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CORRELATION OF GOSLON YARDSTICK SCORING AND LATERAL CEPHALOMETRIC PARAMETERS IN UNILATERAL CLEFT LIP AND PALATE PATIENTS

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ABSTRACT

OBJECTIVE: The aim of the present study was to evaluate the cephalometric validity of Goslon yardstick in non-syndromic complete unilateral cleft lip and palate patients.

MATERIALS AND METHODS: The sample consists of lateral cephalograms and study models of 49 complete, non-syndromic, skeletal Unilateral Cleft Lip and Palate patients. The study models were assigned anonymous numbers and were then scored according to the Goslon yardstick by three investigators separately. A total of 19 hard tissue (17 skeletal and 2 dental) cephalometric measurements were assessed. Intra-class correlation coefficients (ICC) were calculated to determine intra-examiner correlation cephalometric measurements. The intra- and inter- examiner reliability of GOSLON yardstick was checked by using Cohen's weighted kappa statistics. The correlation between Goslon yardstick and cephalometric parameters was analyzed by Spearman's rank correlation test.

RESULTS: The mean age of the sample was 14.73 +- 3.99 years. A highly significant strong correlation was found to exist between the Goslon yardstick and cephalometric parameters for sagittal maxillo-mandibular relation. The vertical parameters; Gonial angle and FMA; showed a positive, moderate association.

Conclusion: The association between the Goslon score and the lateral cephalometric parameters proved the robustness of Goslon yardstick.

KEYWORDS : Goslon yardstick, CUCLP, correlation, lateral cephalogram, kappa

INTRODUCTION

One of the most severe congenital anomalies affecting the mouth and related structures is cleft of the lip and palate [1]. The affected individuals are handicapped physically, socially and psychologically and the success of early surgical repair is judged on the balance between aesthetics, speech and facial growth. Dental occlusion has been introduced as a means to evaluate the results of cleft lip and palate repair [2-12], as it is more objective in reflecting facial growth. Mars et al. in 1987 [13] introduced the GOSLON (Great Ormond Street, London and Oslo, Norway) yardstick with the aim of more sensitive and reliable assessment of the surgical outcome in children with complete unilateral cleft lip and palate (UCLP) in the late mixed dentition stage. The Goslon yardstick categorized the dental arch relationships of patients with UCLP into five groups. The complexity of the problem increases from Group 1 to 5, with the group 5 requiring surgical orthodontic management for full correction. The Goslon yardstick has proven to be the most popular choice for assessing cleft deformities [14] and is the current method of choice for many intercenter comparisons of surgical outcome in UCLP patients [15-17].

The amount of maxillary growth restriction, that is present after cessation of growth, has paramount importance when the final surgical-orthodontic correction is planned. In this regard, the cephalometric parameters that evaluate maxillo-mandibular position could be decisive [18]. Cephalometric evaluation may be more important in older UCLP children as pubertal growth spurt may worsen the maxillary retrognathism. [19-21].

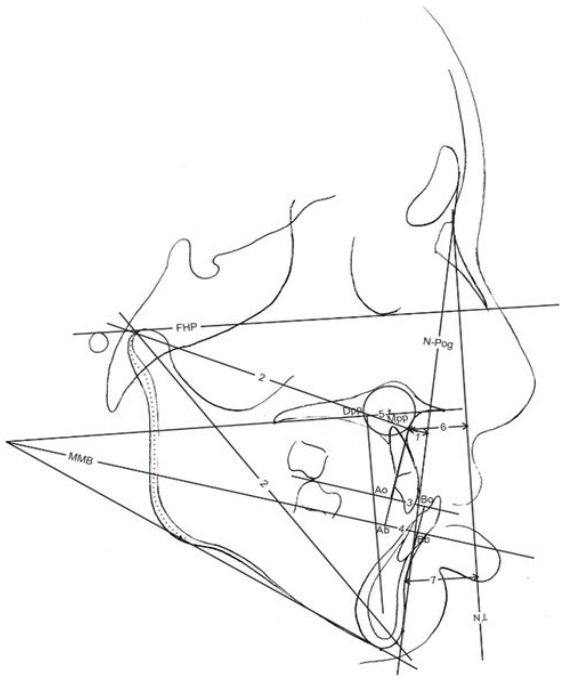
Although Goslon yardstick predicts the treatment outcome in mixed and early permanent dentition [22] (from the age of 9 to 11 years), few studies have been reported related to comparison of Goslon scoring and conventional cephalometric values. Such comparison must be made if cleft palate treatment eventually, is to be rationalized. So the present study has been designed to determine whether Goslon yardstick statistically correlates with lateral cephalometric parameters.

