Special Article

The Assessment of Treatment Outcome by Evaluation of Dental Arch Relationships in Cleft Lip/Palate

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Cleft lip/palate (CLP) patients need an interdisciplinary team approach for optimal treatment, care and results. Evaluation of the treatment outcomes is essential to allow for identification and implementation of the highest possible standard of care. The aim of this paper is to present the less invasive methods of assessment of treatment outcomes by evaluation of dental arch relationships in both unilateral and bilateral CLP.

Keywords: Assessment, Treatment outcomes, Dental arch relationships, Cleft lip/palate, CLP

A cleft lip/palate is a structural defect that usually affects several functional areas. Complex problems may arise regarding the child's feeding, facial appearance, speech, hearing, dental functioning and psychosocial development. These problems can be best managed by bringing together specialists from diverse disciplines to review the physical and psychological changes caused by the defect and to coordinate all interventions and treatments to the best advantage of the patient and his/her parents.

According to the standards of the American Cleft Palate-Craniofacial Association (ACPA), the cleft team should include an operating surgeon, an orthodontist and a speech-language pathologist. Optimal care for cleft patients is provided by teams that see sufficient numbers of patients each year to maintain clinical expertise in diagnosis and treatment[1,2].

The first goal of the cleft team is to provide the optimal delivery of comprehensive care that offers the best overall chance of success for the cleft patients. A longitudinal treatment plan needs to be developed for each patient, which can be modified, if necessitated by treatment progress or new therapeutic insights. Each interdisciplinary team should maintain centralized and comprehensive records for each patient.

Reports of single center studies have been the commonest form of presenting outcomes in cleft lip/palate; however, inter-center studies are more informative than single center reports and will have an important role in future cleft care[3].

Evaluation of treatment outcomes is essential to allow for identification and implementation of the highest possible standards of care. The range of outcomes of the treatment of cleft lip/palate can be considerable. Differences in treatment results may be related to variation in the sequence, timing and technique of treatment, the organization and delivery of care, as well as in the skills and experience of individual surgeons.

Facial growth is one of the key areas of interest for the quality of cleft treatment outcome. Good facial growth may result in dental arch relationships that can be treated conventionally, thereby avoiding surgical correction of the skeletal bases and, thus providing optimal results in terms of facial appearance[4]. The aim of this paper is to review several methods currently in use for rating dental arch relationships among cleft patients.

Evaluation of dental arch relationships in UCLP

The problems of growth of the dentofacial complex in CLP patients, especially unilateral complete CLP are generally reflected in the anteroposterior vertical and transversal dental relationship. Different methods of recording these dental (or dental arch) relationships have been used to document the outcome of surgery in cleft patients. The majority of the scoring methods

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are based on the presence of a crossbite[5-7]. Pruzansky and Aduss[5] classified occlusion into six categories (1 to 6), while Matthews et al[6] used five categories from A over B1 to B3 to C. Although both classifications describe occlusion, a meaningful comparison of the results is difficult because of the dissimilar categories used[8].

Other methods are based on the quality of over-jet, over-bite and molar occlusion in numerical terms[8,9]. Since the Huddart/Bodenham system was designed for use only in primary and complete dentition, it had to be modified for mixed dentition[10].

Huddart and Bodenham described system for measuring upper arch constriction in primary dentiton of patients with repaired CLP. This system uses the frequency and severity of crossbite of the dental occlusion to evaluate maxillary arch constriction in the labial segment and the greater (non-cleft) and lesser (cleft) buccal segments. The buccal segments comprise the canine and primary molars while the labial segment only the central incisors (Fig. 1). Each maxillary tooth is scored according to its relationship with the corresponding tooth in the mandible (Fig. 2). Individual scores are summed to give a total score for each set of models.

Mossey et al[10] modified the scoring system for use in mixed dentition, by scoring premolars in the same way as primary molars, i.e., normal occlusion was scored 0, cuso to cusp -1 and buccal crossbite -2. The modified system requires that all teeth from the first permanent molar forward be given a score to reflect the maxillary arch constriction. Therefore, in all cases where there was an absent or unerupted tooth, the score was determined by the midpoint of the maxillary alveolar ridge at the location of the missing tooth.

