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Publication date
2008

Document Version
Final published version

Published in
New trends in knowledge and skills in orthodontics

2X

New trends in knowledge and skills

Proceedings of the 11th International Orthodontic Study week

Nederlandse Vereniging voor Orthodontische Studie
Nederlandse Vereniging van Orthodontisten DMO

19-21 april 2007
Amsterdam, The Netherlands

Nederlandse Vereniging voor Orthodontische Studie
Rotterdam
2008

Rotterdam, Nederlandse Vereniging voor Orthodontische Studie, 2008

ISBN 978 90 800647 4 4

POST-ORTHODONTIC DEVELOPMENT OF ADULT CLASS II1 MALOCCLUSIONS TREATED WITH AND WITHOUT OSTEOTOMY

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Introduction : Literature

GENERAL REMARKS

In some patients orthodontic treatment is combined with surgical correction if severity of the abnormality is considered to large for orthodontic correction alone.
Just like after orthodontic treatment, after surgical correction of skeletal facial deformities some kind of change can be expected. In most cases one is confronted with relapse but other developments are possible.
Since the seventies systematic research on stability after surgical orthodontic treatment of groups of Class II 1 patients was carried out.
Most patients were treated with a bisagittal split osteotomy (BSSO) and much research involving post treatment stability was aimed at a comparison of the effect of the fixation technique (intermaxillary versus screw versus miniplates).
The size of the samples varies largely from 13 (Mommaerts 1991) to 103 (Scheerlink et al 1994) as does the post treatment observation time varying from 6 weeks (Thomas 1986) to 3.5 years (Hilbe and Pulacher 1994).
The amount of relapse expressed as a percentage of the correction measured at point B or at Pogonion varies between 3,2% (Moenning et al 1991) and 37%. (Thuer et al 1994). These reports don't agree on the influence of the amount of correction, the original skeletal pattern, the post-treatment time and the kind of orthodontic treatment on the amount of relapse. However dental pre- and post surgical orthodontic tooth movement and post orthodontic dental relapse is seldom separately thoroughly studied. Also the post orthodontic and post retention periods generally are rather short.
Most studies on post surgical stability start from the point just after surgery and don't take into account the period of (often extensive) post surgical orthodontic treatment that certainly confounds the results.
Comparison between post orthodontic development of surgical and non surgical cases that originally show similar malocclusions an skeletal pattern could provide better information on the influence of dental movement on the relapse after combined surgical-orthodontic treatment.

Proffit et al (1992) compared the outcomes of orthodontic and surgical orthodontic treatment of Class II malocclusion in two very similar adult groups
It appeared that even in the surgical group skeletal changes were relatively small (ANB angle was reduced on average 2.8 degrees, mandibular plane angle increased 4 degrees , however with a large standard deviation).
Horizontal dental movement was larger in the nonsurgery group (the upper anteriors moving backward more than in the surgical group. In the surgery group the lower anteriors moved more forward than in the non surgery group.
Vertically upper anteriors remained almost stable in both groups but mandibular incisors were extruded more in the surgery group. The outcome of this investigation shows that surgery does not preclude more extensive tooth movement than in non surgery cases. Unfortunately there was no long term follow up in this project.
Berger et al (2005) compared 2 Class II 1 groups of 30 patients . The non surgical group was 10 years 4 months at the start of treatment and was treated with myofunctional appliances. The adult group was 27 years at the start of treatment with orthodontics and BSSO. Comparison was difficult because the children often showed favorable post orthodontic growth whereas the adults displayed comparatively much relapse in vertical dimensions. Moreover dental movement during and after treatment, as far as assessed seemed to have been more extensive in the surgery group than in the myofunctional group After three years relapse tendency seemed to have ceased but later observations were not available.
Mihalik et al (2003) compared in a long term (4-15 years) follow up study the treatment outcome of Class II adult treated with orthodontic camouflage with a similar group of Class II patients treated with orthognathic surgery. Also a longitudinally followed untreated adult Class II control group was involved. Overbite stability was almost equal in both groups, the surgery group however showed somewhat more overjet relapse. There were no significant differences between post treatment changes in horizontal movement of upper anteriors, the lower anteriors however showed significantly more backward movement in the surgery group. Vertically the upper anteriors showed more post treatment eruption in the surgery group compared tot the non surgery group. The results also showed that in the surgery group after treatment upper and lower incisors can show backward and forward movement although the majority shows backward movement. In the non surgery group lower anteriors always showed backward movement and in untreated adults upper and lower anteriors almost always moved forward. Also for skeletal points (A, B, ANB, mand. plane angle) post treatment forward and backward and upward and downward movement was found. Menton showed only post treatment downward movement. Vertically the upper anteriors almost always showed post treatment eruption in all groups. Lower anteriors showed post treatment intrusion and eruption in the surgery group but in the non surgery and

