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THE SOFT-TISSUE FACIAL PROFILE BEFORE AND AFTER SURGICAL CORRECTION OF MANDIBULAR PROTRUSION

by

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INTRODUCTION

One essential reason for the undertaking of osteotomy and correction of mandibular protrusion is the patient's wish to have his/her appearance improved. The result should therefore be judged with reference to the characteristics of the soft-tissue profile before and after the operation. The aim of this investigation is to define the changes in the soft-tissue profile that have resulted from the operation. The authors have also tried to evaluate the esthetic value through a board judging the cases before and after operation. It has thus been possible to discuss the criteria of a good or bad result from the esthetic point of view and to relate these criteria to the changes in the cranial profile and the soft-tissue profile effected by the operation.

The appearance and characteristics of the face have since classical times been analysed by physiognomists from a philosophical aspect and as a rule with reference to *Aristotle's* reflections in his celebrated «Physiognomia», which set the norm for a thousand years. The importance of linear measurements and angles in the cranium and the facial profile have since *Camper* (1792) been a popular subject of dispute among anatomists and anthropologists, including such prominent researchers as *Retzius* (1848), *Virchow* (1856), *Welcker* (1862) and *von Ihering* (1872). *Virchow's* theory of the

importance of the kyphosis of the base of the skull for the degree of prognathism has later been verified on a Swedish material by *Björk* (1947).

For artistic purposes *Albrecht Dürer* (1582) has indicated different types of facial profile in »Hierinnen sind begriffen vier Bücher von menschlicher Proportion«, which may still be consulted with profit.

Since the advent of roentgenographic methods, measurements of the profile have been made more precise and over 500 works have been published, chiefly in the odontological literature, concerning the cranial profile and its changes after treatment (cf. review, *Reichenbach et al.*, 1965). The soft-tissue profile has been metrically analysed in relatively few works.

In 1907 *Angle* declared that »It is that the best balance, the best harmony, the best proportions of the mouth in its relations to the other features requires that there shall be the full complement of teeth, and that each tooth shall be made to occupy its normal position — normal occlusion«. This opinion is shared by *Tweed* (1953), who asserted that a »normal facial pattern« presupposes a »normal occlusion«. *Neger* (1959) has found occasion to contest this view and has pointed out that the measurements of the soft-tissue profile in cases of »excellent occlusion«, of malocclusions and after orthodontic treatment are not regularly coordinated. *Subtelny* (1959), like many other writers, has observed the reduced facial convexity during the growing years and given the mean values for the thickness of the soft tissue. *Burstone* (1959) has also made direct measurements of the soft tissue and found considerable variations with respect to »intergumental extensions« in cases of malocclusion as compared with the standard values, and also a lack of correspondence between the skeletal and soft-tissue profiles, especially as regards the lips. *Sarnäs* (1959) has noted the profile changes during the growing years and indicated standard measurements linearly and angularly. The usefulness of the roentgenological technique for the determination of soft-tissue changes in connection with prosthetic and soft-tissue treatment has been statistically analysed by *Carlsson and Ericson* (1967), who have found coordinate measurement preferable to measurements of distance and angles only.

Secord and Backman (1959) and *Sergl* (1968) have carried out estheticopsychological studies based on a number of observers' »impressions of personality« and related these impressions to occlusion and soft-part profile. They assessed a neutral bite as attractive and positive as compared with mesial and distal bite. »Protruding« or »receding« chin was negatively assessed from the esthetic point of view. Systematic and statistically processed measurements of the soft-tissue profile before and after surgical correction of mandible jaw protrusion have not been found in the literature by the present

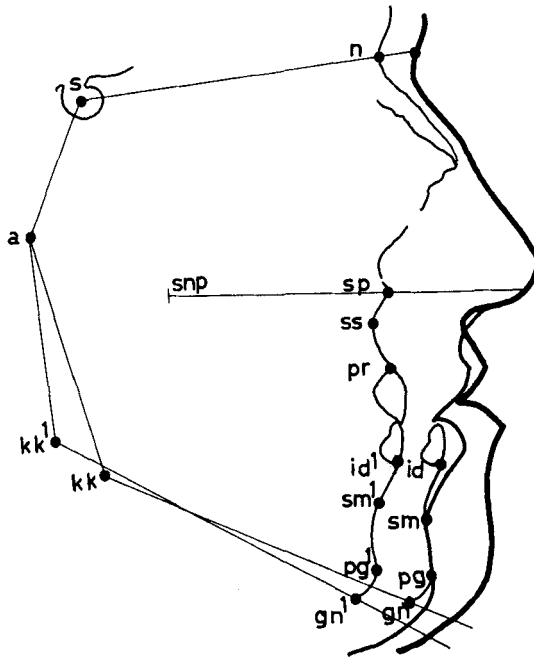


Fig. 1. Reference points. Skeletal profile.

- s* sella — median point
- n* nasion
- sp* spina nasalis anterior
- ss* subspinale
- pr* prorrhion
- id, id¹* infradentale before and after operation
- sm, sm¹* supramentale before and after operation
- pg, pg¹* progonion before and after operation
- gn, gn¹* gnathion before and after operation
- kk, kk¹* intersection between the mandibular base tangent and the ramus tangent through *a* before and after operation
- a* articulare
- snp* spina nasalis posterior

writers, nor have they found any attempts at esthetic assessment of the results of operation.