The modified Huddart/Bodenham scoring system appears to be a valid and reliable indicator of treatment outcome for patients with UCLP. The scoring
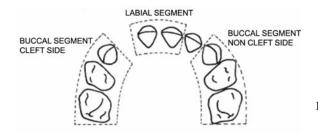
system can be used for 5- and 10-year-old models, or for any age from 3 years up. The reasons for any discrepancy in cases reflects the fact that the Huddart/ Bodenham system measures arch constriction (possibly a more accurate reflection of surgical outcome) rather than the potential for orthodontic correction. The latter is influenced by surgical outcome and by the inherited skeletal pattern. Gray and Mossey[11] concluded that the modified Huddart/Bodenham system provides an objective and reliable assessment of maxillary arch constriction, which has a high degree of correlation with the recommended standards, and is more versatile and sensitive to inner-arch discrepancies.

In 1987, Mars et al[12] introduced and published a new, simple, standardized method called 'the Great Ormond Street, London and Oslo, Norway (GOSLON) yardstick for measuring the outcome of treatment in patients with unilateral CLP in late mixed and/or early permenent dentition'. The outcome of treatment is viewed on models and scored by experienced raters. Patients are categorized into one of the following five groups:
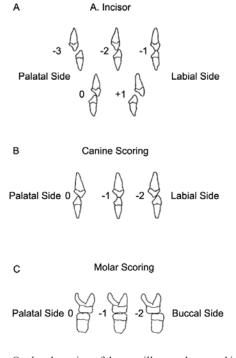

Fig. 2   Occlusal scoring of the maxillary arch as used in the Huddart/Bodenham scoring system:scoring of (A) the anteroposterior relationship of the central incisors; (B) the buccopalatal relationship of the canines; (C) the buccopalatal relationship of the molars (adapted from Huddart and Bodenham,

Fig. 1   Segmental divisions of the maxillary arch as used in the Huddart/Bodenham scoring system (adapted from Huddart and Bodenham, 1972)

Table 1. BCLP Deciduous Dentition Yardstick (6-year Yardstick) (Adapted from Okada Ozawa T et al, 2010)

Guidelines

- Consider apical base relationship first
- Correct inclination of the incisors mentally (also consider excessive retroclination of lower incisors)
- Ignore crossbite of deciduous and permanent laterals and/or deciduous canines
- Ignore edge to edge buccal cusp relationships
- If there is evidence of orthodontics, assume there was a crossbite pre-treatment (*e.g.* bands, teeth flared buccally or over-expanded)

Definitions	Apical base relationship	Incisor relationships	Crossbite	Arch form
Score 1	Class I or Class II	Positive overjet and overbite (no open bite)	None	Good
Score 2	Class I or Class II	Corrected incisors would be positive overjet and overbite (or minimal open bite)	May have	Minor deviation. (If severe deviation or severe open bite, score 3)
Score 3	Edge-to-edge	Corrected incisors would be edge-to-edge	May have	Major deviation
Score 4	Class III	Corrected incisors would not be edge-to-edge	May have	Poor
Score 5	Class III (extreme)	Corrected incisors would not touch lower incisors	May have	Major deviation

Table 2. BCLP Yardstick for Early Mixed Dentition Yardstick (9-year Yardstick) (Adapted from Okada Ozawa T et al.,2010)

Guidelines

- Consider apical base relationship first
- Correct inclination of the incisors mentally (also consider excessive retroclination of lower incisors)
- Ignore crossbite of deciduous and permanent laterals and/or deciduous canines
- Ignore edge to edge buccal cusp relationships
- If there is evidence of orthodontics, assume there was a crossbite pre-treatment (*e.g.* bands, teeth flared buccally or over-expanded)

Definitions	Apical base relationship	Incisor relationships	Crossbite	Arch form
Score 1	Class I or Class II	Positive overjet and overbite (no open bite)	None	Good
Score 2	Class I or Class II	Corrected incisors would be positive overjet and overbite (or minimal open bite)	May have	Minor deviation. (If severe deviation or severe open bite, score 3)
Score 3	Edge-to-edge	Corrected incisors would be edge-to-edge	May have	Major deviation
Score 4	Class III	Corrected incisors would not be edge-to-edge	May have	Major deviation
Score 5	Class III (extreme)	Corrected incisors would not touch lower incisors	May have	Poor