MATERIALS AND METHODS

The sample consists of lateral cephalograms and study models of 49 complete, non-syndromic, skeletal Unilateral Cleft Lip and Palate patients. The maxillary central incisors were reasonably erupted in all the cases and no orthodontic, orthopedic or orthognathic intervention has been initiated. All the surgical techniques were performed in a recognized cleft center. The study models were assigned anonymous numbers and were then scored according to the Goslon yardstick, as described by Hathorn et al 1996 [23] and Mars et al 1987 [13], by three investigators separately. The duplicate copies of master models of the GOSLON Yardstick were available for inspection during model assessment. The study models were re-evaluated after an interval of one week.

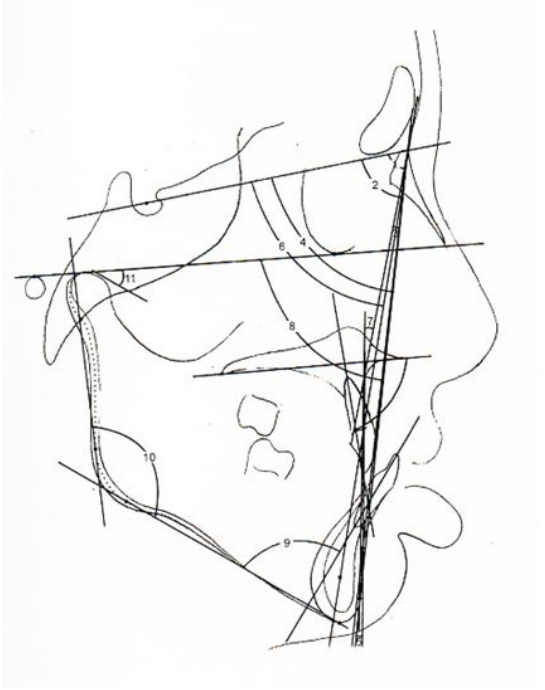
All lateral cephalograms included in the present study were taken with the mandible in intercuspal position and patients in Natural head position (NHP), using a cephalostat (PM 2002 cc PROLINE and Unit, M/s Planmeca, Helsinki, Finland). The exposure parameters were adjusted to get optimum quality radiograph. All the films had been developed in an automatic processor (compact 2 X-ray film processor, model: 1190-I PROTEC® Medizintechnik GmbH & Co. KG. Lichtenberger Straße 35, D-71720 Oberstenfeld, Germany). The radiographs were coded and a standard tracing of each cephalogram was done using a variable intensity view box in a dark room with a 0.50 mm thick 2H pencil on a 0.036 mm thick acetate matt paper by one investigator. Wherever bilateral structures produced a double contour on the cephalometric radiograph, a measurement was made to a point midway between the two contours. All measurements were made to an accuracy of 0.5 mm for linear and 0.5 degrees for angular measurements. The various linear and angular measurements done on the lateral cephalograms are given in Figure 1a & 1b. To determine intra-examiner repeatability, all the radiographs were retraced after an interval of one month. A total of 19 cephalometric measurements of hard tissues were evaluated of which 17 were skeletal and 2 were dental. Of these skeletal parameters, 15 were antero-posterior and 2 were vertical. Only two vertical measurements were assessed, for correlation as GOSLON yardstick is mainly a reflection of the antero-posterior skeletal problem.

Figure 1a: Linear measurements



Description of the linear measurements used in the study. Na A: perpendicular distance from point A to nasion perpendicular to Frankfort horizontal (FH) plane; Na B: perpendicular distance from B to nasion perpendicular to FH plane; A-N-Pog: Angle formed between the points A, N and Pog; MMD: Effective mandibular length minus effective midface length (Maxillo-mandibular differences); Ao-Bo : Wits appraisal; Ab-Bb: Wits assessment made to the maxillo-mandibular angle bisector; Mpp-Dpp: the distance from M point to D point along

Figure 1b: Angular measurements



Description of the angular measurements used in the study. SNA: angle formed between points S, N, and A; SNB: angle formed between points S, N, and B; ANB: angle formed between points A, N, and B; SND: angle formed between S, N and D; SN-Pog: angle formed between S, N and Pog; N-A-Pog: Angle of convexity; FH/N-Pog: angle between FH plane and N-Pog line; AB/N-Pog: AB plane angle; FMA: angle formed between the FH plane and the mandibular plane; SN–GoGn: the angle formed between SN and Go-Gn plane; IMPA: angle formed by the intersection of the mandibular incisor axis to mandibular plane; Gonial Angle: angle formed by a tangent to the lower border of the mandible and a tangent touching the posterior border of the ramus

Statistical analysis

All analyses were performed using the IBM SPSS Statistics Developer, version 21 and a significance level of 5% was considered. Mean and standard deviation were calculated for all data. Intraclass correlation coefficients (ICC) were calculated to determine intra-examiner correlation cephalometric measurements ® value). The intra- and inter- examiner reliability of GOSLON yardstick was also checked by using weighted Kappa statistics [24]. The correlation between Goslon yardstick and cephalometric parameters was analyzed by Spearman's rank correlation test.