MATERIAL AND METHODS

The patient material comprised 26 men and 26 women, aged 21—34 years, with mandibular protrusion (Angle Class III cases) who were operated upon

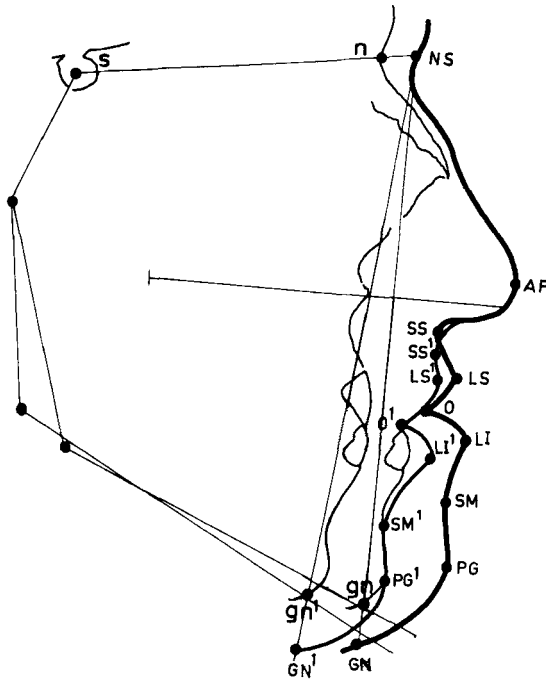


Fig. 2. Reference points. Soft-tissue profile.

- NS* intersection of skull-base line s-n and facial contour
- AP* pronasale — the most prominent point of the soft-tissue profile of the nose
- SS, SS¹* deepest point in contour of upper lip before and after operation
- LS, LS¹* most prominent point of labium superior before and after operation
- SM, SM¹* deepest point in contour of lower lip before and after operation
- PG, PG¹* most prominent point of chin before and after operation
- GN, GN¹* intersection between line NS-gn (*gn¹*) and soft-tissue contour before and after operation
- O, O¹* foremost contact point between upper and lower lip before and after operation

ad modum Babcock-Lindemann (bilateral osteotomy within ramus mandibulae), in collaboration with The School of Dentistry and The Ear Clinic at Umeå University. The operation was performed after exposure of ramus and cap-splints were used for the intermaxillary fixation. Neither toothless cases nor cases where it was difficult to determine the points of reference were included.

The control material in the roentgenological study comprised students at The School of Dentistry, 30 men and 30 women, aged 21--26 years, with good sets of teeth and good occlusion.

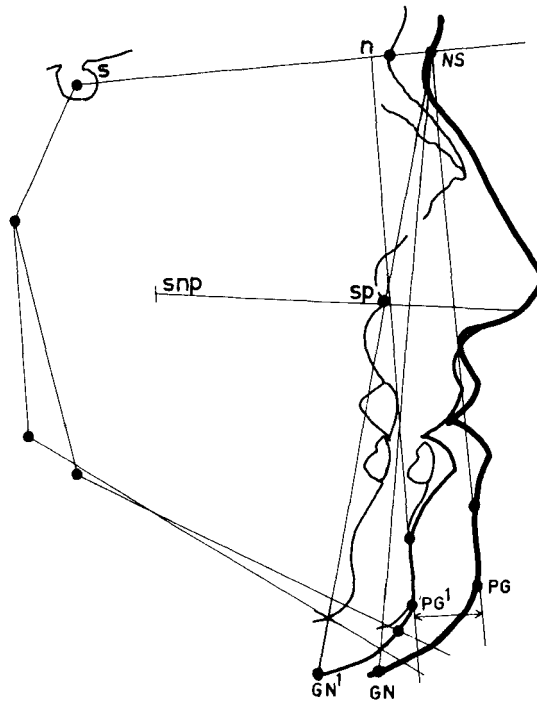


Fig. 3. Linear measurements

The linear shift

the distance between the perpendiculars to skull-base line s-n through PG and PG¹

The morphological height of face

the distance NS-GN (GN¹)

The lower height of face

the distance GN (GN¹) to the intersection of line s-np-sp with line NS-GN (GN¹)

Radiographic examination

Radiographs were taken in a cephalostat of the patient's facial profiles before and two years after the operation, and of the profiles of the individuals included in the control material. The radiographic images were taken in straight lateral projection with the central beam passing the external auditory meatuses at right angles to the sagittal plane of the head and film. The focus to film distance was 155 cm and the film to median plane of the head distance 14 cm. The exposure was made during occlusion (intercuspidal position). The points of reference for the measurements were marked on the radiographic image, after which these points and the outlines of the image were traced for measurement. The points of reference are shown on Figs. 1—6.

