Journal of Cranio-Maxillo-Facial Surgery 41 (2013) 198–203

Contents lists available at SciVerse ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Surgical prediction of skeletal and soft tissue changes in treatment of Class II

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ARTICLE INFO

Article history:
Paper received 27 February 2012
Accepted 4 July 2012

Keywords:
Surgical prediction
Class II malocclusion
Computerized prediction programs

ABSTRACT

Introduction: The purpose of this study was to study the treatment outcomes and the accuracy of digital prediction and the actual postoperative outcome with Dolphin program on subjects presenting Class II malocclusions.
Methods: Forty patients underwent surgical mandibular advancement (Group 1) and 40 underwent combined surgery of mandibular advancement and maxillary impaction (Group 2). The available pre surgical (t_1) and a minimum of 12 months post surgical (t_2) cephalometric radiographs were digitized. Predictive cephalograms (t_3) for both groups were traced.
Results: At all times evaluated, Group 1 displayed a shorter mandibular length and Group 2 had a longer lower face. In both groups the surgical interventions (t_2) were greater than initially predicted. There was no significant difference between groups with regards to overjet, overbite and soft tissue measurements.
Conclusions: In both groups surgeries were more extensive than planned. Facial convexity and the distance of the lips to cranial base presented similar values between t_2 (post surgical) and t_3 (predicted).

1. Introduction

In recent years there has been an enormous demand for combined surgical–orthodontic treatment seeking to correct severe Class II malocclusion. The criteria for success in orthognathic surgeries are not only centered on the correction of the skeletal and dental abnormalities but also on obtaining esthetic improvement (Bailey et al., 2001; Nanda, 1990; Tsang et al., 2009).

Studies with computerized prediction programs have attempted to promote better diagnosis and treatment planning through the prediction of orthognathic surgery results, enabling the orthodontist and oral-maxillofacial surgeons to evaluate the relationship between hard tissue manipulation and its effect on overlying soft tissues. These programs have greatly enhanced the clinician's ability to quickly evaluate different estimates of the postoperative profile with all possible surgical options (Burden et al., 2007; Cousley et al., 2003; Eckhardt and Cunningham, 2004; Power et al., 2005).

Computer-assisted surgical prediction has a significant impact on patient's expectations with regards to the final result, so the accuracy of what is shown becomes critical and several studies have reached contrasting conclusions (Cousley and Grant, 2004; Gossett et al., 2005; Marple et al., 2005; Noguchi et al., 2007).

Donatsky et al. (2009) observed that the variability of the predicted hard and soft tissue individual outcome seems to be relatively high, and caution should therefore be taken when the planned and predicted hard and soft tissue positional changes are presented to the patient preoperatively.

The anticipation of a result's prognosis can guide treatment planning through the established normative values, within which the outcoming results are expected to lie.

The purpose of this research was to study the treatment outcomes and the accuracy of digital prediction and the actual postoperative outcome with Dolphin program on subjects presenting Class II malocclusions.

2. Materials and methods

This research is a case series study, retrospective. One hundred sixty digitized cephalometric radiographs of 80 Class II and caucasians patients treated with combined surgical and orthodontic

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http://dx.doi.org/10.1016/j.jcms.2012.07.009

treatment were evaluated. The research protocol was approved by the Ethics Committee, number CAAE 0062.0.239.000-09. In 40 patients (19 males and 21 females, mean age 22.8–1.37 years) the surgery consisted of mandibular advancement, with sagittal split ramus osteotomy (SSRO) (Group 1) and another 40 (20 males and 20 females, mean age 22.4–1.8 years) were treated with combined mandibular advancement (SSRO) and maxillary impactation, with Le Fort I osteotomy (Group 2).

All patients were adults (confirmed by cervical vertebral maturation status of IV, V, or VI) (Hassel and Farman, 1995), treated either with or without extractions and received rigid fixation. The inclusion criteria for both groups were overjet >4 mm, bilateral Angle Class II molar relationship, ANB > 5°, Wits > 1 mm (Anderson et al., 2006). Only patients who had received routine orthognathic treatment for a skeletal base relationship anomaly, and who had sufficiently severe skeletal malocclusion, needing both orthognathic surgery and orthodontic treatment, were included. All the three surgeons involved on the research performed a minimum of 20 years of surgical experience.

