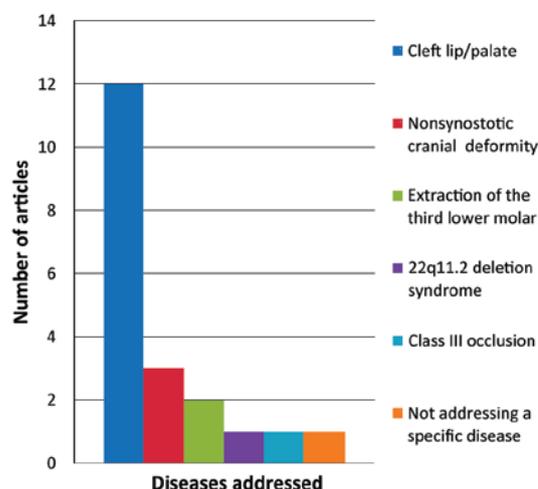


Figure 2 – Distribution of diseases according to the number of articles that addressed them.

[I] 3dMD® (3dMD, Atlanta, GA, USA): company responsible for the production of systems of digital stereophotometry and associated software.

[II] 3dMD Cranial® (3dMD, Atlanta, GA, USA): a digital stereophotometry system for acquiring craniofacial images.

[III] 3dMD Face® (3dMD, Atlanta, GA, USA): a digital stereophotometry system for acquiring facial images.

[IV] 3dMD DSP 400® (3dMD, Atlanta, GA, USA): a digital stereophotometry system for acquiring facial images.

[V] C3D® (Glasgow University Dental School): a digital stereophotometry system.

[VI] Rollei 6006 Réseau® (Rollei Fototechnik GmbH, Braunschweig, Germany): a semimetric camera.

[VII] Nikon FM2® (Nikon Corporation, Tokyo, Japan): a professional photo camera.

[VIII] Genex FaceCam 250® (Genex Technologies Inc., Kensington, MD, USA): a digital stereophotometry system.

- Class III occlusion – addressed by 1 article, additionally referring to cleft lip and palate¹²;
- Nonspecific – 1 article does not address any specific disease¹¹.

Reference Points Used by Disease

We identified the reference points used in each of the articles and in accordance with the condition addressed. When there was correspondence, we used the nomenclature proposed by Farkas & Munro²⁶ or Kolar & Salter²⁷ for identification of the reference points in each article. Some of the items made use of nonanthropometric/constructed reference points without connection to a specific anatomical structure^{7,9,12,15,23,24}.

Tables 1 and 2 list, respectively, the reference points of the 2 conditions addressed more often – nonsynostotic cranial deformities, and cleft lip and palate. Bilateral points on the face were analyzed as a single entity, since all the studies used the left and right sides in the analysis; when

they are mentioned, the items have been marked with an asterisk.

Studies that have addressed extraction of the mandibular third molar used only nonanthropometric points in their analysis^{23,24}.

Table 2 – Distribution of reference points analyzed in three-dimensional images of cleft patients.