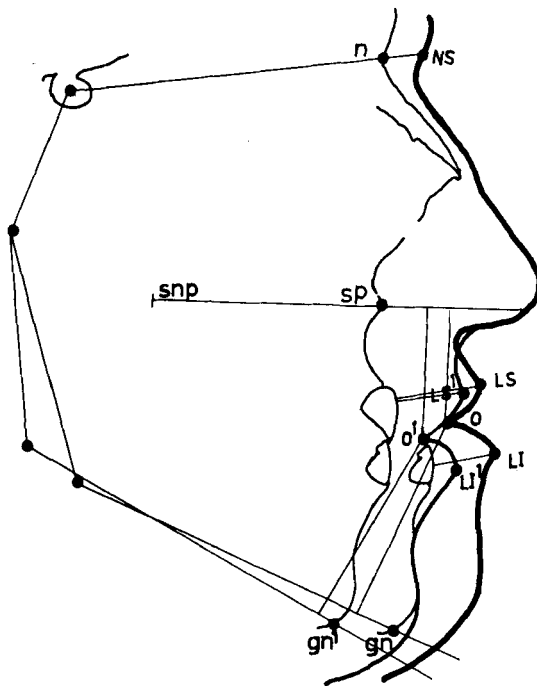


Fig. 4. Linear measurements
 perpendicular distance to line snp-sp
 perpendicular distance to mandibular base-line before and after operation
 longest distance between foremost medial incisor and lip contour

Height of upper lip
 Height of lower lip
 Thickness of upper lip

Esthetic assessment

Owing to racial and other conventions it is probably not possible to make an assessment of a facial profile with any claim to general validity. An assessment of the results of operation must be restricted to an estimation of the change in the profile effected by the operation in each individual case by a relatively large number of persons in the patient's milieu who have not been engaged in the treatment.

The patients were photographed in profile and colour before the operation and 2 years later. The images were fitted into one frame and projected on the screen for simultaneous comparison and evaluation. The same procedure was used with regard to the outline silhouettes of the face drawn from the radiographic images. The board evaluating the appearance of the patients comprised 120 nurses and probationers. Each individual member of the

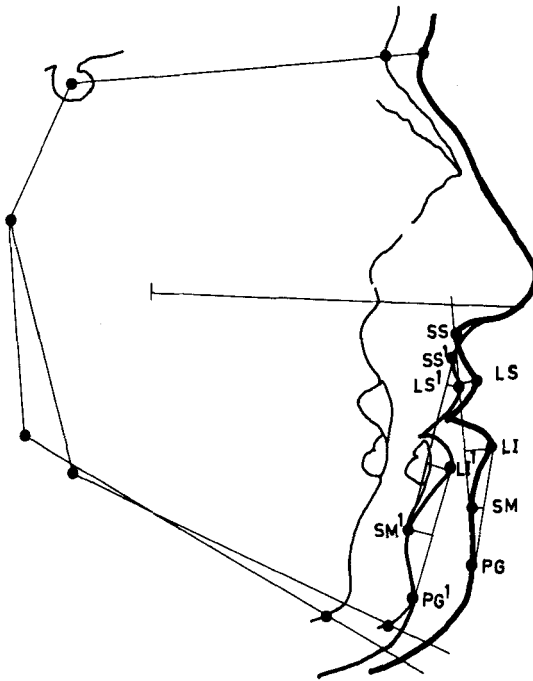


Fig. 5. Linear measurements

Relative prominence of upper lip
Relative prominence of lower lip
Depth of lip curvature

the distance LS (LS') perpendicularly to line SS-SM ($SS'-SM'$)
 the distance LI (LI') perpendicularly to line SS-SM ($SS'-SM'$)
 the distance SM (SM') to line LI-PG ($LI'-PG'$)

board estimated the change in appearance by allotting one of the following points -1, 0, +1, +2, +3, +4, +5, +6; +6 being the highest mark, 0 no improvement and -1 a worsening of the appearance. The observers were informed that it was not a matter of some sort of »beauty competition» or comparison between different individuals, but only of changes in each individual case.

The mean of the points allotted to each patient was calculated as well as the distribution of the different points as a percentage of the number of votes given.

Precision of the method

Radiographic examination. All measurements of the radiographic images were made by the same person. In the case of repeated taking of two linear

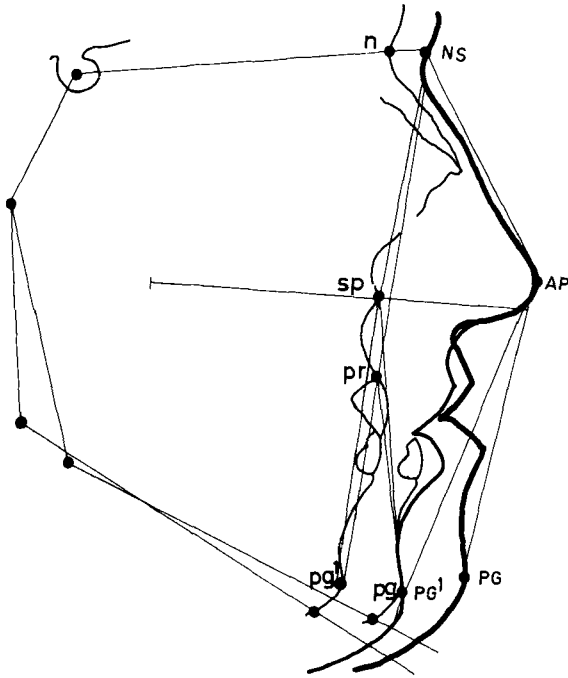


Fig. 6. Angle measurements

N-AP-PG »total facial angle» — angle of tip of nose — before operation
N-AP-PG¹ »total facial angle» — angle of tip of nose — after operation
 are compared with the skeletal angles:
n-sp-pg before operation
n-sp-pg¹ after operation
n-pr-pg before operation
n-pr-pg¹ after operation

Table I.

