ORIGINAL PAPERS

Dent. Med. Probl. 2016, 53, 4, 447–453
DOI: 10.17219/dmp/64741

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ISSN 1644-387X

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Soft Tissue Profile Changes After Mandibular Setback Surgery

Zmiana profilu tkanek miękkich po jednoszczękowych zabiegach korekcji progenii

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation;
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Abstract

Background. The improvement of facial aesthetics is an important element of restoring the correct bone and occlusal relation. Planning and objectively assessing the outcome of surgical-orthodontic defect treatment in the craniofacial area is based on multiple measurements of cephalometric parameters performed on radiographs.

Objectives. The aim of this study was to assess soft tissue profile changes after vertical (25 patients) and sagittal split ramus osteotomy (28 patients).

Material and methods. The study included 53 patients with mandibular prognathism. The study group included 28 women and 25 men. The age of the patients ranged from 17 to 51 years. Lateral cephalograms (performed before the surgery and 6 months after the surgery) were used to evaluate the results of the treatment. The method proposed by Hwang et al. and the facial contour angle were used as a cephalometric analysis of soft tissue profile changes.

Results. There was no significant difference concerning the changes within the value of the facial contour angle depending on the type of treatment ($t = 0.401$, $p > 0.05$). The absolute change of this parameter in the overall group of patients equaled $11.39^\circ \pm 6.84$, $10.99^\circ \pm 7.33$ after the EVRO, and $11.75^\circ \pm 6.49$ after the BSSO.

Conclusions. Both sagittal split ramus osteotomy and vertical ramus osteotomy provide similar improvement in the aesthetics of the facial profile, assessed with cephalometric measurements (**Dent. Med. Probl.** 2016, 53, 4, 447–453).

Key words: bilateral sagittal split ramus osteotomy (BSSO), extraoral vertical ramus osteotomy (EVRO), cephalometry.

Słowa kluczowe: obustronna strzałkowa osteotomia gałęzi żuchwy, zewnątrzustna pionowa osteotomia gałęzi żuchwy, cefalometria.

To ensure accurate planning of combined orthodontic-surgical treatment of patients with gnathic defects, a careful assessment concerning the severity of the maxillo-facial and occlusal defect is required. An extremely important element of restoring the correct bone and occlusal relation is taking into consideration the improvement of facial aesthetics. Planning and assessing the objective outcome of the surgical-orthodontic defects' treatment in the craniofacial area is based

on multiple measurements of cephalometric parameters performed on radiographs. The standard remains to conduct measurements on two dimensional images (2D), however, the popularity of three-dimensional cephalometry is continuously increasing (3D). Nonetheless, due to the lack of population norms and the lack of recognized, repeatable, not to mention reliable, parameters, the 3D method is not perceived as a routine procedure [1].

Planning the treatment of patients with maxillo-facial defects is nowadays considerably facilitated, since a large number of computer programs have been created. These programs are based on different two-dimensional (2D) and three-dimensional (3D) visualization methods of the soft tissues, bones and teeth [2–9]. Due to the great potential provided by modern technology, it is also possible to perform a virtual surgery. In addition, the available programs are able to provide an approximate visualization of the aesthetic effect after surgical treatment. Both conventional and the newest ideas in treatment implemented while developing a therapeutic strategy for patients with gnathic defects take into account and focus on profile changes within the soft tissue.

An accurate prediction of soft tissue changes after mandibular osteotomies is difficult. This may be related to the large individual variabilities in soft tissue thickness and response to the surgical procedure and changes in bone relation. Other confounders that are difficult to foresee include differences in skeletal stability, technical issues and factors associated with the operator, as well as a possible gender and age impact [10]. Although there are certain studies on soft tissue changes, these are mostly based on small samples, and frequently concern additional surgical procedures, such as genioplasty or maxillary surgery [11–17].

The aim of this study was to assess soft tissue profile changes after vertical and sagittal split ramus osteotomy.

Material and Methods

The study included 53 patients with mandibular prognathism, who underwent orthognathic surgery in our department between January 2005 and December 2013. All patients included in the study also received preoperative orthodontic treatment. The age of the patients ranged from 17 to 51 years (mean age = 25.25 years $\pm$ 6.95). The study group included 28 women (mean age = 23.64 years $\pm$ 7.02) and 25 men (mean age = 27.04 years $\pm$ 7.15). The majority (28 out of 53) of patients underwent bilateral sagittal split osteotomy (BSSO) of the mandibular ramus with intraoral access with Obwegeser-Dal Pont's [18] modification. The remaining patients were treated with an extraoral vertical ramus osteotomy (EVRO). Patients that, for correction of aesthetic defects, required rotation movement of the mandible and those who did not accept the presence of scars were qualified for the BSSO method. EVRO was performed in cases for whom feeling disturbances were less acceptable than facial scars.