untreated controls only eruption of lower anteriors was found. Generally it appeared that in the surgery cases more post treatment dental movement could be expected than in the adult non surgery and adult untreated control group.

STUDIES ON ONLY LEFORT I SURGERY

Proffit et al (1987) studied the post treatment stability after LeFort I osteotomy up to 1 year post treatment. This study found an ongoing post treatment upward movement of the maxilla. Proffit et al could not find a relation between post treatment changes on one side and the amount of presurgical tooth movement and the age of the patient on the other.It also appeared that after treatment point A and upper anteriors could move forward and backward even more than 4mm although average changes were very small

But as for the skeletal landmarks only 20% of the patients had 2mm or more post treatement movement in any direction.

Bishara et al (1988) studied the stability of the LeFort I one piece maxillary osteotomies in a post fixation (60-160 days) follow up.

The results show even in this short period a large range in size and directions of post treatment skeletal and dental movements.

Menton could move 7mm. forward or 5mm. backward and 2mm upward or 5 mm downward. Point A could move 1 mm. forward or 2mm backward and 3.5 mm upward or 1.5 mm downward. Upper anteriors could move 2.5mm forward or 4.5mm backward and 3mm upward or 2 mm downward.

Lower anteriors could move 5mm forward or 3mm backward and 6mm upward or 2.5 mm downward. Angle ANB could change between +2.6 and –2 degrees. As all measurements were performed in relation to the same reference lines it was impossible to distinguish between dental and skeletal changes but a large variation was shown. After upward repositioning the maxilla could continue to move upward, and movement of the upper anteriors seemed to exceed the vertical movement of the maxilla.

DIFFERENTIATION BETWEEN LOW ANGLE AND HIGH ANGLE CASES

Mobarak et al (2001) compared the post surgical development in high angle, vertical normal and low angle cases 3 years after treatment.They found more relapse in the high angle cases, moreover this relapse in this group developed later than the relapse in the low angle cases. The mean posterior relapse movement of the anterior part of the mandible was about 2mm. (almost 5mm. in the high angle group and 3mm in the low angle group) with a very large variation.

All groups showed cases with ongoing forward movement of point B or Pogonion after treatment, but these cases were more frequent in the low angle group. Overall half of all patients showed relapse of equal or less than 2 mm. and the in-

crease of the lower face height appeared to be rather stable, 70% of the increase being maintained after 3 years. As for the post treatment dental movement on average lower anterios moved backward about the same distance in high- and low angle group (1.5-2mm) . Upper anteriors remained stable in the high angle group but moved somewhat backward in the low angle group
Upper and lower anteriors in the high angle group and upper anteriors in the low angle group showed some post treatment intrusion 0.5-1mm). Only the lower anteriors in the low angle group showed a mean 1.7 mm post treatment eruption. However the standard deviation was large for all these dental movements and all of these measurements were related to the base lines also used for assessing skeletal changes, that means that de changes in incisor position is a combination of skeletal and dental change.
Blomqvist et al (1997)) followed 60 patients for 6 months after BSSO. They found a high correlation between relapse and the age of the patients , older patients showing less skeletal relapse than the younger ones. Moreover the low angle cases showed more post surgical changes because they also had larger changes during surgery. There was a large variation in the amount of post treatment change varying between –4 to +3 mm. , 16 cases (28%) showed ongoing forward movement of point B after treatment. The group of patients over 41 years (N-17) showed almost no average relapse and 42% showed forward post surgical movement of point B.