Difference in average marks in esthetic assessment between two separate assessments of the same group and between assessments of two different groups

		Difference in average marks				Total
		0	1	2	3	
Number	Same group	45	6	1	—	52
	Two groups	34	17	—	1	52

measurements, n-s and n-sp, and one angle measurement, n-s-a, the mean difference was 0.1 mm, 0.1 mm, and 0.5° respectively. The error of the mean value, s_e , was 0.4 mm, 0.4 mm and 0.4° respectively, which shows good precision in the measurements.

Esthetic assessment. In order to judge the consistency of the esthetic assessment the evaluation was repeated a month later by the same group that made the first assessment and also by a new, smaller group. The result is shown in Table I, which proves that the method was fully adequate for its purpose.

RESULTS

Radiographic examination

The mean values of the parameters and their standard deviations of the women and men in the control group are given in Table II. The table shows that there are significant differences between men and women for all linear measurements, except the thickness of the chin. As regards the angle measurements there were no differences. The corresponding values for women and men with mandibular protrusion are shown in Table III. The same difference between men and women as regards upper lip and height of face was found in this group as in the control group. The significant difference regarding the thickness of the lower lip, as observed in the control material, was not observed in the study group. Nor were there any differences regarding the angle measurements in the latter group.

Table II.

Radiographic examination of the soft-tissue profile in the control group

	Women		Men		Diff.	Sign.
	Mean	SD	Mean	SD		
Height of upper lip	25.1	3.1	28.8	3.0	-3.7	***
Height of lower lip	43.3	3.7	48.7	4.6	-5.6	***
Thickness of upper lip	11.6	1.6	14.7	2.5	-3.1	***
Thickness of lower lip	13.7	1.7	16.2	2.3	-2.5	***
Depth of depression under lower lip	5.8	1.3	7.1	1.3	-1.3	***
Thickness of chin	10.5	1.7	11.3	1.8	-0.8	---
Height of face	127.4	6.3	141.7	6.4	-8.5	***
Lower height of face	73.5	4.5	84.2	4.9	-8.6	***
Angle of tip of nose	129.2	5.0	127.6	5.9	-1.6	—
Angle of spina n-sp-pg	166.7	4.7	167.6	7.5	-0.9	—
n-pr-pg	171.4	6.4	171.6	7.8	-0.2	---

Table III.

Radiographic examination of the soft-tissue profile in persons with mandibular protrusion

	Women		Men		Diff.	Sign.
	Mean	SD	Mean	SD		
Height of upper lip	24.8	3.6	28.1	2.5	— 3.3	***
Height of lower lip	46.3	4.2	51.4	3.0	— 5.1	***
Thickness of upper lip	13.7	3.8	17.3	2.9	— 3.6	***
Thickness of lower lip	12.2	2.1	16.2	6.7	— 4.0	—
Depth of depression under lower lip	3.0	1.3	3.7	1.6	— 0.7	—
Thickness of chin	8.8	2.2	8.8	2.2	0.0	—
Height of face	133.1	6.9	144.9	7.0	—11.8	***
Lower height of face	79.4	5.5	89.4	4.2	—10.0	***
Angle of tip of nose	143.4	8.4	140.7	6.4	2.7	—
Angle of spina n-sp-pg	181.1	8.5	178.8	19.8	2.3	—
n-pr-pg	189.8	11.4	188.8	19.1	1.0	—

Table IV.

Difference between prognathous and normal women in radiographic examination of the soft-tissue profile

	Diff.	Sign.
Height of upper lip	— 0.3	—
Height of lower lip	3.0	**
Thickness of upper lip	2.1	—
Thickness of lower lip	— 1.5	**
Depth of depression under lower lip	— 2.8	***
Thickness of chin	— 1.7	**
Height of face	5.7	**
Lower height of face	5.9	***
Angle of tip of nose	14.2	***
Angle of spina n-sp-pg	14.4	***
n-pr-pg	18.4	***

A comparison between the prognathous women and those in the control group (Table IV) shows significant differences as regards the linear measurements of the lower lip and the chin, the height of the face and all the angle measurements. A corresponding comparison between the men with mandibular protrusion and the men in the control group gives a somewhat different result (Table V). There was thus a significant difference in the thickness of the upper lip but not in the thickness of the lower lip, contrary

Table V.