Table 3. BCLP Yardstick for Early Permanent Dentition Yardstick (12-year Yardstick) (Adapted from Okada Ozawa T et al.,2010)

Guidelines

- Consider apical base relationship first
- Ignore crossbites
- A moderate to severe anterior open bites would increase the score by one grade
- Add a D for severe deep bites, and O for severe open bite

Definitions	Apical base relationship	Incisor relationships
Score 1 + 2	Class I or Class II	Positive overjet and overbite (actual or achievable)
Score 3	Edge-to-edge	Corrected incisors would be edge-to-edge
Score 4	Class III	Corrected incisors would not be edge-to-edge
Score 5	Class III	Corrected incisors would not touch lower incisors

Group 1: Positive overjet with average inclined or retroclined incisors with no crossbite or open bite. Long-term outcome: excellent.

Group 2: Positive overjet with average inclined or retroclined incisors with unilateral crossbite or crossbite tendency around the cleft site. Long-term outcome: good.

Group 3: Edge-to-edge bite with average inclined or proclined incisors or reverse overjet with retroclined incisors. Unilateral crossbite with or without open bite tendency around the cleft site. Long-term outcome: fair.

Group 4: Reverse overjet with average inclined or proclined incisors. Unilateral crossbite with or without bilateral crossbite with or without open bite tendency around the cleft site. Long-term outcome: poor.

Group 5: Reverse overjet with proclined incisors. Bilateral crossbite and poor maxillary arch form and palatal vault anatomy. Long-term outcome: very poor [13].

The GOSLON yardstick is widely accepted as a tool to assess the outcome of treatment in patients with unilateral cleft lip/palate (UCLP) and to compare treatment outcomes between different centers in regard to maxillary growth. The GOSLON yardstick provides a reliable and reproducible means of measuring dental arch relationships which in turn reflects the quality of facial growth. It also gives a practical indication of the proportion of cases that can be treated by orthodontics alone or that will require a combination of orthodontics and surgical skeletal correction.

The GOSLON score is also a useful method for longitudinal assessment of the dental arch relationships and serves as an indicator of the outcome of treatment so may be used to compare outcomes between different centers and different surgical treatments. While the GOSLON yardstick was developed for mixed and early permanent dentition (*i.e.,* from the age of 9 to 11 years), a similar index called the the 5-year index[14] was developed in 1997 for 5-year-old children with UCLP. The authors were able to demonstrate a good correlation between the two indices in longitudinal study models taken at 5 and 10 years of age in the same patient sample. Both the 5-year and GOSLON indices use five categories (*i.e.,* ranking from excellent to very poor) and these categories are based on criteria used to describe the dental arch relationship.

The use of the GOSLON and 5-year indices require a degree of professional judgement with regard to the possibility of orthodontic correction, which introduces an element of subjectivity. Reference models have to be used for comparison and a calibration course is necessary for competent use.

The 5-Year index is a reproducible and reliable assessment of the primary outcome in unilateral cleft lip/palate patients[14-16]. This assessment allows an early audit of outcome in the primary dentition prior to any external influences (*i.e.,* orthodontic interventions). Notwithstanding, the use of this study model index relies on the ability of clinicians to take the study model
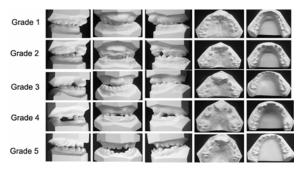
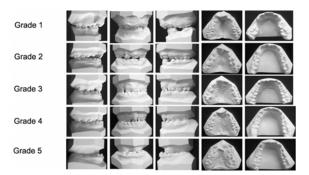**Fig. 3** Example of BCLP Yardstick for 6 year olds (adapted from Okada Ozawa T et al.,2010)

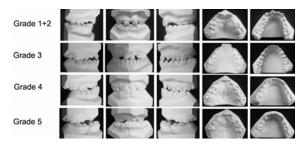**Fig. 4** Example of BCLP Yardstick for 9 year olds (adapted from Okada Ozawa T et al.,2010)

Fig. 5 Example of BCLP Yardstick for 12 year olds (adapted from Okada Ozawa T et al.,2010)

records at the age of 5, which can present its own difficulties.