The surgery performed in Group 1 was mandibular advancement with Sagittal Split Ramus Osteotomy, because patients showed short face with low mandibular plane. Rigid internal fixation with two miniplates was placed on each side. In Group 2 mandibular advancement with Sagittal Split Ramus Osteotomy, was combined with Le Fort I without segmental surgery because patients showed long face with high mandibular plane. Combined surgery was necessary because the malocclusion was worst in this group, with grave mandibular retrognathism.

Exclusion criteria for both groups were syndromic patients or those with cleft palate, treatment of posttraumatic injuries, reconstruction or correction of congenital birth defects and genioplasty. Cephalometric radiographs taken between 1998 and 2009 of pre surgical (t_1) and a minimum of 12 months post surgical (t_2) were digitized. A minimum time interval of 1 year between pre surgical and the last cephalogram (t_2) was required to rule out any effects of postoperative swelling.

Eighty predictive cephalometric (t_3) tracings were made, being 40 for Group 1 and 40 for Group 2, from presurgery (t_1) cephalometric radiographs, so that the border of the lower incisor contacted the palatal surface of the upper incisor; the upper incisor border should rest 1–2 mm below the resting upper lip, overjet and overbite >0 mm (Gossett et al., 2005).

Digital tracings were performed with Dolphin Imaging software (version 11.0 Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). Digital lateral cephalometric radiographs were scanned (HP Scanjet G4050) into the imaging system and traced at the same time to minimize the error variance. Compensation for radiographic magnification was done in the Dolphin program before tracing the cephalograms so that the angular and linear measurements would not be affected.

An *X*–*Y* cranial base coordinate system was constructed over the clearest radiograph of each patient's series. The *X*-axis corresponded to the horizontal Frankfort plane and was used to measure vertical changes; the vertical *Y*-axis passed through point Nasion perpendicular to the *X*-axis and accounted for horizontal changes (Figs. 1 and 2).

2.1. Method error and statistical analysis

The reproducibility of measurements was determined by randomly selecting 20 cephalograms of two phases (t_1 and t_2) and repeating the tracing by the same examiner, 1 month after the initial tracing. The Dalberg formula, (Dalberg, 1940), was used: $ME = \sqrt{\sum d^2/2n}$, where *n* is the number of duplicate measurements used to verify the degree of method error. This did not exceed 0.37° for angular measurements and 0.29 mm for linear measurements.

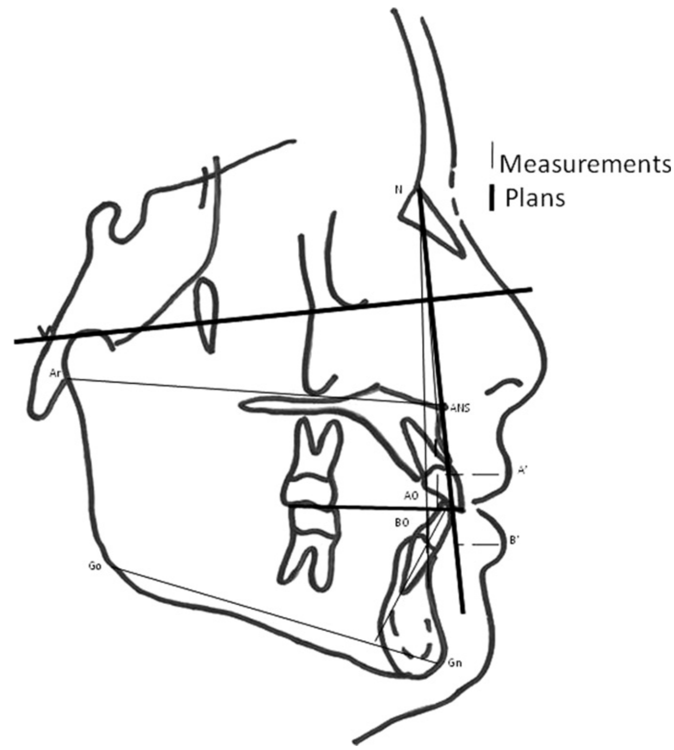

Fig. 1. Cephalogram illustrating horizontal measurements used in the study.