Difference between prognathous and normal men in radiographic examination of the soft-tissue profile

	Diff.	Sign.
Height of upper lip	— 0.7	—
Height of lower lip	2.7	**
Thickness of upper lip	2.6	***
Thickness of lower lip	— 0.1	—
Depth of depression under lower lip	— 3.4	***
Thickness of chin	— 2.5	***
Height of face	3.2	—
Lower height of face	5.2	***
Angle of tip of nose	13.1	***
Angle of spina n-sp-pg	11.2	**
n-pr-pg	17.2	***

Table VI.

Comparison of values measured before and 2 years after operation in women with mandibular protrusion

	Mean	SD	Difference before and 2 yrs. after operation	Sign.
Height of upper lip	27.4	3.0	— 2.6	***
Height of lower lip	47.0	5.3	— 0.7	—
Thickness of upper lip	13.4	6.9	0.3	—
Thickness of lower lip	13.2	1.7	— 1.0	—
Depth of depression under lower lip	4.1	1.1	— 1.1	**
Thickness of chin	9.1	2.0	— 0.3	—
Height of face	135.1	6.3	— 2.0	—
Lower height of face	81.6	4.9	— 2.2	—
Angle of tip of nose	135.0	5.7	8.4	***
Angle of spina n-sp-pg	170.9	6.0	10.2	***
n-pr-pg	175.1	6.0	14.1	***

to what was found in women. Otherwise there were the same differences as regards lower lip, chin, height of face and angle measurements as in the women. The mean values and standard deviations for the parameters investigated in the patients with mandibular protrusion 2 years after operation

Table VII.

Comparison of values measured before and 2 years after operation in men with mandibular protrusion

	Mean	SD	Difference before and 2 yrs. after operation	Sign.
Height of upper lip	29.6	2.2	— 1.5	**
Height of lower lip	50.6	4.0	0.8	—
Thickness of upper lip	15.0	3.7	2.3	**
Thickness of lower lip	17.7	7.0	— 1.5	—
Depth of depression under lower lip	4.7	1.8	— 1.0	**
Thickness of chin	9.3	2.7	— 0.5	—
Height of face	146.6	6.3	— 1.7	—
Lower height of face	88.6	3.7	— 0.8	—
Angle of tip of nose	133.5	8.9	7.2	***
Angle of spina n-sp-pg	172.4	10.2	16.4	***
n-pr-pg	179.2	7.7	9.6	***

and a comparison between the values measured before and 2 years after operation are shown in Tables VI and VII. As regards the soft-tissue profile, the height of the upper lip increased in both women and men. In the men also the thickness of the upper lip increased. The length and thickness of the lower lip was not changed, while the depth of the depression under the lower lip increased in both women and men. All angle measurements were markedly reduced in both women and men.

Esthetic assessment

The results of the esthetic assessment are shown in Figs. 7--14. The mean values of the points of all patients were positive with the majority distributed in the middle of the scale of points. No difference between men and women, or between the respective assessment of profile portraits and silhouettes was observable.

About 10 per cent of the individual voters voted negatively, i.e. no change at all or a worsening of the appearance. Here, too, however, the majority of the votes were closely bunched in the middle of the scale of points (Figs. 11--14).