Evaluation of dental arch relationships in BCLP

It is essential to have reliable methods for assessing treatment outcomes among patients with bilateral complete cleft lip/palate (CBCLP). Dental arch relationships provide a valid proxy for the underlying skeletal base relationship. In order to assess the dental arch relationship in CBCLP, two methods are available, the recently developed BCLP-yardstick[17,18] and the older Huddart/Bodenhamm scoring system (HD-

system)[10].

The low incidence of CBCLCP[19] explains the low number of published reports of BCLP treatment outcome and why a yardstick for treatment outcomes in BCLP was developed only recently. The BCLP-yardstick is a GOSLON-type yardstick adapted to the clinical characteristics of CBCLP patients. It assesses the dental arch relationship in terms of anteroposterior, transverse and vertical discrepancies[17,18]. In the CBCLP-yardstick, the sagittal dental base relationship is considered the most important feature, because it is an indicator of the treatment outcome.

The use of a BCLP-yardstick requires orthodontists with experience in treating patients with clefts and who have enrolled in a calibration course with reference models which correspond to the different categories of the yardstick.

Assessment using the BCLP-yardstick involved allocating the casts to one of five categories, defined by written guidelines and by examplar reference casts of the different categories. The score 1 (excellent results) and 2 (good results) represented the most favorable dental arch relationships. Patients in these categories would be treated by orthodontic treatment alone. Score 3 indicated an edge-to-edge, apical base relationship and required more complex orthodontic treatment to correct the malocclusion. Score 4 (poor results) was given to patients who required complex orthodontic treatment, probably in combination with orthognathic surgery. A very poor dental arch relationship was scored 5, which represented patients who required orthognathic surgery.

In the newly developed BCLP-yardstick, scores of 1 and 2 are combined in the 12-year group as the occlusal status of some patients may have been improved by intermediate orthodontic treatment to correct the incisor position and arch form was ignored to take account of the high likelihood of corrective orthodontic treatment (Table 1-3, Fig. 3-5)[17,18]. In the course of the ratings, some examples of marked premaxillary displacement were noted, especially among the younger age groups. This led us to explore the possible creation of a supplementary index for such cases (*i.e.,* subdividing the initial yardstick into three yardsticks, representing: deciduous, early mixed and early permanent dentition (*i.e.*, a 6-, 9- and 12-year yardstick, respectively)[18].

Conclusion

Orthodontists, one group of professionals on the cleft multidisciplinary team, play an important role

in the evaluation of treatment outcome of cleft patients. Many methods are available for assessement. Part of the assessment of facial growth and development in children, both with UCLP and BCLP, should be a dental arch relationship evaluation. Many standardized methods for the measurement of treatment outcomes exist and are based on analyses of the skeletal and dental relationships using study models. These models provide reproducible and reliable assessment of the treatment outcome(s) of CLP.

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การประเมินผลการรักษาในผู้ป่วยปากแหว่งเพดานโหว่โดยการพิจารณาความสัมพันธ์ของส่วนโค้งแนวฟัน

ทัศนีย์ วังศรีมงคล, วัลลภ จันทร์สว่าง

ผู้ป่วยปากแหว่งเพดานโหว่จำเป็นต้องได้รับการรักษาโดยทีมสหสาขาวิทยาการ เพื่อให้ได้มาซึ่งผลลัพธ์ของการรักษาที่เหมาะสม ดังนั้นจึงมีความจำเป็นอย่างยิ่งที่จะต้องมีการประเมินผลการรักษา เพื่อเป็นการปรับปรุงและพัฒนามาตรฐานการรักษาให้มีประสิทธิภาพที่ดีที่สุดเท่าที่จะเป็นไปได้ดังนั้น บทนิพนธ์ทบทวนวรรณกรรมฉบับนี้มีวัตถุประสงค์ เพื่อนำเสนอวิธีการประเมินผลการรักษาสำหรับผู้ป่วยปากแหว่งเพดานโหว่ โดยการพิจารณาความสัมพันธ์ส่วนโค้งแนวฟัน ซึ่งเป็นวิธีการที่ได้รับความนิยมแพร่หลายในศูนย์ดูแล ผู้ป่วยปากแหว่งเพดานโหว่ทั่วโลก