Reference points	n (%)
Endocanthion (en)* ^{3,12,13,15-18,20-22}	10 (90.9%)
Pronasale (prn)* ^{3,9,13,15-18,20-22}	10 (90.9%)
Subnasale (sn) ^{3,9,12,13,15,16,18,20-22}	10 (90.9%)
Alare (al)* ^{3,9,12,13,16,18,20-22}	9 (81.8%)
Cheilion (ch)* ^{3,9,12,13,17,18,20-22}	9 (81.8%)
Exocanthion (ex)* ^{3,12,16-18,20-22}	8 (72.7%)
Crista philtri (cph)* ^{9,13,17,18,20-22}	7 (63.6%)
Nasion (n) ^{9,13,17,18,20-22}	7 (63.6%)
Alar curvature (ac)* ^{9,15-18}	5 (45.5%)
Gnathion (gn) ^{12,13,20-22}	5 (45.5%)
Labiale superius (ls) ^{17,18,20-22}	5 (45.5%)
Sublabiale (sl) ^{13,18,20-22}	5 (45.5%)
Labiale inferius (li) ^{18,20-22}	4 (36.4%)
Pogonion (pg) ^{18,20-22}	4 (36.4%)
Subalare (sbal)* ^{9,13,16,18}	4 (36.4%)
Alare' (al')* ²⁰⁻²²	3 (27.3%)
Apex of columela (c')* ¹⁶⁻¹⁸	3 (27.3%)
Pupila (pu)* ²⁰⁻²²	3 (27.3%)
Stomion superius (stos) ²⁰⁻²²	3 (27.3%)
Subnasale' (sn')* ¹⁶⁻¹⁸	3 (27.3%)
Superalare (sa)* ²⁰⁻²²	3 (27.3%)
Wing base* ¹⁷	1 (9.1%)
Cheilion médio (ch m) ³	1 (9.1%)
Exocanthion médio (ex m) ³	1 (9.1%)
Glabella (g) ¹⁷	1 (9.1%)
Gonion (go)* ¹²	1 (9.1%)
Labiale superius lateralis (ls')* ¹⁶	1 (9.1%)
Maxillofrontal (mf)* ¹⁶	1 (9.1%)
Lower otobasion (obi)* ¹⁸	1 (9.1%)
Upper otobasion (obs)* ¹⁸	1 (9.1%)
Reconstructed pupil* ³	1 (9.1%)
Sellion (s) ¹⁶	1 (9.1%)
Stomion (sto) ¹³	1 (9.1%)
Stomion inferius (stoi) ¹⁸	1 (9.1%)

Note: One article¹⁹ was not counted in the percentages because it did not specify the reference points used.

Table 1 – Reference points analyzed in three-dimensional images of patients with nonsynostotic cranial deformities.

Reference points
Alare (al)* ⁷
Cupid's bow ⁷
Occipital area near the lambdoid suture* ¹⁰
Center of deformity* ⁷
Center of eyeball* ⁷
Cheilion (ch)* ⁷
Endocanthion (en)* ⁷
Scalp at the height of the top of the helix* ⁷
Euryon (eu)* ¹⁰
Exocanthion (ex)* ⁷
Frontotemporal (ft)* ¹⁰
Glabella (g) ¹⁰
Inion ⁷
Lobe* ⁷
Middle of eyebrow* ⁷
Nasion (n) ⁷
Opisthocranium (op) ^{7,10}
Pogonion (pg) ⁷
Pronasale (prn)* ⁷
Tragion (t)* ⁷
Vertex (v) ⁷

Note: One of the articles⁸ did not specify in writing the reference points used.

Advantages and Disadvantages

Mentioned by the Authors

The advantages and disadvantages of stereophotogrammetry and methods of three-dimensional imaging, as indicated by the authors, were analyzed according to the system used.

Tables 3 and 4 list, respectively, the advantages and disadvantages mentioned in the articles that used the 3dMD® system.

The study that used the FaceCam 250 Genex® system¹³ was considered along with those that used the 3dMD®, as these systems are considered equivalent. A percentile analysis was made for the advantages of 3dMD®.

Quality of the Articles

To assess the quality of the articles, they were categorized by study design, presence of a control group, sample size, group composition analysis, evaluation of intra- and inter-operator reliability, and time tracking.

Study Design

Concerning study design, the following results were obtained:

- Clinical trials – 10 articles^{3,7,9,10,15,17-19,23,24};
- Observational studies – 5 articles^{13,16,20-22};
- Technical notes – 2 articles^{11,12};
- Diagnostic accuracy studies – 2 articles^{8,14}.

Control Group

Seven articles had no control group^{3,8-11,17,24}, whereas 12 articles included a control group^{7,12-16,18-23}.

Sample Size

In studies with a control group, the sample size was established by the total number of patients analyzed, subtracting those belonging to the control group. The studies had samples between 10 and 181 individuals (Figure 3).

Table 3 – Advantages mentioned by the authors in studies with the 3dMD® system.