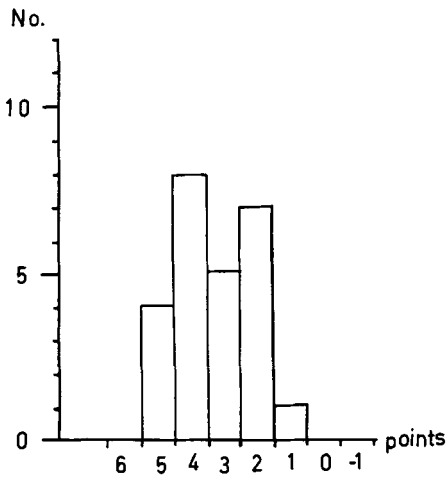


FIG. 7

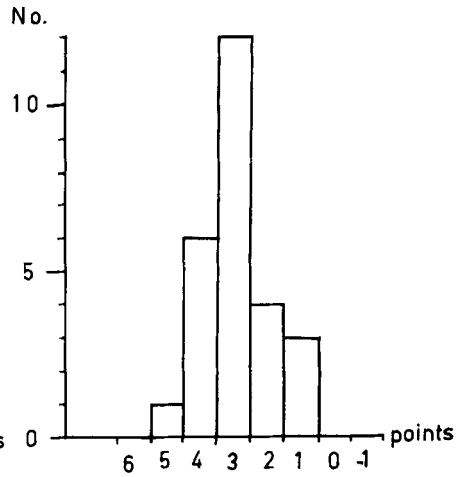


FIG. 8

Fig. 7. Esthetic assessment.
Profile portraits. Average points. Men

Fig. 8. Esthetic assessment.
Profile portraits. Average points. Women

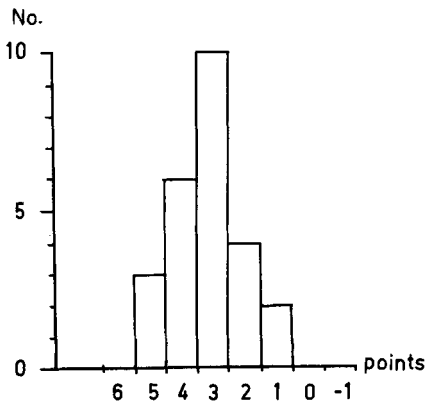


FIG. 9

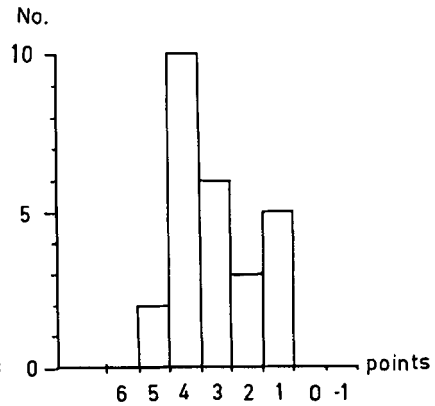


FIG. 10

Fig. 9. Esthetic assessment.
Silhouettes. Average points. Men

Fig. 10. Esthetic assessment.
Silhouettes. Average points. Women

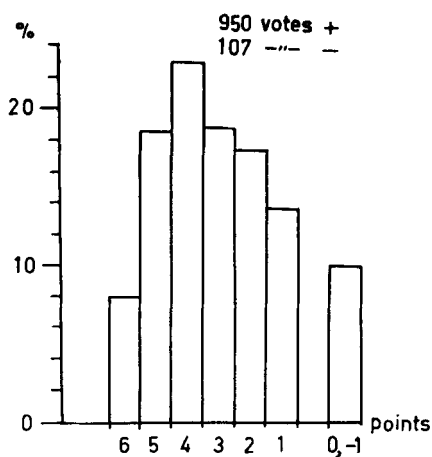


FIG. 11

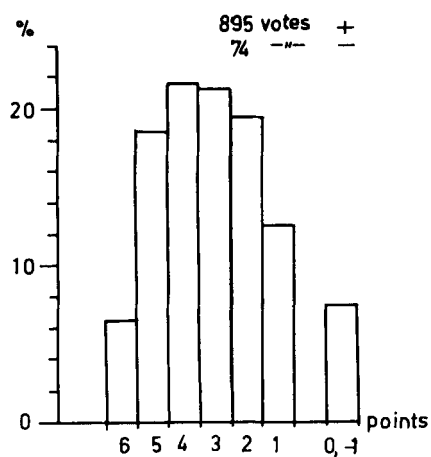


FIG. 12

Fig. 11. Esthetic assessment.
Profile portraits. Individual votes. Men

Fig. 12. Esthetic assessment.
Profile portraits. Individual votes. Women

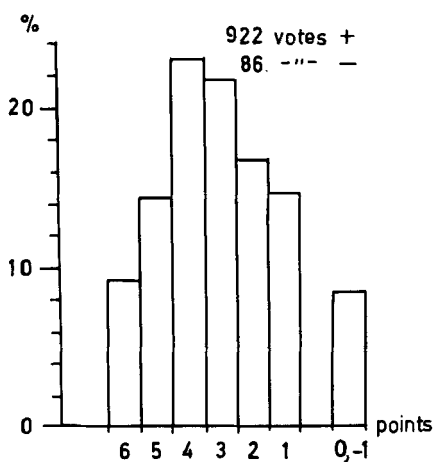


FIG. 13

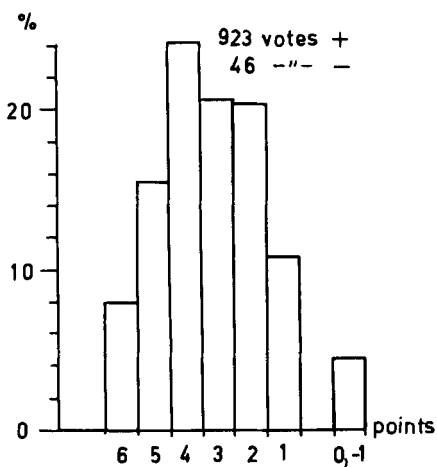


FIG. 14

Fig. 13. Esthetic assessment.
Silhouettes. Individual votes. Men

Fig. 14. Esthetic assessment.
Silhouettes. Individual votes. Women

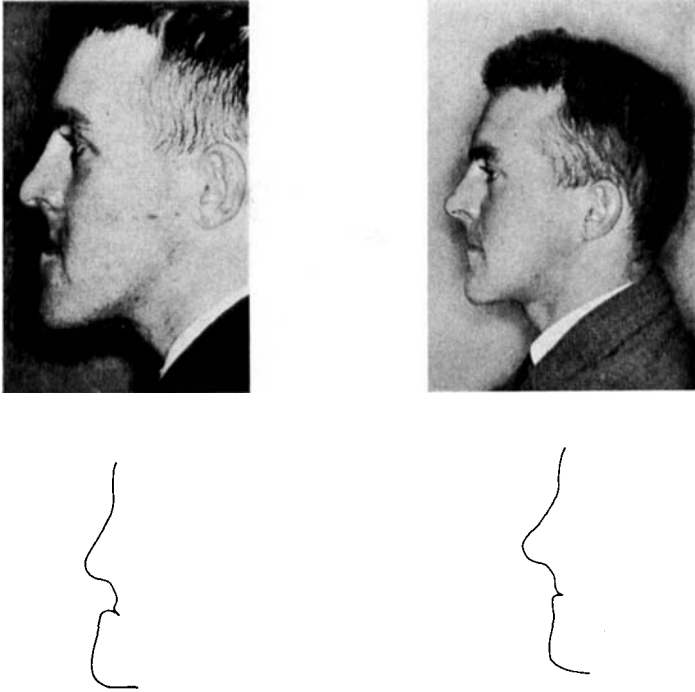


Fig. 15. Patient with advanced mandibular protrusion.
Silhouette and profile portrait. Average point +5 Left: Before operation. Right: After operation.