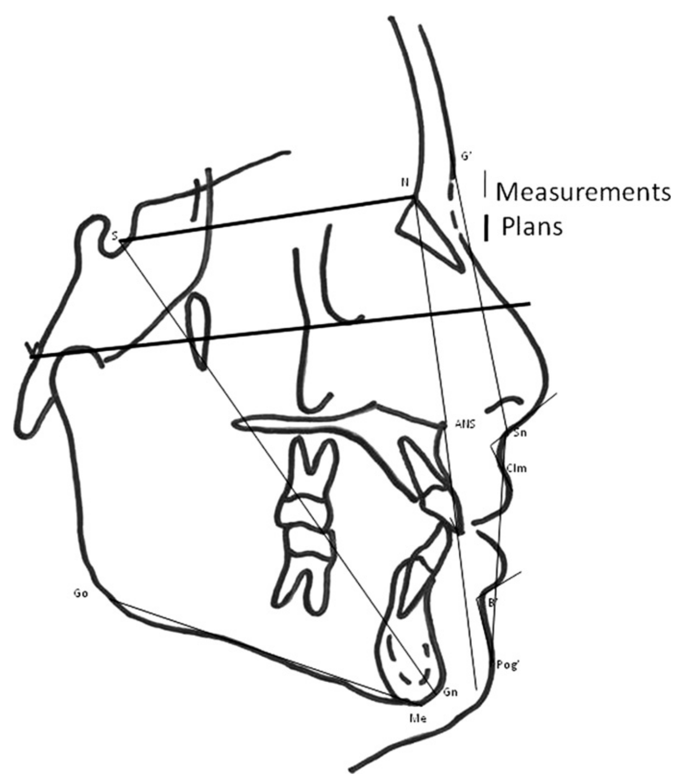

Fig. 2. Cephalogram illustrating vertical measurements used in the study.

Descriptive statistics included mean and standard deviations (SDs). The collected data were subjected to statistical analysis using SPSS software package (SPSS, Chicago III). Differences between groups were evaluated using unpaired *t*-test and among each group the paired *t*-test was applied to the level of significance of $p < 0.05$.

3. Results

Tables 1 and 2 present mean and standard deviation results of angular and linear skeletal, dental and soft tissue measurements for Groups 1 and 2 at t_1, t_2 and t_3.

Results of the statistical analyses were based on the mean values found in each studied group. Mandibular advancement surgery was planned and performed only in Group 1, with a mean distance of 6.98 mm, being the mandibular length bigger at t_2 than at t_3 (Table 2).

In Group 2 mandibular advancement surgery was planned and performed with approximated value to Group 1, with a mean distance of 6.88 mm. Meanwhile, maxillary impaction surgery was necessary, with a mean distance of 0.73 mm, collaborating to decrease the lower third of the face and to increase mandibular length (Tables 1–3).

Mandibular length was shorter in Group 1 at all times evaluated, as confirmed by Go-Gn (mm) and *Y*-axis (mm). The lower third of the face was longer in Group 2 than in Group 1 at all times studied, which can be confirmed by angular measurements SN-MP and *Y*-axis. There was no significant difference between mean soft tissue values at all three moments studied, except for the mentolabial angle, bigger in Group 2 at time t_1 (Table 1).

The differences between t_1 and t_2, in the two groups resulted from the surgeries performed (Table 3). Between t_2 and t_3, it was found that surgical mandibular advancement was greater than the predicted value, in both groups, confirmed by Go-Gn and *Y*-axis length. In Group 2, the maxillary impaction and reduction in mandibular angle and in lower third of the face were significantly greater at t_2. In both groups, the mean Overbite and Overjet values at t_2 were less than those at t_3. The surgically obtained facial improvement occurred as predicted, confirmed by G'-Sn-Pog', Upperlip-Nperp and Lowerlip-Nperp measurements (Table 4).

In both groups only Mentolabial, Nasolabial and Upperlip-Nperp measurement showed correlation with hard tissue measurements, concurrently (Table 5).

Table 1
Mean, standard deviation (SD) and *p*-value of pre surgical (t_1) measurements for Groups 1 and 2.