OBSERVATION AND RESULTS

The present study was conducted on 49 unilateral cleft lip and palate patient and the mean age of the sample was 14.73 +- 3.99 years. The males to female ratio was 1:1 and there was a preponderance of left sided cleft over right side.

Intra and inter examiner reliability

The inter- and intra-examiner agreement in the GOSLON scoring were determined by using kappa statistics. The level of agreement was determined by the weighted kappa coefficient with a linear weighting applied. No significant intra- and inter examiner differences were found in the scoring of UCLP sample. Both the intra- and inter-examiner reliability was very good (Table 2a & Table 2b). A Kappa value of 0.8 or more represents a very good agreement [25] . Intra examiner reliability was high for all lateral cephalometric measurements (intra-class Coefficient 0.905<r<0.981).

Table 2a: Intra-examiner agreement (k values) for the Goslon yardstick

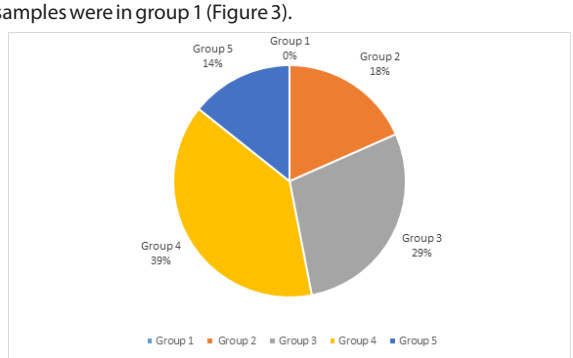
Examiner	kappa value
Au1 - Au2	0.89
Sp1– Sp2	0.84
SS1 – SS2	0.86

Table 2b: Inter- examiner agreement (k values) for the Goslon yardstick

Assessment		SP	SS
First assessment	Au SP	0.82 -	0.85 0.76
Second assessment	Au SP	0.92 -	085 0.86

GOSLON score of the sample.

The mean GOSLON score of the younger UCLP sample (n=49) was 3.49 +-0.96. Of these,9 were in group 2 (18 %), 14 were in group 3 (29 %), 19 were in group 4 (38%) & 7 were in group 5 (14 %). None of the samples were in group 1 (Figure 3).



Correlation between Goslon yardstick and cephalometric parameters

The Spearman rank correlation test was used to know whether there was any association between Goslon yardstick and the various skeletal and dental cephalometric measurements (Table 3).It was found that significant strong correlations existed for ANB angle (r = -0.766, p < 0.01), AB plane angle (r = 0.767, p < 0.01), angle of facial convexity (r = -0.596, p < 0.01), A to N-Pog (r=-0.746, p < 0.01), maxillo-mandibular differential MMD (r=0.785, p < 0.01), Wits appraisal on maxillary – mandibular plane angle bisector (r = -0.746, p < 0.01) and Wits appraisal on occlusal plane (r = -0.685, p < 0.01). Significant moderato weak associations existed between Goslon scores and SNA Angle (r=-0.310, p <0.05), Mpp-Dpp (r = -0.301, p < 0.05), IMPA (r = -0.378, p < 0.01), Gonial angle, (r = 0.427, p < 0.01), FMA (r= 0.428, p < 0.01), Upper incisor to Nasion vertical (r=-0.359, p<0.05) and Upper Incisor to Palatal Plane (r = 0.406, p < 0.01). The Spearman rank correlations tells whether the increase in Goslon yardstick score (1 to 5) is associated with a corresponding increase (+) or decrease (-) of the cephalometric values.