In a comparison between the radiographic and esthetic investigations, an attempt was made to analyse the changes of the radiographic parameters (Tables VI and VII) representing a good or bad esthetic result. An analysis of these parameters in cases with high and low marks showed that the dorsal shift of the corpus fragment was significantly greater both linearly and angularly in cases with high marks. The reduction of the total facial angle («angle of tip of nose») was also significantly greater for cases with high marks. These results imply that the change in the advanced prognathous cases was assessed more positively than in cases with slight mandibular protrusion (Figs. 15—16). The prolonging of the upper lip to approximately equal size of lips was assessed positively (Fig. 17). The result was the reverse if this labial relation already existed before the operation.

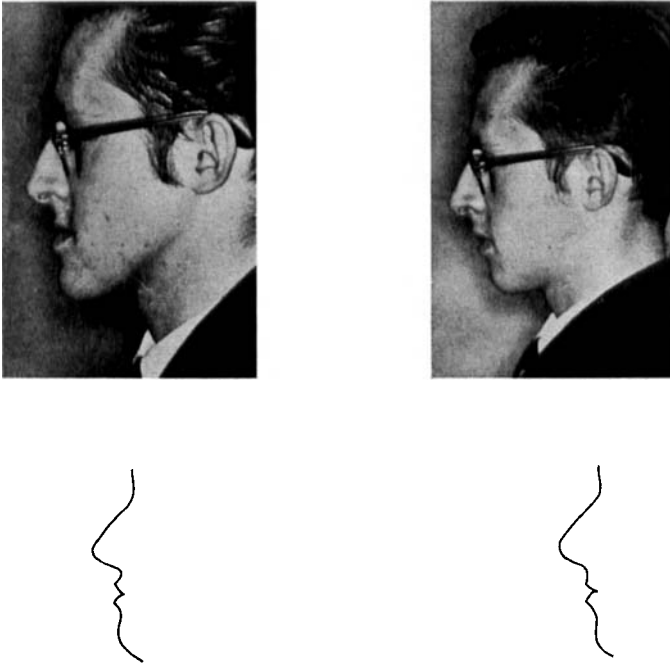


Fig. 16. Patient with slight mandibular protrusion. Silhouette and profile portrait. Average point +1. Left: Before operation. Right: After operation.

DISCUSSION

An analysis of the results revealed definitive differences between women and men. These differences, however, were entirely referable to the size of the face — the linear measurements — while there were no differences in the form of the face — the angle measurements.

The differences between the control group and the protrusion group were referable to differences in the size of the face and differences in the angle measurements. The differences in size were to be found almost exclusively in the mandibular part of the face.

The changes observable after the operation referred almost entirely to a change in the angle measurements and to an increased depth of the depression under the lower lip, which approached the values for the control group. The remaining differences observed for the linear measurements still existed,

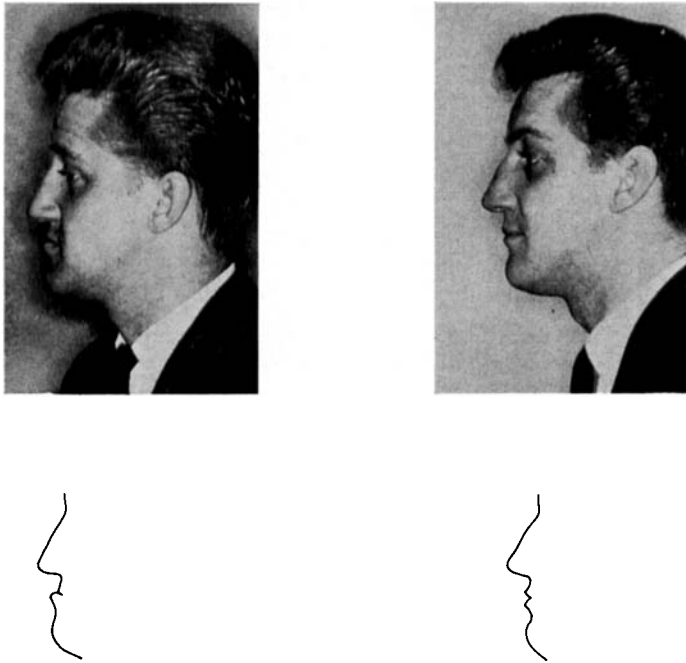


Fig. 17. Patient with large prominence of lower lip.
Silhouette and profile portrait. Average point +4 Left: Before operation. Right: After operation.

and a significant increase in the length of the upper lip was observed. Before the operation there was no difference between the control group and the protrusion group in this respect.

