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NOVEL DIFFICULTY INDEX FOR CLEFT MAXILLARY ORTHOGNATHIC SURGERY

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ABSTRACT

Purpose: this study aims to provide and suggest a difficulty index or score for anticipated challenges in orthognathic surgeries for the CL/P patient.

Methods: This was a retrospective study, done by collecting data of orthognathic surgeries performed on CL/P patients in the period from December 2020 to March 2022. Patients included were those with retrognathic or hypoplastic maxilla, that had a history of cleft lip, cleft palate or both, and had either failed or skipped alveolar bone grafting, with or without oronasal fistulae, and had undergone LF-1 osteotomy to advance the maxilla. Proper description of the clinical and radiographic findings was collected for each patient, along with the subjective score and any occurring difficulties reported by the surgeon at the time of the surgery. An objective score was formulated and statistically correlated with the subjective score.

Results: Patients included in this study summed up to be 9 patients. The subjects were 44% males with age range of 16 to 21 years. 78% had cleft lip with palate, and 22% were cleft lip only, with primary palate. Various difficulties were reported by the surgeon in each patient, with wide range of subjective scores. Spearman correlation showed a positive correlation of 0.866 between the subjective score and the proposed difficulty index.

Conclusion: The proposed difficulty index proved to be a promising tool, permitting better planning and preparation in the future of these surgeries. More validation is required with studies of bigger sample size.

KEY WORDS: Cleft, orthognathic surgery, cleft lip, cleft palate, orthognathic planning

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INTRODUCTION

Patients with cleft lip with or without cleft palate (CL/P) are faced with a long series of treatments and operations throughout their life, to repair cleft lip, cleft palate, revision surgeries, speech surgeries, and alveolar defect repairs.[1] Through the effect of nature and nurture, dentofacial discrepancies arise in these patients.[2] Nature has a role through a probable intrinsic factor, slowing down the growth of the facial skeleton. Moreover, evidence suggests that the repair of cleft palate has a hindering effect on maxillary bones, where various surgical techniques for cleft palate repair create variable effects of growth hinderance. Whereas lip repair might have an effect on the growth.[3–8]

An Angle class III facial deformity is created, due to a small, rotated maxilla, with rotation of the mandible to meet the maxilla, creating a pseudoprognathism. In some patients, however, the mandible is actually larger than the normal.[4,5] This creates the need for orthognathic correction in CL/P patients in almost 80% of cases,[9] and as stated by Ohrmann[10] "a link in the chain of cleft care modalities". It has been categorized by an Index of Orthognathic Functional Treatment Need (IOFTN) by Ireland et al.,[11] to be in the highest rank as "very great need for treatment". Levy-Bercowski[12] stated that "Early intervention and multiple phases of treatment permit many patients to be treated with acceptable results without the need for orthognathic surgery", adding that the improper timing or missing of dentofacial orthopedics necessitates orthognathic surgery later on.[12]

The chief goal of orthognathic surgery in the cleft maxilla is to move the lesser segment(s) forward to minimize the cleft-dental gap, thus, moving the canine in place of the lateral incisor. Any oronasal communications and palatal fistulae are repaired at the same time. This entails the maxilla to be divided into segments, even if the alveolar bone defect is grafted successfully.[13] If there is no intention of closing the cleft-dental gap, one piece maxilla can be utilized.[14] Le Fort I (LF-1) osteotomy is the best choice for moving the cleft maxilla.[3]

Forward movement of the cleft maxilla using orthognathic surgery is challenged by numerous difficulties.[3,4] Lip repair and subsequent lip revision surgeries cause excessive tightness of the lips. This low elasticity created in the lips holds back the required forward advancement of the maxilla.[15–17] Along with these, are difficulties in any orthognathic surgery, whether cleft or not, such as stability of occlusion, combined soft tissue and other structural problems, and patient factors such as other disease or psychosocial problem.[18]

Surgeries to correct the cleft palate, if performed, create a palatal scar, resulting from formation and contraction of fibrous tissue in a wound. This defies the movement of the maxillary segments, and might even jeopardize the maxillary blood supply, if a forceful attempt is made to move the segments.[19, 20] This is owing to the poor viability of the palatal pedicle in cleft patients, with presence of the palatal fibrous scar. Therefore, palatal tissue should be critically evaluated before major advancements and/or expansions of the maxilla are planned.[21]

Another struggle in LF-1 osteotomy for cleft patients is the wide and thick pterygomaxillary junction. The downfracture of the maxillary segments demands the disjunction of the pterygoid plates from the maxilla. However, in CL/P patients, this area is wider and thicker than normal, with shorter pterygoid plates. This creates greater resistance during the disjunctioning step, thus requiring more force and time.[13,22,23]

Several attempts in different surgical fields have been made to provide an index to allow the assessment of the difficulty of the surgical procedure[24–28]. In the field of orthognathic surgery, scores have been proposed to determine the need for undergoing surgery such as the IOFTN,[11] and

the Severity and Outcome Index (SOI).[29] Scores to assess the actual difficulty to be faced by the surgeon during an orthognathic procedure, are very few, if any are present, with limited available literature regarding this topic.[18]

The aim of this retrospective study is to evaluate orthognathic surgeries performed for CL/P patients, in an attempt to come up with an index allowing the future preoperative assessment of difficulty of orthognathic cleft surgeries.