The groups of patients treated by sagittal and vertical osteotomy did not differ significantly as far as sex is concerned ($\chi^2 = 0.013$; $p > 0.05$). What is more, the groups did not differ significantly in the aspect of age ($p > 0.05$). The average age equaled 25.8 years $\pm$ 6.61 in the group treated with EVRO and 24.8 years $\pm$ 7.45 in patients after the BSSO treatment.

Lateral cephalometric radiographs (performed before the surgery and 6 months after the surgery) were used to evaluate the results of the treatment. Cephalometric measurements based on the method proposed by Hwang et al. [19] and facial contour assessment were performed [20]. All measurements were carried out by one person, using the digital radiographs and the OrthView 0.6 computer program created in cooperation with the Technical University of Lodz. Each point was marked twice. In case of any discrepancies between the measurements (angles and lengths) exceeding 1° or 1 mm, the mean values were included in further analysis and comparisons. Each image underwent computer geometrical calibration before performing any measurements.

Cephalometric Measurements

The following points are used for measuring the facial contour angle: N' (soft tissue nasion), Sn (subnasale) and WPg (soft tissue pogonion) [20]. The following lines are conducted through these points: the SnWPg line and the N'Sn line. The desired angle is contained between the extension of the SnWPg line and the N'Sn line. Negative values of the angle occur when the WPg point is located rearwardly from the extension of the N'Sn line. Angle values ranging from -15° to -7° are assumed as the norm [20]. The method implemented to determine the angle of the facial contour is shown in Fig. 1.

Cephalometric analysis according to Hwang et al. [19] includes the determination of the following reference points:

N – hard tissue nasion, the most prominent point in the frontonasal suture,

N' – soft tissue nasion, the most concave point in the tissue overlying the frontonasal suture area,

O – indicates the intersection of the NP line (line perpendicular to the Frankfort plane) and the forehead,

G' – soft tissue glabella, the most prominent point in the midsagittal plane of the forehead,

Prn – pronasale, the most prominent point of the nose,

Sn – subnasale, the point at which the columella merges with the upper lip in the midsagittal plane,

Fig. 1. Method implemented to determine the angle of the facial contour

Cm – columella, the most anterior soft tissue point on the columella (nasal septum) of the nose,

Ls – labrale superius, the most anterior point on the upper lip,

Li – labrale inferius, the most anterior point on the lower lip,

Sm – supramentale, the point of the greatest concavity in the midline of the lower lip between the labrale inferius and the soft tissue pogonion point,

Pog' – soft tissue pogonion, the most anterior point on the soft tissue of the chin,

Me' – soft tissue menton, the most inferior point on the soft tissue of the chin,

Th – throat, the intersection between the submental area and the tangent line of the neck.

The main reference lines determined in this method include:

- NP – nasion perpendicular, established by dropping a line inferiorly from the nasion (N) that is perpendicular to the Frankfort horizontal line,
- the line established by the Frankfort plane.

The points and main reference lines of the Hwang et al. [19] analysis are shown in Fig. 2, whereas the cephalometric parameters are presented in Table 1.

Statistical Analysis

The mean values of the angles before and after surgical treatment were compared using the Student's t-test for independent samples. In or-

Fig. 2. Points and main reference lines of Hwang et al. [19] analysis

der to compare the size of an angle change before and after orthognathic surgeries in the analyzed groups of patients, the Student's t-test was also used. The comparison of the number of patients whose angles were within the norm was made using the χ^2 test. The normality of the quantitative variable distributions were assessed using the Kolmogorov-Smirnov test. The p value < 0.05 was accepted as the level of significance.

Results

The average value of the facial contour angle measured in the overall group of patients (including the patients classified to sagittal split and vertical ramus osteotomy) before surgery equaled $1.52^\circ \pm 6.62$, and after the treatment it reached $-9.87^\circ \pm 4.44$. All values of this angle after the surgery were lower than the values before surgery, so changes of these values are expressed as an absolute value. Statistical analysis showed that the value of the facial contour angle after the surgery was significantly improved in comparison to the value before the treatment ($t = 12.119$; $p < 0.0001$).