POST SURGICAL DENTO-ALVEOLAR COMPENSATION

Ellis and Gallo(1985) followed 20 patients after BSSO during the first 8 post surgical weeks when orthodontic treatment was still going on and intermaxillary fixation wad also present They observed some uprighting of upper anteriors and some flaring of lower anteriors (up to 8 degrees) both changes with a large variation. Moreover the uprighting of the upper anteriors was correlated to the distal movement of Pogonion suggesting a dental compensation for skeletal relapse.
Scheerlinck et al (1994) studied a group of 103 patients 24 to 60 months after BSSO . It appeared that only 9.7% showed relapse at point B. Of these 10 patients 8 showed condylar resorption. According to the report post treatment changes ('relapse") at point B included posterior movement of 9.5mm to anterior movement of 1.7 mm . In all patients with skeletal "relapse" of point B (from 35% to 120%) the occlusion remained a good Class I in frontal and molar area indicating a strong tendency for dental compensation for skeletal changes.
Simmons et al (1992) studied a sample of 35 BSSO cases 1-5 years post surgery. Average post surgical backward movement of point B was 0.9mm. However in 6 patients the decrease in mandibular length was 2-4mm and in 2 patients even 4mm., these changes were not reflected in overjet increase suggesting a continuing dental compensation for skeletal relapse. Mean post treatment overjet changes were small.

Post treatment overbite increase was related to eruption of upper and lower anteriors and not to skeletal changes. Moreover Simmons et al compared post surgical changes during the first year and the changes between 1 and 5 years , there appeared large variation in amount and direction of the (mostly) small changes for many variables although most changes took place during the first year the overbite being one of the few dimensions showing al larger increase after 1 year.

Variation in post treatment changes was very large, point B could move backward up to 4mm and forward even more than 4mm. Upper and lower anteriors could also move backward or forward up to 4mm. The same was the case for vertical up- and downward movement for point B and lower anteriors. The upper anteriors only showing post treatment eruption up to 4mm.

Van Sickels et al (1988) studied a sample of 51 BSSO cases 6 months to 3 years post surgery Average post surgical change of Pogonion was forward movement of 0.37 mm.(8.2% relapse) (S.D. 2.5mm). Mean post surgical skeletal linear and angular changes were very small however with a large standard deviation, so there were cases with considerable relapse and cases with considerable post treatment forward movement of pogonion.

Results indicated that the magnitude of advancement during surgery was the only predictor for skeletal post surgical relapse. Moreover they found that post treatment forward movement of Pogonion was correlated to decrease in mandibular plane angle, anterior flaring of maxillary incisors and uprighting of mandibular incisors suggesting a post treatment dental compensation for forward movement of pogonion.

PRE- AN POST SURGICAL ORTHODONTIC TOOTH MOVEMENT AND POST TREATMENT TOOTH MOVEMENT

Douma et al (1991) performed a longitudinal study involving presurgical and, post surgical (orthodontic) changes and post treatment development up to 7-18 months in a group os of 36 BSSO cases. Most skeletal relapse occurred during the 6-8 weeks post surgical period. Lower face height increased during surgery but decreased during the post surgical treatment and the post treatment period, however on average some increase was maintained.

The upper and lower anteriors were retroclined during presurgical orthodontics, and proclined during post surgical orthodontics, after treatment they retroclined again. After all a net mean retroclination was achieved for upper and lower anteriors. The mean changes were small but the range was very large. Unfortunately the authors don't show actual numbers.