METHODS

A retrospective study was carried out by collecting data of orthognathic surgeries performed on CL/P patients in the period from December 2020 to March 2022, leading to inclusion of 9 patients.

Patients included were those with retrognathic or hypoplastic maxilla, that had a history of cleft lip, cleft palate or both, and had either failed or skipped alveolar bone grafting, with or without oronasal fistulae, and had undergone LF-1 osteotomy to advance the maxilla. The same surgical technique was used in all patients, and that was done by the same surgeons.

The standard technique used for maxillary advancement in these patients was access through a vestibular incision extending from upper first molar on one side to upper first molar on the other side, and dissection to expose maxillary walls, nasal structures, and zygomatic buttress. Osteotomy was done by ultrasonic cutting instruments, extending from lateral nasal wall to zygomatic buttress, on each side. Chisels and mallets were used to separate lateral nasal wall, and the pterygoid junction. Smith spreaders were used to downfracture the maxilla, and Rowe's disimpaction forceps to mobilize the maxilla, if palatal shelves were present. If no palatal shelves were present, Tessier mobilizers were used. The maxilla is downfractured as two or three segments, due to the presence of the cleft palate. After downfracture and mobilization, the maxillary segments were advanced into the pre-fabricated stent indicating the intended maxillomandibular relation, and intermaxillary fixation was carried out. The segments were then fixated into the new position using titanium miniplates and screws.

The method of difficulty assessment was divided into three steps:

Subjective scoring of the operation

Surgical records were obtained, and surgeons' comments written after the operation were considered. Also, following the operations, surgeons gave a score from 1-10 noting the extent of difficulty encountered, 1 being no difficulties, and 10 being highly difficult operation. This score was added to the records for this study.

Objective score development

Different factors and aspects correlating with operational difficulties, as gathered from the subjects' records, were used to formulate a score or a "difficulty index". Data was collected from the records to include the following:

1. Type of cleft defect
2. The number of previous palatal surgeries
3. Presence or absence of palatal fistulae (Figure 1)
4. Photographic record of the palatal tissues (Figure 2)
5. Type of surgery, whether maxillary or bimaxillary surgery

Data from radiographic records, cone-beam computerized tomographic scans (CBCT), were collected to include:

1. Presence or absence of a palatal shelf of bone (Figure 3)
2. Persistent alveolar defect gap

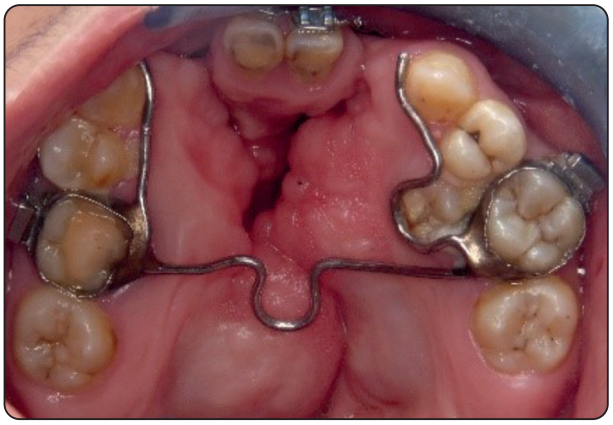

Fig. (1) Clinical picture showing a palatal fistula

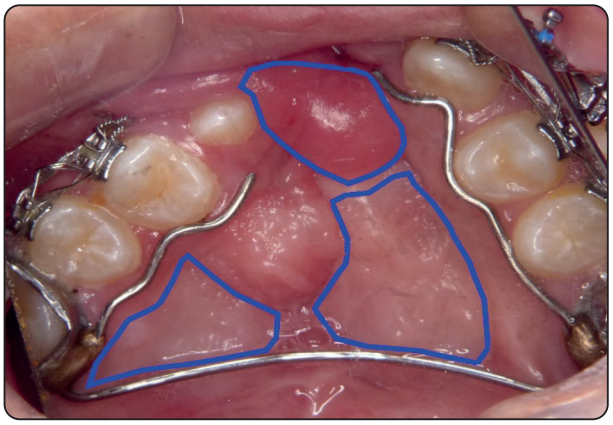

Fig. (2) Clinical picture depicting native and scarred tissues in the palate, circled areas indicate scarred tissue