Pre surgical					
Measurements	Group 1		Group 2		*p*-value
	Mean	SD	Mean	SD	
Ar-ANS (mm)	94.86	5.9	95.42	7.65	0.76 n.s.
Go-Gn (mm)	79.94	6.63	85.18	8.73	0.021
ANB (°)	9.40	1.34	8.88	1.29	0.16 n.s.
Wits (mm)	9.12	1.81	7.92	2.97	0.093 n.s.
N-ANS/perpHP (mm)	53.21	5.34	54.03	4.39	0.55 n.s.
ANS-Gn/perpHP (mm)	65.96	4.93	78.30	5.55	<0.001
SN-MP (°)	33.47	2.16	39.62	8.32	0.001
Y-axis length (mm)	128.83	7.04	137.59	8.43	<0.001
Y-axis (°)	68.25	2.19	72.62	4.54	<0.001
IMPA (°)	98.44	4.27	92.66	8.67	0.004
Overbite (mm)	2.82	1.76	2.16	1.53	0.16 n.s.
Overjet (mm)	8.72	1.49	9.30	1.88	0.23 n.s.
G'-Sn-Pog' (°)	161.06	10.98	159.18	3.78	0.42 n.s.
Upperlip-Nperp (mm)	18.12	3.86	18.02	4.55	0.93 n.s.
Lowerlip-Nperp (mm)	12.98	3.89	11.77	3.87	0.27 n.s.
Nasolabial (°)	102.40	7.98	104.72	5.13	0.22 n.s.
Mentolabial (°)	117.07	11.64	125.76	11.93	0.050

n.s. = not significant.

Table 3
Mean difference, standard deviation (SD) and *p*-value of preoperative (t_1) and final (t_2) measurements for Groups 1 and 2.

Measurements	Group 1			Group 2		
	Mean	SD	*p*-value	Mean	SD	*p*-value
	Difference t_1−t_2			Difference t_1−t_2		
Ar-ANS (mm)	−0.012	0.14	0.68 n.s.	−0.80	0.07	<0.001
Go-Gn (mm)	−6.97	1.98	<0.001	−6.88	1.40	<0.001
ANB (°)	5.00	1.29	<0.001	4.99	1.51	<0.001
Wits (mm)	6.37	2.95	<0.001	5.49	2.11	<0.001
N-ANS/perpHP (mm)	−0.036	0.61	0.76 n.s.	0.72	1.64	0.036
ANS-Gn/perpHP (mm)	−0.38	1.49	0.20 n.s.	0.28	1.72	0.42 n.s.
SN-MP (°)	0.39	1.57	0.22 n.s.	2.42	1.95	<0.001
Y-axis length (mm)	−5.21	2.23	<0.001	−6.32	2.55	<0.001
Y-axis (°)	1.50	1.55	<0.001	2.77	1.84	<0.001
IMPA (°)	1.78	2.00	<0.001	0.42	2.53	0.40 n.s.
Overbite (mm)	1.24	1.66	0.001	0.54	1.30	0.047
Overjet (mm)	5.95	1.60	<0.001	6.63	1.68	<0.001
G'-Sn-Pog' (°)	−6.19	2.38	<0.001	−5.81	2.42	<0.001
Upperlip-Nperp (mm)	−0.048	0.15	0.14 n.s.	−0.10	0.31	0.11 n.s.
Lowerlip-Nperp (mm)	−4.37	2.45	<0.001	−6.00	3.76	<0.001
Nasolabial (°)	0.78	5.20	0.050	1.09	3.94	0.040
Mentolabial (°)	0.49	3.02	0.055 n.s.	2.90	4.31	0.003

n.s. = not significant.

Table 2
Mean, standard deviation (SD) and *p*-value results of final (t_2) and predictive (t_3) measurements for Groups 1 and 2.