Table 3: Spearman rank correlation coefficient for the total UCLP sample

Sr.No	Variables		Spearman's rho	Level of significance
1	SNA	Goslon yardstick	-0.310	*
2	SNB		0.197	ns
3	ANB		- 0.766	**
4	SNPog		0.172	ns
5	FH/NPog		0.274	ns
6	AB/NPog		0.767	**
7	NAPog		-0.596	**
8	A to NPog		-0.661	**
9	MMD		0.785	**
10	MM-Wits		-0.746	**
11	Wits		-0.685	**
12	Mpp-Dpp		-0.301	*
13	SND		0.156	ns
14	A-NV		-0.359	*
15	B-NV		-0.054	ns
16	Gonial angle		0.427	**
17	FMA		0.428	**
18	IMPA		-0.378	**
10	1 to PP		0.406	**

ns = non-significant, *P <0.05, **P<0.01

Comparison between favorable and unfavorable Goslon groups

Goslon scoring can be grouped into favorable and unfavorable groups based on the prospects for orthodontic rectification (burden of care). Patients in the favorable groups could be treated with conventional orthodontics, whereas patients in the unfavorable groups required surgical orthodontic correction. When favorable (category 1,2 & 3) and unfavorable Goslon groups (category 4 & 5) were compared for various cephalometric parameters (Table 4), SN Angle (75.76+-3.66 & 72.71+-5.21), A-N-B angle (2.07+-2.34 & -2.67+-2.11), AB plane angle (-3.74+-4.97 & 2.83+-2.94), N-A-Pog (2.94+-5.71 & -5.423+-6.79), Facial Angle (75.35+-3.96 & 86.33+-8.33), A to N-Pog (1.07+-2.68 & -3.17+-3.07), Maxillo-mandibular differential (21.91+-4.42 & 32.04+-4.88), Maxillo-Mandibular plane angle bisector to Point A and Point B distance (-2.37+-4.10 & -10.00+-3.85), Wits appraisal (1.96+-3.09 & -3.56+-2.92), NA (-4.80+-3.61 & -8.21+-4.22), Gonial angle (124.54+16.78 & 129.37=-6.36), Upper Incisor to PP (74.24+-8.97 & 80.56+-8.632) and IMPA (88.52+-8.57 & 83.15+-6.99) showed a significant difference between the mean values.

ns = non-significant, *P <0.05, **P<0.01

Sr No.	Cephalometric Measurements	Group2&3 (N=23)		Group 4&5 (N=26)		't' value	Level of significance
		Mean	SD	Mean	S D		
1	SNA	75.761	3.6614	72.712	5.2099	2.341	*
2	SNB	73.761	3.4637	75.500	5.2192	-1.355	ns
3	A-N-B	2.065	2.3370	-2.673	2.1069	7.465	**
4	S-N-Pog	75.348	3.9613	76.712	4.6758	-1.094	ns
5	FH/N-Pog	83.935	3.2414	86.327	3.9521	-2.298	*
6	AB/N-Pog	-3.739	4.9701	2.827	2.9392	-5.706	**
7	N-A-Pog	2.935	5.7075	-5.423	6.7878	4.631	**
8	A to N-Pog	1.065	2.6812	-3.173	3.0658	5.120	**
9	MMD	21.913	4.4176	32.038	4.8784	-7.577	**
10	MM- Wits	-2.370	4.0988	-10.000	3.8497	6.717	**
11	Wits	1.957	3.0856	-3.558	2.9200	6.424	**
12	Mpp-Dpp	1.891	5.3000	-1.962	5.4441	2.503	*
13	S-N-D	72.152	4.1215	73.077	4.3970	-.757	ns
14	A-NV	-4.80	3.614	-8.21	4.215	2.984	**
15	B-NV	-9.957	6.1735	-9.923	6.6689	-.018	ns
16	Gonial angle	124.543	6.7839	129.365	6.3554	-2.568	*
17	FMA	25.870	5.9050	28.673	5.1922	-1.769	ns
18	IMPA	88.522	8.5685	83.154	6.9925	2.413	*
19	1 to PP	74.239	8.9733	80.558	8.6317	-2.510	*

DISCUSSION

The management of patients with cleft lip and palate is complex, requiring a number of surgical interventions. A number of investigators[26, 27] have shown that persons with unoperated cleft lip and palate have a similar growth potential as that of the non-cleft normal population and the differences between the two populations result from surgical intervention alone. Mars in 1987 [13] introduced the GOSLON yardstick to evaluate the treatment outcome in UCLP patients in the late mixed dentition stage. It is a simple method for recording the clinical features that reflect the burden of care [16]. Those patients with Goslon scores of 3.5 and higher were considered likely candidates who require maxillary advancement after pubertal growth [28]. The main limitation of the yardstick is that; it is essentially a subjective ordered categorical classification. Hence a substantial degree of professional judgment with regard to the possibility of orthodontic correction is needed while grading the study models into five groups [22, 29]. Moreover, timing of hard palate closure, the presence of Simonart bands, use of primary bone grafting, the underlying skeletal morphology associated with a particular population, etc. may all influence Goslon score [16,30].