Advantages	n (%)
Accuracy ^{3,7,9,10,12,14,16}	7 (70%)
Quick acquisition of images ^{8,10-14}	7 (70%)
Not invasive ^{3,7,9,11-14}	7 (70%)
Precise ^{7,10,12,13,16}	5 (50%)
Easy acquisition of images ^{9,10,12,16}	4 (40%)
High-resolution images ^{7,12,13}	3 (30%)
Allows repeated measurements ^{8,10,12}	3 (30%)
Capture of texture of soft facial textures ^{11,12}	2 (20%)
Reliable in evaluating the face's 3D structure ^{14,16}	2 (20%)
Allows analysis of the reference points on a static surface ^{8,10}	2 (20%)
Possibility of quantifying alterations of soft tissues ^{7,14}	2 (20%)
Possibility of quantifying angles, areas, and volumes ^{8,10}	2 (20%)
Possibility of storage for later evaluation ^{3,14}	2 (20%)
Proven reproducibility ^{3,11}	2 (20%)
Overlay of pre- and postoperative images allows accurate and quantifiable results ⁹	1 (10%)
Wide variety of analytical techniques available ⁷	1 (10%)
Allows capturing the skin tone ¹¹	1 (10%)
Elimination of the difficulty and errors associated to direct measurements ⁷	1 (10%)
Easy analysis of facial asymmetry ¹²	1 (10%)
Easy to interpret ¹²	1 (10%)
Easy to store data ¹¹	1 (10%)
Easy to share data ¹¹	1 (10%)
Resolution ³	1 (10%)
Possibility of imaging part of or the whole face ¹²	1 (10%)
It allows that other persons besides the operator to perform measurements ⁸	1 (10%)
Possibility of rotation and image amplification ¹⁴	1 (10%)

Composition of the Analysis Groups

When extracting data on the composition of the groups formed in each study, there was heterogeneity in 2 articles:

- “Facial surface changes after cleft alveolar bone grafting”⁹ – results that belonged to the group with unilateral cleft lip and those that belonged to the group with bilateral cleft lip and palate were not segregated;
- “3D stereophotogrammetric assessment of pre- and postoperative volumetric changes in the cleft lip and palate nose”³³ – results that belonged to the group with unilateral cleft lip and palate and those that belonged to the group with unilateral cleft lip alone were not segregated.

Evaluation of Intra- and Interoperator Reliability

The presence or absence of evaluation of intra- and interoperator reliability was analyzed (Figure 4). Four articles^{3,8,14,18} verified both types of reliability, whereas 11 articles^{9,10,13,15,17,19-24} did not.

Follow-up Time by Treatment

Data on follow-up time were extracted from articles involving stereophotogrammetry after therapeutic intervention (Figure 5). Studies involving surgery presented the shortest period between the procedure and the acquisition of three-dimensional photos. When the approach was nonsurgical, data were included on the duration of treatment. The articles were additionally separated by the type of therapeutic approach.

DISCUSSION

Nowadays, stereophotogrammetry is the most promising three-dimensional imaging system for accurate diagnoses

Table 4 – Disadvantages mentioned by the authors about the 3dMD® system.

Disadvantages
Expensive ^{3,11}
Only available in certain research centers ¹¹
Not possible to detect the difference in color in the mucocutaneous junction in the lip region ¹¹
Nonsatisfactory options for analysis: reference points cannot be individually corrected ¹²
Need to carefully correct the light in the place where photos will be taken ³
Restricted portability ³
Inability to capture complex anatomical shapes and dark cavities ³
Difficulty in locating reference points that need to be palpated for better identification ¹⁴

Size of the sample
(Number of subjects)

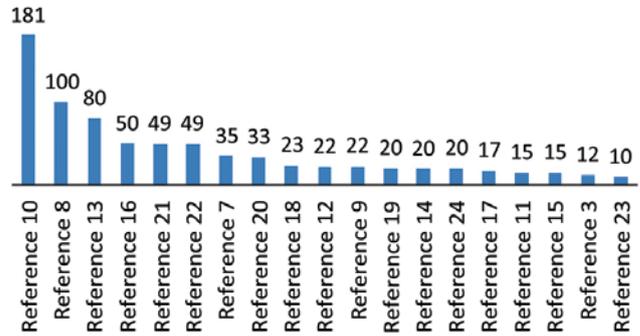


Figure 3 – Distribution of references of the 19 articles selected according to sample size.

Inter- and intraoperator reliability
■ Analyzed ■ Not analyzed

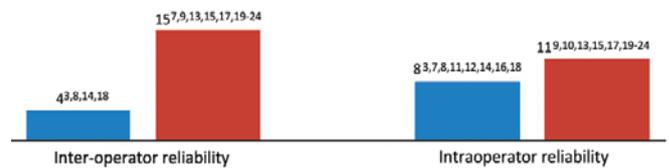


Figure 4 – Distribution of the 19 articles selected according to the presence or absence of analysis of inter- and intraoperator reliability.