There was no significant difference concerning the changes within the value of the facial contour angle depending on the type of treatment ($t = 0.401$, $p > 0.05$). The absolute change of this parameter in the overall group of patients equaled $11.39^\circ \pm 6.84$, after the EVRO: $10.99^\circ \pm 7.33$, and after the BSSO: $11.75^\circ \pm 6.49$. In the female

Table 1. Angles determined in the Hwang et al. [19] analysis

Abbreviation	Name	Manner of determination	Norm
FHA	forehead angle	angle between the NP line and the line passing through points O and G'	14.55 ± 3.28
FNA	frontonasal angle	external angle between the line passing through points O and G' and the line determined by points G' and N'	155.42 ± 5.79
NDA	nasal depth angle	external angle between points G' and N' and Prn	141.60 ± 5.40
D-NP	dorsum-nasion perpendicular	internal angle between the line passing through points N' and Prn and the NP line	28.38 ± 2.85
NTA	nasal tip angle	internal angle between lines passing through points N' and Prn and points Prn and Sn	104 ± 4.66
NLA	nasolabial angle	external angle between points Cm, Sn and Ls	93.45 ± 8.49
UL-NP	upper lip-nasion perpendicular	internal angle between the line passing through points Sn and Ls and the NP line	19.79 ± 7.40
LL-NP	lower lip-nasion perpendicular	internal angle between the line passing through points Li and Sm and the NP line	50.62 ± 10.46
MLA	mentolabial angle	angle between points Li, Sm and Pog'	127.49 ± 11.4
PMA	pogonion-menton angle	angle between the line passing through points Sm and Pog' and the line determined by points Th and Me'	93.32 ± 8.04

and male groups, the mean change of this angle was also similar and equaled $11.56^\circ \pm 7.12$ and $11.20^\circ \pm 6.66$, respectively ($t = 0.187$; $p > 0.05$).

Additionally, the number of patients with a normal value of the facial contour angle reported before and after the treatment was compared. This comparison revealed that there was no significant correlation between the gender, type of surgery and the opportunity to obtain the correct value of this parameter after the surgery (Table 2).

Based on the results of the Hwang et al. [19] analysis, it was observed that the only significant differences in the values of the soft tissue profile noted before and after the treatment concerned the following angles: NLA, UL-NP, LL-NP, MLA and PMA (which essentially relate to the maxillary portion of the face) (Table 3).

Sagittal split and vertical ramus osteotomy cause similar changes in the soft tissue profile. We observed that there were no significant differences within the range of changes concerning particular angles depending on the type of surgery conducted (Table 4).

Additionally, we analyzed the number of patients with angle parameters falling in the normal range before and after surgery. Only three parameters revealed significant increases in the number of patients reaching the population norm after the surgical procedure (lower lip-NP line angle, mentolabial angle and pogonion-menton angle). It is worth emphasizing that, after the surgery, the value of the angle between the lower lip and NP line was higher in all patients. After the treatment, the number of patients with a normal value of this parameter increased from 0 to 17 ($\chi^2 = 4.63926$, $p < 0.05$). The value of the mentolabial angle decreased after surgery in all patients. Twenty-four patients reached the normal values of this parameter after the treatment ($\chi^2 = 21.91561$, $p < 0.0001$). In the case of the pogonion-menton angle, its value increased in 37 patients and decreased in 16. However, the average value of this parameter increased statistically significantly. After the treatment, the number of patients with a normal value of this parameter increased from 12 to 28 ($\chi^2 = 10.27879$, $p < 0.005$).

Table 2. Number of patients with normal value of the facial contour angle in the analyzed groups of patients

Groups	After the treatment				Statistical analysis	p value
	angle within the norm		angle out of the norm			
	n	%	n	%		
Women	18	51	10	56	0.0812	0.77
Men	17	49	8	44		
EVRO	17	49	8	44	0.0812	0.77
BSSO	18	51	10	56		

n – number of patients, BSSO – bilateral sagittal split osteotomy, EVRO – extraoral vertical ramus osteotomy.

Table 3. Values of the parameters before and after surgical treatment

Parameters	Values before surgery		Values after surgery		Statistical analysis	p value
	mean	SD	mean	SD		
Facial contour angle	1.52	6.62	-9.87	4.44	12.1190	< 0.0001
FHA	21.97	3.83	21.19	3.92	1.8735	0.96
FNA	148.22	8.49	148.32	8.60	-10.865	0.28
NDA	131.35	6.28	131.38	6.43	-0.2781	0.78
D-NP	22.97	5.36	22.91	5.49	0.5382	0.59
NTA	89.95	8.74	89.90	8.81	0.4203	0.67
NLA	90.55	11.88	91.85	11.88	-131.047	< 0.0001
UL-NP	17.82	7.18	19.09	7.27	-126.710	< 0.0001
LL-NP	17.35	8.17	31.59	9.03	-136.736	< 0.0001
MLA	150.98	13.08	136.66	13.29	133.474	< 0.0001
PMA	80.48	6.31	85.54	5.01	-47.939	< 0.0001

Table 4. Changes in values of parameters in group of patients who underwent EVRO and BSSO