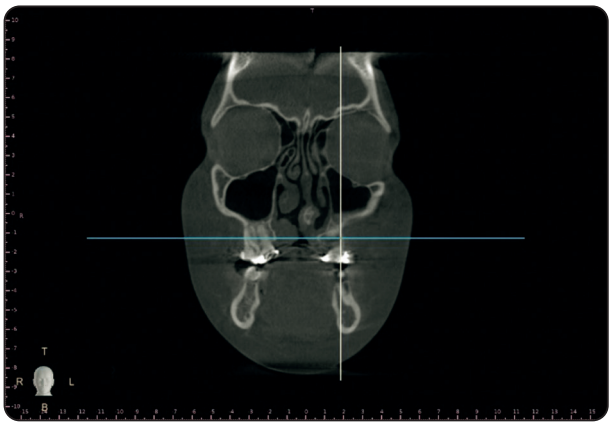

Fig. (3) Coronal CT scan indicating absence of the palatal shelf of bone

Two examiners evaluated the clinical photographs of the patients, separately from each other. Areas of native tissue and areas of scarred or fibrous tissue were delineated, and the amount of scarred tissue relative to the native tissue was estimated.

These records were summed up to provide an objective score for each patient as shown in Table 1.

TABLE (1) Proposed difficulty index

Difficulty Index for Le Fort I osteotomy in Cleft Lip and Palate patients	
Classification	Difficulty Index value
Number of Previous Palatal surgeries	
No previous surgery	1
1 – 2 surgeries	2
More than 2 surgeries	3
Lip Status	
No tightness present	1
Tightness present	2
Palatal Tissue Status	
Scarring in less than 1/3 of palatal area	1
Scarring in 1/3 - 2/3 of palatal area	2
Scarring in more than 2/3 of palatal area	3
Presence of palatal shelves	
Fully developed	1
Partially developed	2
Not present	3

Score of 4-5: mildly difficult; 6-8: moderately difficult; 9-11: very difficult

Other factors to consider: thickness of pterygomaxillary junction, thickness of lateral maxillary sinus walls, stability of teeth

Statistical Correlation

The subjective and objective scores were correlated together using Spearman Correlation Test.

RESULTS

Table 2 shows the details of the study subjects. The subjects were 56 % females, 44% males with age range of 16 to 21 years. 78% had cleft lip with palate, and 22% were cleft lip only, with primary palate

Records of surgeons' notes after the operation revealed variable commentaries about the difficulties encountered in each subject. Subjects #1, #6 and #7 had no surgical comments, which meant no particular difficulties were encountered. Surgeons commented on subjects #3 and #9 that they had mild to moderate difficulty in the mobilization of the segments. Segments were very difficult to mobilize in subjects #2, #4, #5, and #8. There was poor bone quality for plates and screws fixation in subjects #2, #3, #4, #5.

Subject #3 suffered from tooth avulsion during the operation, while subject #4 still had impacted teeth, which presented difficulties for the surgeons. Subjects #2 and #4 experienced some degree of necrotic wound healing after the orthognathic surgery region.

Scores indicating the extent of difficulty given by surgeons postoperatively for each subject is shown in Table 3 as "subjective score". Table 3 also demonstrates the objective score calculated for each patient. Spearman correlation showed a positive correlation of 0.866 between the subjective score and the proposed difficulty index. (Table 4)

TABLE (2) Subject details

Subject Number (#)	Age at operation (years)	Gender	Cleft type	Pharngyeal flap	Palatal Fistula	Cleft-dental gap	Number of Previous Surgeries	Lip Status	Amount of Palatal Scarring	Presence of Palatal Shelf
1	21	F	BCLP	Yes	Yes	Yes	1	Not tight	Between 1/3 - 2/3	No
2	18	M	BCLP	No	Yes	Yes	5	Not tight	More than 2/3	No
3	16	M	BCLP	No	No	Yes	3	Tight	Between 1/3 - 2/3	Partial
4	19	M	BCLP	No	No	Yes	2	Not tight	Between 1/3 - 2/3	No
5	21	F	UCLP	No	Yes	Yes	3	Not tight	Between 1/3 - 2/3	No
6	20	F	UCL	No	No	Yes	0	Not tight	Less than 1/3	Partial
7	19	F	BCL	No	No	Yes	0	Tight	Less than 1/3	Yes
8	16	F	BCLP	No	Yes	Yes	2	Tight	More than 2/3	No
9	17	M	BCLP	No	No	Yes	1	Not tight	Between 1/3 - 2/3	Partial