Follow-up time
(in days)

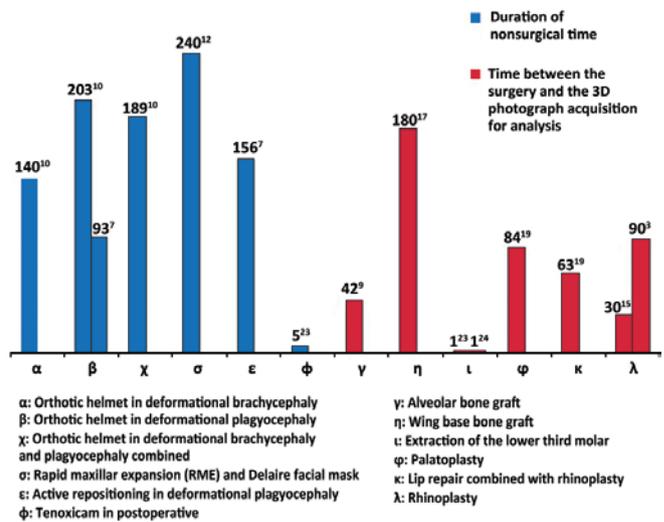


Figure 5 – Follow-up time of the patient in each of the therapeutic interventions addressed.

and face assessments²⁸. Therefore, to understand the advances, limitations, and applicability of this technology, a systematic review was conducted on its application in craniofacial abnormalities.

Systematic reviews are among the study designs with the highest level of evidence, being based on a comprehensive and exhaustive search of primary studies focused on a specific subject²⁹. In our search, we used the Medline, Cochrane Library, LILACS, and SciELO databases, selected for their relevance among those that had free access. The search was performed using MeSH terms or other words that match the topic of “stereophotogrammetry in craniofacial abnormalities.” The words used were “photogrammetry” and “craniofacial abnormalities”, using only the first word when the results of the search were lacking or insufficient. Using predetermined exclusion criteria, we selected 19 scientific papers.

Concerning the systems used in the 19 selected articles, it was observed that about 57.9% of studies used the 3dMD® system, with the other 4 systems individually covering minor fractions of similar magnitude. Probably, this finding is justified by the fact that the 3dMD® system has been a pioneer in the market (launched in 2005⁶), among the systems capturing the three-dimensional morphology of the face, combining stereophotogrammetry with the projection of a random pattern of structured light. There are several advantages attributed to such a system, especially accuracy^{3,7,9,10,12,14,16}, reproducibility^{3,11}, quick acquisition of images^{3,8,10-14}, and the possibility of capturing the facial texture^{11,12}. When analyzing the advantages listed about the other systems, it appears that the majority are already included in the list for 3dMD®.

As far as the year of publication is concerned, it was found that from 1994, few studies were being produced, until a peak emerged in 2010. This peak was generated by 6 articles, all of which used the 3dMD® system. Furthermore, the 3 studies that used the system to capture three-dimensional cranial images (Cranial 3dMD®) are included among these 7 articles^{7,8,10}. This increase in the number of published papers can be attributed to the effectiveness of the disclosure system and its advantages over the conventional technologies^{4,5,11}. Furthermore, because the system has restricted portability³ and high cost^{3,11}, it is understandable that there is a delay from its launch to its application in routine medical practice, as a result of certain factors that require time, such as technology validation, capture of funds, importation, and familiarity with its use.

Concerning the diseases addressed, 63.2% of the articles studied cleft lip and palate, and nonsynostotic cranial deformities were the second most common condition (15.8%). Although both conditions require a three-dimensional approach for appropriate treatment^{8,7,10,20-22}, nonsynostotic cranial deformities are usually solved with active repositioning of the child, with the use of orthotic helmets reserved

for more severe cases. The possibility of surgical resolution of nonsynostotic cranial deformities is very low^{7,30}, with aesthetic improvement being the only aim of surgery³¹. On the other hand, cleft patients should always undergo surgery, which aims to improve the patient's functional and aesthetic outcome, although the management of this condition is still a subject of debate³². Thus, the main focus of the scientific community concerning clefts is possibly the difficulty of treating them satisfactorily and evaluating the final results.