The »static« assessment of the face in profile gave thus a relatively mediocre award for the method used for correction of the mandibular protrusion. However, there is reason to assume that a simultaneous observation of the facial mimicry, the movements of the head and, not least, the teeth would result in a better assessment of the results of operation from the esthetic point of view.

The results of the investigation confirmed the assumption that a profile esthetically acceptable before operation can not be considerably improved and that it may even be worsened according to the »objective« assessment of the existing results of operation. The most important factor to take into account is the configuration of the lips. If the lips remain in approximately

the same protrusion, there is no reason expect an improvement in the esthetic evaluation. Thus the need for operation should in such cases be judged restrictively from the esthetic point of view.

SUMMARY

An investigation has been carried out in order to examine the changes in the soft-tissue profile after surgical correction of mandibular protrusion.

The patient material comprises 26 men and 26 women with mandibular protrusion who have been operated on *ad modum* Babcock-Lindemann. As control material has been used 30 men and 30 women, students at the School of Dentistry.

The investigation has been carried out with use of radiographic examination and esthetic assessment by a large number of persons using a scale of improvement from -1 to $+6$.

The results of the radiographic examination revealed significant differences between men and women. These differences were referable to the size of the face. The differences between the control group and the protrusion group were referable both to the size of the face and to the form of the face. The changes observable after the operation were almost entirely changes in the form of the face. The differences in the size of the face still exist. In this respect the operation has not given the patient a normal appearance.

The results of the esthetic assessment show that in average all patients have been assessed positively with the majority in the middle of the scale of points.

An attempt was made to correlate the change of the parameters in the radiographic investigation to the grade of improvement in the esthetic assessment.

RÉSUMÉ

PROFIL DES TISSUS MOUS DE LA FACE AVANT ET APRÈS CORRECTION CHIRURGICALE DU PROGNATHISME MANDIBULAIRE

Cette étude a été entreprise dans le but d'examiner les modifications du profil des tissus mous après correction chirurgicale du prognathisme mandibulaire.

Le matériel comprenait un groupe de patients, 26 hommes et 26 femmes, traités pour un prognathisme mandibulaire par intervention chirurgicale selon la technique de Babcock-Lindemann. Le groupe témoin comprenait 30 hommes et 30 femmes, étudiants à l'École Dentaire.

L'étude a été exécutée en utilisant l'examen radiographique et l'évaluation esthétique par un grand nombre de personnes suivant une échelle graduant l'amélioration de -1 à $+6$.

Les résultats de l'examen radiographique mettent en évidence des différences significatives entre les hommes et les femmes. Ces différences correspondaient à la grandeur de la face. Les différences entre le groupe témoin et le groupe prognathe correspondaient à la grandeur et à la forme de la face. Les modifications que l'on pouvait constater après l'intervention correspondaient presque entièrement à la forme de la face. Les différences concernant la grandeur de la face persistaient. À ce point de vue, l'intervention n'a donc pas donné au patient une apparence normale.

Les résultats de l'évaluation esthétique montraient que tous les patients avaient fait l'objet d'une évaluation positive, la majorité se trouvant dans la partie moyenne de l'échelle des points.

Une tentative a été faite pour mettre en corrélation la modification des paramètres dans l'étude radiographique avec le degré d'amélioration dans l'évaluation esthétique.

ZUSAMMENFASSUNG

DAS PROFIL DER WEICHTEILE VOR UND NACH OPERATIVER KORRIGIERUNG DER MANDIBULÄREN PROTRUSION

Eine Untersuchung ist durchgeführt worden, um die Veränderungen des Profils der Weichteile nach operativer Korrigierung der mandibulären Protrusion zu studieren.

Die behandelten Patienten, 26 Männer und 26 Frauen mit mandibulärer Protrusion, sind nach der Babcock-Lindemanner Methode operiert worden. 30 Männer und 30 Frauen, alle Studenten an der odontologischen Fakultät (in Umeå) sind als Unerlage für die Kontrolle benutzt worden.

Mit Hilfe röntgenologisches Studiums und ästhetischer Beurteilung ist die Untersuchung von vielen Personen mit Anwendung eines »Verbesserungs-Masstabes« von -1 bis $+6$ gemacht worden.

Die Ergebnisse der röntgenologischen Studien zeigen signifikante Unterschiede unter Männer und Frauen. Diese Unterschiede beziehen sich auf die Grösse des Gesichtes. Die Unterschiede unter der Kontrollgruppe und der Protrusionsgruppe sind sowohl auf die Grösse des Gesichtes als auch auf seine Form zu beziehen.

Die Veränderungen die man nach der Operation beobachten kann zeigen sich beinahe immer als Formveränderungen des Gesichtes. Die Unterschiede

der Grösse des Gesichtes bestehen aber. In dieser Hinsicht hat die Operation den Patienten kein normales Aussehen gegeben.

Die Ergebnisse der ästhetischen Beurteilung stellen hervor dass alle Patienten positiv beurteilt worden sind. Die Mehrzahl von ihnen findet man zentral auf dem Poingmasstabe wieder.

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