UCLP: unilateral cleft lip and palate, BCLP: bilateral cleft lip and palate, UCL: unilateral cleft lip, BCL: bilateral cleft lip

TABLE (3) Comparing the subjective surgeon score with the proposed difficulty index

Patient	Subjective Score (1-10)		Score According to Difficulty Scale (4-11)	
1	4	Moderate	7	Moderate
2	9	Severe	11	Severe
3	7	Severe	9	Severe
4	8	Severe	7	Moderate
5	7	Severe	9	Severe
6	3	Mild	5	Mild
7	3	Mild	5	Mild
8	9	Severe	10	Severe
9	5	Moderate	5	Mild

Subjective Score of 1-3: mildly difficult; 4-6: moderately difficult; 7-10: very difficult

Difficulty Score of 4-5: mildly difficult; 6-8: moderately difficult; 9-11: very difficult

TABLE (4) Correlation between the subjective surgeon score and the proposed difficulty index

	Correlation Coefficient (Rho)	P value
Subjective surgeon score VS proposed difficulty index	0.866	0.003*

****Statistically significant difference at p value<0.05***

DISCUSSION

This study aimed to systematize a means of estimating the amount of anticipated complexity or difficulties in an upcoming cleft orthognathic surgery, by a retrospective analysis of previous orthognathic surgeries performed on patients with CL/P. Through the evaluation of these previous cases, four main factors have been found to adversely affect the surgical process; (1) number of palatal surgeries performed on the patient before the orthognathic surgery; (2) presence or absence of lip tightness; (3) amount of scarring found in the palatal tissues; and (4) presence or absence of palatal shelves.

In patients with moderate and severe palatal scarring, the two maxillary segments were difficult to mobilize, fibrous scarring present impeding the advancement process. The scarring also hindered the differential movement of the segments away from each other, that was needed to bring the segments in the correct lateral position.

Cleft palate repair usually results in fibrotic scarring of the tissues. Even though oral mucosa usually heals uneventfully, but in the case of cleft palate, fibrosis occurs due to the absence of supporting bony structure.[30] Many authors correlated that this scar tissue has lower number of fibroblasts and elastin fibers, and is poorly vascularized. This makes the scar tissue very stiff and rigid.[30-32] Also, the palate is covered by keratinized mucoperiosteum, rather than the nonkeratinized mucosa on the buccal areas. This mucoperiosteum is firmly attached to the palate, with less elastin, implying that even the physiological nature of the cleft palate tissues is more rigid.[8] This explains the obstacle one comes across when trying to differentially move the two maxillary segments anteriorly and laterally to achieve the proposed position of the maxillary teeth. There is greater soft tissue tension, and subsequent instability of the segments.[33] That's why the first and third factors of the difficulty score have been added, to provide an idea of the amount of scarring present for each patient. In this study, patients presenting with very scarred palate (more than 2/3 of palate), the required anteroposterior and lateral movement was not fully achieved due to the tightness of the tissues. Cases that had increased number of former palatal surgeries also presented with poor blood supply, complicating the healing process after the orthognathic surgery.

Similar to the cleft palate repair, cleft lip repair ensues variable degrees of fibrotic scarring in the lip. This scarring, along with inconsistent techniques used by various surgeons, gives rise to a tight, short lip with little or no labial sulcus. Several attempts to repair the esthetics of the lips results in even greater tightness.[15,16,30] This necessitates the use of an Abbe flap, as a separate surgical procedure in some of these cases, before undergoing the orthognathic surgical procedure.[34,35] Therefore, it is believed that this creates a greater burden on the patient during the preparation for the orthognathic surgery. Thus, the third factor of the difficulty scale has been added.

The fourth factor in the difficulty scale was added for two aspects of the surgery. Absence of palatal shelves in CL/P patients results in a compensatory thickening of the pterygomaxillary junction.[13,22,23] Surgeons at our center found that patients with no palatal shelves required greater time and force to completely release this junction. Also, the absence of the palatal shelves eliminated the means of grasping of the maxilla by the Rowe's disimpaction forceps. Thus, the mobilization of the maxilla after the downfracture was also challenging. And as mentioned before, the deficiency of the palatal shelves deprives the wound healing process of the palate from a supporting framework, thus contributing to a fibrotic scar healing of the tissues.

CONCLUSIONS

A difficulty score has been proposed to allow surgeons to foresee complexities in planning for orthognathic surgery for CL/P patients. It is believed to be a promising tool, permitting better planning and preparation in the future of these surgeries. More validation is required with studies of bigger sample size.

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