In the analysis of the 5 conditions addressed in 19 scientific papers, the use of facial reference points was unanimous. With the exception of 2 studies on swelling after third lower molar extraction^{23,24}, all other articles used anthropometric reference points. Among these anthropometric reference points, those that had higher application were the most widespread and easily located: endocanthion, exocanthion, pronasale, subnasale, wing, cheilion, crista philtri, nasion, and opisthocranion. The clefts, the most commonly used reference points, are located in the middle third of the face and in the upper portion of the lower third of the face. In turn, the analysis of nonsynostotic cranial deformities evaluated cranial and facial key points such as euryon, opisthocranion, inion, nasion, trignon, vertex, cheilion, and alare, which provide general morphological information about the head. In the study of 22q11.214 deletion, facial analysis sought to quantify the “facies” typical of the syndrome, addressing the 3/3 and ears with facial reference points already established. With respect to the list made to evaluate a patient with class III malocclusion¹², no anthropometric points of the middle and lower third of the face covering both such other conditions that the paper studies.

The main difficulty in extracting data on the reference points used in each article was the heterogeneity of the names used to refer to the same facial parameter. While some articles^{14,18} applied, for the most part, the classifications proposed by Farkas & Munro²⁶ or Kolar & Salter²⁷, other studies⁷ referred to the points by using a description of its location. An effort to use the same nomenclature is essential to avoid misinterpretations of the work and facilitate the use of information in other articles.

In assessing the quality of the articles, it was found that 63.2% of the studies had a similar design to clinical trials or diagnostic accuracy studies considered to have good level of scientific evidence by the Oxford Centre for Evidence-based Medicine³³. Following these criteria, 26.3% of the remaining studies showed low level of evidence, being observational studies, and 16.7% were without evidence, since they were in the form of technical notes.

Additionally, it was found that 63.2% of the articles used control groups; however, the majority consisted of healthy individuals in order to have a standard for comparison of the final results. Only 2 articles used control groups that included

REFERENCES

subjects having the medical condition of the group to which they were compared; in one of these articles²³, placebo was prescribed for the controls and the other used a traditional treatment⁷.

The sample size in the studies varied between 10 and 181 individuals. Possibly, this difference is due to the presence of services that already have the technology for some time and others who are only starting their research with the equipment. A fact supporting this hypothesis is that the 2 studies with larger samples (181¹⁰ and 100⁸ patients) have a common origin – the University of Giessen, Germany.

Interestingly, only 2 studies used 2 different conditions to form a group of analysis^{3,9}. Probably, these instances are justified more by the lack of research subjects rather than the lack of knowledge of the authors about the distinction between the conditions.

Since most studies used measurements and digital identification reference points, the evaluation of both intra- and interoperator reliability is necessary for a substantially validated work. However, there were no data on the interoperator reliability in 79% of articles. A possible explanation for this result could be the difficulty of finding persons familiar with the system and available to obtain the measurements.

In the final analysis of this systematic review, we obtained data on the follow-up time of patients in some studies involving a therapeutic approach (68.4%). A great source of errors that can be probed in this data extraction is the time to photograph the patient postoperatively (in 10 of 13 articles with some therapeutic approach involving surgery), because if the photograph was taken very early, the final appearance may still not be reflected. Concerning this aspect, the largest discrepancy was observed in surgeries involving the nose, which showed the following follow-up times: 9 weeks¹⁹; 1 month¹⁵; and 1, 3³, and 6 months¹⁷. Therefore, as the end result of a rhinoplasty can take 6 months to 2 years to show³⁴, the article with the longest follow-up time waited only until the lower limit of the safe range.

Digital stereophotogrammetry can overcome the limitations of the traditional two-dimensional analysis of facial soft tissues. Therefore, high-quality scientific studies are required to validate the use of this method in several conditions that constitute the spectrum of craniofacial abnormalities.

CONCLUSIONS

Digital stereophotogrammetry is a noninvasive, accurate, and easy-to-manipulate technology for the evaluation of treatments and quantification of craniofacial deformities. Currently, the most frequently applied system offering a high number of advantages cited is 3dMD[®]. However, there is need for more studies with long-term monitoring and on the association of a wider variety of systems.

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