Measurements	Final (t_2)					Predictive (t_3)				
	Group 1		Group 2		*p*-value	Group 1		Group 2		*p*-value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Ar-ANS (mm)	94.87	5.45	95.50	7.65	0.73 n.s.	94.86	5.50	95.42	7.65	0.76 n.s.
Go-Gn (mm)	86.92	6.45	92.06	8.76	0.022	85.82	6.48	91.32	9.06	0.017
ANB (°)	4.40	1.19	3.88	0.88	0.086 n.s.	4.88	1.20	4.34	1.32	0.012
Wits (mm)	2.74	3.54	2.43	1.66	0.68 n.s.	3.49	2.36	1.59	1.71	0.002
N-ANS/perpHP (mm)	53.25	5.35	53.30	4.15	0.96 n.s.	53.21	5.34	54.03	4.39	0.55 n.s.
ANS-Gn/perpHP (mm)	66.34	5.14	78.02	4.27	<0.001	66.28	4.95	78.98	4.57	<0.001
SN-MP (°)	33.08	3.07	37.19	8.34	0.025	32.01	2.31	38.20	8.27	0.001
Y-axis length (mm)	134.04	7.41	143.92	9.10	<0.001	132.58	6.91	143.03	8.83	<0.001
Y-axis (°)	66.74	3.04	69.85	3.94	0.003	66.21	2.39	70.26	3.70	<0.001
IMPA (°)	96.65	4.04	92.23	7.60	0.013	99.32	4.02	93.61	8.35	0.003
Overbite (mm)	1.58	0.56	1.61	0.59	0.84 n.s.	2.76	1.41	2.12	1.14	0.080 n.s.
Overjet (mm)	2.76	0.79	2.46	0.44	0.58 n.s.	3.16	0.94	2.85	0.86	0.34 n.s.
G'-Sn-Pog' (°)	167.25	10.93	164.99	3.03	0.32 n.s.	166.89	12.15	165.11	2.80	0.47 n.s.
Upperlip-Nperp (mm)	18.16	3.87	18.12	4.65	0.97 n.s.	18.12	3.86	18.02	4.55	0.93 n.s.
Lowerlip-Nperp (mm)	17.36	3.24	17.77	4.24	0.70 n.s.	17.83	3.32	17.44	3.43	0.68 n.s.
Nasolabial (°)	101.68	8.27	103.69	5.58	0.69 n.s.	102.40	7.98	104.72	5.13	0.22 n.s.
Mentolabial (°)	116.58	9.46	122.86	9.91	0.055 n.s.	117.07	11.64	123.76	11.93	0.060 n.s.

n.s. = not significant.

4. Discussion

Combined orthodontic–surgical treatment aims to improve function and facial aesthetics, reestablishing a normal and stable occlusion. Some of the factors that determine the success of orthognathic cases are an appropriate treatment plan and the accuracy with which the surgeon can reproduce that plan in the operating room (Kiyak and Zeitler, 1988; Nanda, 1990; Proffit et al., 1992).

In this research the program used to obtain digital predictive tracings from the pre surgical digitalized cephalograms was Dolphin Imaging software. Cephalometric radiographs of pre surgical (t_1) and post surgical (t_2) times were scanned into the imaging system and cephalometric analyses were performed.

Before addressing Dolphin's ability to predict a result during orthognathic surgery planning stage, the changes that occurred in the craniofacial complex over the studied time intervals will be approached.

At $t_{1,}$ Go-Gn, SN-MP, *Y*-axis length and *Y*-axis measurements were significantly bigger in Group 2, so patients in this group had increased mandibular length and plane angle when compared to those in Group 1. The overjet and mentolabial angle were bigger in Group 2 because of the better positioning of the lower incisors over the bone, which could be confirmed by the lower average in IMPA (Table 1). Sample in Group 1 presented dentofacial and skeletal features characteristic of short face patients, with a retrusive mandible, horizontal facial pattern and low mandibular plane angle. While those in Group 2 displayed long face characteristics, with retrusive mandible, vertical facial growth and high mandibular plane angles. Some authors (Kiyak and Zeitler, 1988; Proffit et al., 1992; Thuer et al., 1994), observed similar characteristics.

Short-faced individuals exhibit a short lower facial height, excessive forward rotation of the mandible, low mandibular plane angle, and deep bite malocclusion. The opposite has been reported for long-faced individuals, in agreement with some authors (Kiyak and Zeitler, 1988; Nanda, 1990; Proffit et al., 1992; Thuer et al., 1994; Janson et al., 1998; Potts et al., 2009).

The maxilla was longer in Group 2 although not to a significant level. Other studies report that the worsening of the profile in pre surgical stages is due to the elimination of dental compensations and the better positioning of the incisors over the basal bone (Shelly et al., 2000; Tsang et al., 2009).