Changes in values of parameters	EVRO		BSSO		Statistical analysis	p value
Facial contour angle	-10.99	7.33	-11.75	6.49	0.4012	0.68
FHA	-0.88	0.49	-0.68	0.44	0.6021	0.54
FNA	0.13	0.74	0.09	0.77	0.1889	0.85
NDA	0.00	0.74	0.06	0.76	-0.2973	0.76
D-NP	-0.20	0.83	0.06	0.80	-1.1804	0.24
NTA	-0.06	1.11	-0.05	0.87	-0.0514	0.95
NLA	1.28	0.76	1.33	0.70	-0.2614	0.79
UL-NP	1.25	0.72	1.30	0.75	-0.2383	0.81
LL-NP	14.41	7.88	14.10	7.45	0.1462	0.88
MLA	-14.56	8.13	-14.10	7.65	-0.2156	0.83
PMA	4.12	7.34	5.91	8.03	-0.8458	0.40

Discussion

An objective evaluation of facial aesthetics is extremely difficult. That is why different methods of cephalometric measurement, based on determining the angles and distances, have been created [19–21]. In this study, the facial contour angle measurements and analysis proposed by Hwang et al. [19] were applied in order to evaluate the changes within the soft tissue profile. The evaluation was performed 6 months after surgery. Our results of the cephalometric analysis showed a significant improvement in soft tissue profile proving the favorable aesthetic result of the treatment.

In the group of patients examined, the angle of the facial contour improved significantly. The absolute change in the value of this parameter 6 months after surgery was similar in both groups, female and male, both among patients after the BSSO and the EVRO.

Other authors have also observed an improved value of this angle in patients with mandibular prognathism who underwent combined orthodontic-surgery treatment [22]. Williams [20] emphasizes that the facial contour angle is particularly useful in assessing changes in the soft tissue profile in patients with mandibular prognathism due to the fact that it takes into consideration the change in the position of the pogonion point towards the line passing through the following skin points: nasion and subnasale.

Out of 10 angle parameters measured in the soft tissue profile analysis proposed by Hwang, et al. [19], only 5 parameters, describing the maxillary part of the face, improved significantly after surgery. Both methods of surgical treatment led to similar changes in the angles. A statistically significant change was observed in the average value of the angle expressing the position of the upper lip to the nose (NLA), which strongly affects the

aesthetic evaluation of the face. It is worth emphasizing that the improvement in the value of the angle did not cause a significant change in the number of people who reached the norm values after the surgery.

The NLA parameter is extremely important in an aesthetic evaluation of the facial profile. The nasolabial angle is characterized by a large inter-individual and population variability, which is reflected in a wide range of norms provided by various authors [21, 23, 24]. Some authors emphasize that the value of this angle should be slightly higher for women than for men [24]. These slightly higher values of the nasolabial angle for women prove the fact that a slightly upturned female nose may be, and even should be, considered as attractive. The standard value assumed in this paper comprised within the range between 84.96° and 101.94° (according to the range proposed by Hwang et al. [19]). Differences in variabilities of the norm accepted for this angle are caused by several factors affecting its value – maxillary hypoplasia, position of the upper incisors, as well as nasal anomalies (upturned nose). Its size is also affected by the retrusion of the upper lip causing vermilion reduction, as well as prominent upper lip vermilion, which gives a nice, youthful appearance [25].

The upper lip-NP angle revealed similar dependencies as the ones observed in the case of the NLA angle. The mean value of this parameter improved after both types of treatment, although it did not lead to a statistically significant increase in the number of people with a normal value of this parameter after the surgery. Some authors suggest that the change of the nasolabial angle is parallel to changes in the upper lip-NP angle.

The average values of the remaining angles, describing the maxillary part of the face, also

changed in a significantly positive way: the lower lip-NP angle (LL-NP), the mentolabial angle (MLA) and the pogonion-menton angle (PMA), wherein the LL-NP angle and the PMA angle increased, and the MLA angle decreased. Changes in these parameters resulted in a statistically significant increase in the number of patients who scored within the normal range within six months after surgery, which indicates a favorable outcome. As far as this study is concerned, approximately half of patients obtained the normal values of MLA and PMA angles after the surgery. There were no statistically significant differences in the mean value of the changes in these parameters in patients after the BSSO and the EVRO. The group of women and group of men did not differ in this aspect either.

Discussing the clinical significance of these angles, it is essential to emphasize that, in the case of these parameters, the morphology of the mandible had a huge influence on the values measured. Therefore, after surgical correction of mandibular prognathism a noteworthy improvement of the above-mentioned angles is observed and these angles often reach population norms [22]. However, despite the invention of objective measurements and cephalometric analysis, the evaluation of the soft tissue profile still mainly depends on the subjective opinion of the physician and the patient's expectations.

Conclusion

Both sagittal split ramus osteotomy and vertical ramus osteotomy provide similar improvement in the aesthetics of the facial profile, as assessed by cephalometric measurements.

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Conflict of interest: None declared

Received: 17.07.2016

Revised: 24.07.2016

Accepted: 18.08.2016