The inter and intra-examiner agreement of Goslon assessment was determined by Kappa statistical analysis with linear weighting applied [31]. The weighted kappa statistic was derived by Cohen and it takes into account distances in ratings among raters and measures the degree of disagreement [25]. The different kinds of disagreement are allowed to be differentially weighted in the construction of the overall index. Possible values for kappa statistics range from –1 to 1, with 1 indicating perfect agreement and 0 indicating random agreement. Depending on the magnitude of agreement, a benchmark scale was proposed by Landis and KochI in 1977. A Kappa value between 40% and 60% indicates a moderate agreement level, while the values 60% to 80%, and 80% to 100% indicate substantial and almost perfect agreement levels respectively [32].

The mean age of the sample was 14.73 +- 3.99 years and no effort was made to separate mixed dentition patients from permanent dentition. Noverraz et al. 1993 [33] in a mixed longitudinal study of 88 consecutive UCLP patients found that, Goslon yardstick is a useful tool for the assessment of dental arch relationship at all stages of dental development, i.e., deciduous dentition, early mixed dentition, late mixed dentition and permanent dentition. Atack et

al.1997 modified Goslon yardstick to predict surgical outcome as early as 5 years of age[11]. Buj-Acosta et al. 2017 [34] in a systematic review pointed out the lack of evidence in the literature for the predictive validity of the GOSLON Yardstick and questioned its capability in longitudinal research.

When treatment outcomes of primary surgical management are assessed, it is critical to analyse not only the dentition, but also the maxillo-mandibular skeletal relationships in all dimensions. Assessment of the occlusal aspect alone does not provide the complete information. The antero-posterior and vertical position of the maxilla and mandible, and its relation to the rest of the craniofacial skeleton is best assessed in lateral cephalogram. The lateral cephalometric parameters used in the present study were selected to represent a comprehensive pattern of maxillary and mandibular antero-posterior discrepancy, so that clinically meaningful information could be derived thereof. Morris in 1994, had shown that overjet is the most significant factor in predicting the Goslon score [9] and anteroposterior relationships of study models were considered to be of greatest clinical importance while scoring of GOSLON yardstick [13]. Mars and Plint (1985) in a paper presented at the 5th International Congress of cleft palate and related craniofacial anomalies, Monte Carlo, demonstrated that antero-posterior relationships of study models were comparable to those determined from the cephalometric measurements. But, the details of the above paper were not available. In the Americleft study, Daskalogiannakis et al. 2011[35] assessed the cephalometric validity of Goslon Yardstick using three angular parameters and found a significant, but weak correlation for SNA (r2 = .081), and SNB (r2 =.064). A significant moderate negative correlation was found between Goslon rating and ANB angle (r = -.607, p.0.001)). However, no linear measurements were included in this study.

In the present study, Spearman's rank correlation was used to determine the cephalometric validity of Goslon yardstick. An advantage of the Spearman rank correlation coefficient is that the two variables can be continuous or ordinal, and approximate normal distributions of variables are not required. A highly significant strong correlation was found to exist between the Goslon yardstick and cephalometric parameters for sagittal maxillo-mandibular relation. Both Gonial angle and FMA showed a positive, moderate association, which indicates that, as the Goslon yardstick score increases, the mandible rotates clockwise. Dental parameters showed moderate correlation for upper incisor to palatal plane (r=0.406, p<0.01) and weak correlation for IMPA (r=-0.378, P<0.01) suggesting that the amount of dental compensation increases with the increase in Goslon score, which camouflage the underlying skeletal problem. There was no correlation for any of the mandibular measurements in the sagittal plane.

When favourable group (category 1to 3) was compared against the unfavourable group (category 4 & 5), for various cephalometric parameters, by unpaired 't' test, a statistically significant difference was found for anteroposterior discrepancy, dental compensation and mandibular rotation, indicating the robustness and cephalometric validity of GOSLON yardstick.

CONCLUSION

The investigation was undertaken with the primary aim to evaluate correlation of the Goslon yardstick rating and lateral cephalometric analysis in UCLP patients. Forty-nine samples were assessed using GOSLON yardstick and lateral cephalograms. High correlation between the GOSLON scores and cephalometric parameters were found for maxillo-mandibular anteroposterior relation, moderate correlation for mandibular clockwise rotation and moderate to weak correlation for dental compensation. From the present study it was elucidated that, the association between the Goslon score and the lateral cephalometric parameters proved the robustness of Goslon yardstick.

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