At t_2, Group 2 continued to display greater values for the same measurements taken at $t_{1,}$ to the required level of significance. In Group 1 an increase of 6.98 mm in Go-Gn and 5.21 mm in *Y*-axis was obtained after the surgical advancement of the mandible. Similar values were observed in Group 2, with 6.88 mm in Go-Gn and 6.33 mm in *Y*-axis length, which explains the significant difference between the groups at t_2 (Table 2). For both groups, at t_2, the dentofacial skeletal pattern remained the same showed at t_1. Similar results were found by other authors, whose concluded that whenever bigger mandibular plane has been (SN-MP), smaller mandibular advancement to anterior direction, will be observed at the end of treatment, like was reported by others authors (Shelly et al., 2000; Tsang et al., 2009; Boeck et al., 2010).

Maxillary impaction was of 0.73 mm in Group 2, not enough to cause a significant difference between groups in terms of N-ANS/perpHP. The mandibular plane angle was reduced in both groups however SN-MP and *Y*-axis remained significantly bigger in Group 2, suggesting the maintenance in the facial pattern at t_2 (Table 2).

At t_3, for Group 1 an increase of 5.88 mm for Go-Gn and of 3.75 mm for *Y*-axis length were planned, and increase of 6.14 mm for Go-Gn and 5.44 mm for *Y*-axis length were planned for Group 2.

As lower incisors were more retroinclined (IMPA) in Group 2 than in Group 1 at t_1, it was possible planning a bigger mandibular advancement for Group 2, with significantly lower estimated ANB and Wits values for this group. The predictive tracing maintained the same facial pattern for each group, so mean values of ANS-Gn/

Table 4
Mean difference, standard deviation and *p*-value of final (t_2) and predictive (t_3) measurements for Groups 1 and 2.

Measurements	Group 1		Group 2	
	Mean ± SD	*p*-value	Mean ± SD	*p*-value
	Difference t_2–t_3		Difference t_2–t_3	
Ar-ANS (mm)	0.008 ± 0.14	0.78 n.s.	0.08 ± 0.07	<0.001
Go-Gn (mm)	1.10 ± 1.66	0.003	0.74 ± 0.80	<0.001
ANB (°)	−0.48 ± 1.23	0.071 n.s.	−0.46 ± 1.28	0.084 n.s.
Wits (mm)	−0.74 ± 2.17	0.10 n.s.	0.84 ± 1.12	0.001
N-ANS/perpHP (mm)	0.036 ± 0.61	0.76 n.s.	−0.72 ± 1.64	0.036
ANS-Gn/perpHP (mm)	0.064 ± 1.36	0.81 n.s.	−0.96 ± 0.90	0.031
SN-MP (°)	1.06 ± 1.58	0.003	−1.00 ± 1.82	0.011
Y-axis length (mm)	1.46 ± 1.79	<0.001	0.88 ± 1.30	0.002
Y-axis (°)	0.52 ± 1.46	0.074 n.s.	−0.41 ± 1.62	0.21 n.s.
IMPA (°)	−2.66 ± 2.34	<0.001	−1.38 ± 2.74	0.019
Overbite (mm)	−1.18 ± 1.37	<0.001	−0.50 ± 1.01	0.020
Overjet (mm)	−0.39 ± 0.81	0.025	−0.39 ± 0.91	0.030
G'-Sn-Pog' (°)	0.36 ± 3.18	0.57 n.s.	−0.11 ± 1.30	0.66 n.s.
Upperlip-Nperp (mm)	0.048 ± 0.15	0.14 n.s.	0.10 ± 0.31	0.11 n.s.
Lowerlip-Nperp (mm)	−0.47 ± 2.02	0.25 n.s.	0.32 ± 1.46	0.27 n.s.
Nasolabial (°)	−0.72 ± 5.20	0.050	−1.03 ± 3.94	0.030
Mentolabial (°)	−0.49 ± 3.49	0.082 n.s.	−0.90 ± 4.31	0.032

SD = standard deviation, n.s. = not significant.

Table 5
Correlation of corresponding hard and soft tissue changes in both groups.

Measurements	G'-Sn-Pog' (°)		Upperlip-Nperp (mm)		Lowerlip-Nperp (mm)		Nasolabial (°)		Mentolabial (°)	
	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2
	r *p*	r *p*	r *p*	r *p*	r *p*	r *p*	r *p*	r *p*	r *p*	r *p*
Ar-ANS (mm)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	-0.70^{***}	-0.78^{***}
Go-Gn (mm)	n.s.	0.54^{***}	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	-0.60^{***}	-0.77^{***}
ANB (°)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	-0.61^{***}	0.52^{***}	0.59^{***}	0.55^{***}
Wits (mm)	n.s.	-0.64^{***}	n.s.	n.s.	-0.52^{***}	n.s.	n.s.	-0.51^{***}	n.s.	n.s.
N-ANS/perpHP (mm)	n.s.	0.57^{***}	n.s.	n.s.	n.s.	n.s.	n.s.	0.51^{***}	n.s.	-0.84^{***}
ANS-Gn/perpHP (mm)	n.s.	0.79^{***}	0.53^{***}	-0.59^{***}	n.s.	n.s.	-0.52^{***}	0.89^{***}	n.s.	-0.65^{***}
SN-MP (°)	-0.52^{***}	n.s.	n.s.	-0.79^{***}	n.s.	-0.84^{***}	n.s.	n.s.	n.s.	n.s.
Y-axis length (mm)	n.s.	0.81^{***}	n.s.	n.s.	n.s.	n.s.	-0.57^{***}	-0.59^{***}	-0.54^{***}	-0.83^{***}
Y-axis (°)	-0.54^{***}	n.s.	n.s.	n.s.	n.s.	-0.78^{***}	n.s.	n.s.	n.s.	0.73^{***}
IMPA (°)	n.s.	n.s.	n.s.	0.81^{***}	n.s.	0.71^{***}	n.s.	-0.54^{***}	n.s.	n.s.
Overbite (mm)	n.s.	n.s.	n.s.	0.64^{***}	n.s.	0.74^{***}	n.s.	n.s.	n.s.	n.s.
Overjet (mm)	n.s.	-0.90^{***}	0.59^{***}	0.51^{***}	n.s.	n.s.	n.s.	-0.66^{***}	0.71^{***}	0.63^{***}

G1 = Group 1, G2 = Group 2, r = Pearson correlation, *** = 0.1% significant level, n.s. = not significant.

perpHP, SN-MP and *Y*-axis were significantly higher in Group 2 (Table 2). Authors reported whenever bigger the incisors retroinclination has been, bigger the surgically mandibular advancement will be planned (Cousley et al., 2003; Eckhardt and Cunningham, 2004; Gossett et al., 2005; Power et al., 2005).

The predictive tracings established that the lower incisor border should rest against the palatal surface of the upper incisor. There was no significant difference between groups with regards to overjet, overbite and soft tissue measurements at t_3 (Table 2). Surgical planning aimed to obtain similar values of dental and profile measurements in both groups at t_3. In order to do so, predictive surgery was more significant in Group 2 because of the bigger incisors retroinclination present when compared to Group 1 at t_1.

Authors reported that computerized orthognathic predictions of retrognathism correction aim to achieve dentofacial and skeletal harmony, regardless of the severity of the malocclusion (Kiyak and Zeitler, 1988; Eckhardt and Cunningham, 2004; Gossett et al., 2005; Power et al., 2005). The same was done for both studied groups using the Dolphin software.

In both groups there was a significant increase in Go-Gn, *Y*-axis length, G'-Sn-Pog', Lowerlip-Nperp between t_1 and t_2 and decrease in ANB, Wits, Overbite and Overjet, possibly because of the orthognathic surgery that was carried out. In Group 2 the significant increase in Ar-ANS suggests that maxillary impaction was accompanied by its forward positioning of 0.80 mm $\pm$ 0.07 mm, but this did not portray clinical expression. Maxillary impaction occurred both in the anterior region, with average increase in N-ANS/perpHP, as in the posterior region, with a decrease in SN-MP and *Y*-axis (Table 3).

When the lower lip is projected, it is expected that the upper counterpart will follow because of the supporting relation maintained between one another. The Nasolabial angle decreased at t_2 in both groups probably as a result of the surgical mandibular advancement. Thuer et al. (1994) reached similar conclusions when they observed that the anterior displacement of the lips happened in 88% of his sample following mandibular advancement surgery. Proffit et al. (1992) affirmed that the effects of this surgery on the lower lip are variable and unpredictable.

In both groups the surgical mandibular advancement was bigger than predicted, as confirmed by t_2–t_3. Higher values were registered for Go-Gn, *Y*-axis length, with lower Overjet values in t_2. As Group 1 consisted of short-face individuals, Dolphin (t_3) software programmed the closure of the mandibular plane and increase in Overbite, greater than what was surgically achieved (t_2). This was confirmed by the difference in mean SN-MP, *Y*-axis and Overbite values (Table 4).

Some manuscripts explain that video imaging facilitate the communication between the orthodontist and the surgeon because of the visualization of the surgical outcome (Cousley et al., 2003; Eckhardt and Cunningham, 2004; Power et al., 2005).

In Group 2 there was an increase of 0.08 mm in Ar-ANS at t_2, beyond the foreseen in t_3, resulting in an increase of 0.84 mm in Wits after the surgical treatment. It means that maxillary impaction was followed by low maxillary advancement of 0.08 mm, but without clinical implication. This corroborates with other authors who emphatically affirm that the predictive tracing serves as a guide to obtain surgical results (Thuer et al., 1994; Eckhardt and Cunningham, 2004; Power et al., 2005; Donatsky et al., 2011).

At t_2 impaction was 0.72 mm bigger than at t_3, generating smaller values for N-ANS/perHP, Overbite, SN-MP and *Y*-axis (Table 4), providing bigger mandibular advancement and reduction of lower face height in Group 2. These findings support the literature when it comes to surgical predictability (Thuer et al., 1994; Cousley and Grant, 2004; Eckhardt and Cunningham, 2004).

Mentolabial and nasolabial angles were smaller at t_2 than at t_3 in both groups, probably due to smaller values obtained for ANB and overjet, after the bigger mandibular advancement had taken place (Table 4). Some studies reported that lip position seems to be determined by the anteroposterior positioning of the basal bone, and as the upper lip rests against the lower, these bear a direct relation (Thuer et al., 1994; Shelly et al., 2000; Tsang et al., 2009).

As for the correlation between hard and soft tissues, it was observed that in Group 1 whenever bigger Ar-ANS, Go-Gn, *Y*-axis length values, smaller the mentolabial angle will be. Values of N-ANS/perpHP, IMPA and overbite were not correlated to the soft tissue measurements (Table 5). In Group 2 it was observed that the bigger Ar-ANS, Go-Gn, N-ANS/perpHP, ANS-Gn/perpHP and *Y*-axis length, the smaller the mentolabial angle. It was verified that the smaller the SN-MP, the bigger the distances Upperlip-Nperp and Lowerlip-Nperp. This supports some authors that affirm that the higher the mandibular plane (SN-MP and *Y*-axis) the smaller the facial convexity angle (G'-Sn-Pog') (Thuer et al., 1994; Shelly et al., 2000; Tsang et al.,2009).

Dentoskeletal changes in the anteroposterior direction generated bigger effects on profile than changes on the vertical direction. This finding has been reported in previous researches (Kiyak and Zeitler, 1988; Thuer et al., 1994; Tsang et al., 2009).

5. Conclusions

In both groups mandibular advancement surgery was more extensive than planned. Facial convexity and the distance of the lips to cranial base presented similar values between t_2 (post surgical) and t_3 (predicted).

In Group 2 maxillary impaction also was more extensive than planned, providing bigger mandibular advancement and reduction of lower face height. The statistical differences in the evaluated measurements do not invalidate de surgical predictability software, because the predicted modifications were close to those of the surgical results.

In both groups anteroposterior dentoskeletal changes present higher correlation with the facial profile than those changes taking place on the vertical plane.

Conflict of interest

The undersigned authors warrant that the scientific judgment was not influenced by potential conflicts related with financial or personal relationships, academic competition and intellectual passion in the manuscript: **"SURGICAL PREDICTION OF SKELETAL AND SOFT TISSUE CHANGES IN TREATMENT OF CLASS II"** We agree to disclose any conflict of interest in the space provided below. Neither we nor a member of our families, directly or indirectly, participate in a commercial, financial, or have a proprietary interest in, an outside related entity, or serve in an advisory or fiduciary capacity for a third party that would affect our position on the subject issue. This information shall be accessible to "Journal of Cranio-maxillofacial Surgery" officials to the extent permitted by law.

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