LARGE DENTAL CHANGES

Watzke et al (1990) studied a group of 70 patients 1 year after BSSO.
Average post surgical changes were small but variation was large.
Points B and Pogonion could move forward or backward up to 2mm. but forward movement of more than 4 mm also occurred. Upper and lower anteriors could also move forward or backward up to 2mm. but lower anteriors could even move backward more than 4 mm.
Points B and Pogonion could move upward or downward up to 2mm but upward movement of more than 4 mm also occurred. Upper and lower anteriors could also move upward up to 4mm but only lower anteriors could also move downward more than 4 mm. Upper anteriors didn't show downward post treatment movement. Unfortunately the dental measurements were a combination of dental and skeletal effects.

VARIATION IN CHANGES AND STABILITY IN SHORT TERM STUDIES

Will and West (1989) studied a group of 235 patients 6 weeks after BSSO.
61% of the patients remained stable during this short observation period. A strong correlation between the amount of surgical correction and length of the post surgical period and the amount of relapse was found. The facial morphology was not related to the amount of relapse. It is interesting to note that the age of the patients at surgery was between 7 and 54 years.
Blomqvist et al (1994) followed 38 patients for 6 months after BSSO. They found a high correlation between relapse and amount of correction. There was large variation in the amount of correction and amount of relapse. Moreover they also found ongoing post surgical forward movement of point B in 10 cases.
Rubens et al (1988) studied a group of 20 patients 6 to 14 months after BSSO. It appeared that relapse at point B amounted 10.7%, there was a large variation in amount of relapse, 4 cases (20%) didn't show post treatment changes and 2 cases (10%) showed ongoing forward movement of point B.
Abeloos et al (1993) studied a sample of 20 BSSO cases 6 months post surgery Average post surgical change of point B was 0.3 mm forward movement , according to the authors because of occlusal setting, in the mean time the length of the mandible showed a mean decrease of 0.3 mm.(5.2% relapse) (S.D. 1.6mm). Mean post surgical skeletal linear and angular changes were very small however with a large standard deviation.
Kohn (1978) studied 12 cases with BSSO treatment 2-4 years after surgery He found that post surgical relapse was mainly related to condylar displacement during surgery. Kohn found a range for relapse for point Pogonion between –5 to + 1mm for horizontal displacement and between –4 to +2 mm. for vertical displacement, the post treatment changes in mandibular plane angle varied between +8 an –4 degrees

Kierl et al (1990) followed post surgical changes 2-4 years after BSSO.
Mean post surgical relapse at point B was 1.3 mm (14%). However large variation in the amount and direction of movement (of point B and menton) was found, 14 subjects showed relapse (up to 5mm), 2 of them more than 50%, 5 subjects showed ongoing forward movement up to 5mm.

Introduction of the problem

In adult Class II 1 cases treatment of the malocclusion can be performed with orthodontics alone but treatment can also involve orthognathic surgery.
Reasons to seek for a combined surgical -orthodontic solution may be esthetic (profile improvement), avoid complicated long lasting treatment, avoid extensive tooth movement and achieve more (dental) stability.
To investigate if these suppositions can be confirmed and how often these aims are achieved short- and long-term treatment results and mainly dental changes during and after treatment were assessed in an originally Class II1 sample of adult patients that underwent either traditional orthodontic treatment or combined surgical orthodontic correction.
Clinical observations comparing Class II 1 patients treated with either combined or only orthodontic treatment can produce interesting common post treatment developments that might be related to relapse of common dental movements during active treatment, but may also have a different background such as skeletal relapse in the surgery patients and dental relapse in the non surgery patients. Figures 1, 2 and 3 show 2 Class II 1 patients with different treatment procedures with rather common post treatment dental development.

Fig 1 A, B and C show the development of a Class II 1 patient that had only orthodontic treatment, before treatment at the end of active treatment and 25 years later at 50 years (10 years out of retention).

Fig 1 A, the frontal view shows, that although the malocclusion was corrected it is difficult find improvement.

Figure 1B The soft tissue profile improved, even flattening after treatment, although no skeletal correction was achieved.

Fig 1C shows the development of overbite and overjet and of the proclination of the upper anteriors. The overjet changed from 11 to 1 mm during treatment and the overbite from 7 to 1mm. After treatment overjet and overbite showed relapse of 3 to 4mm.

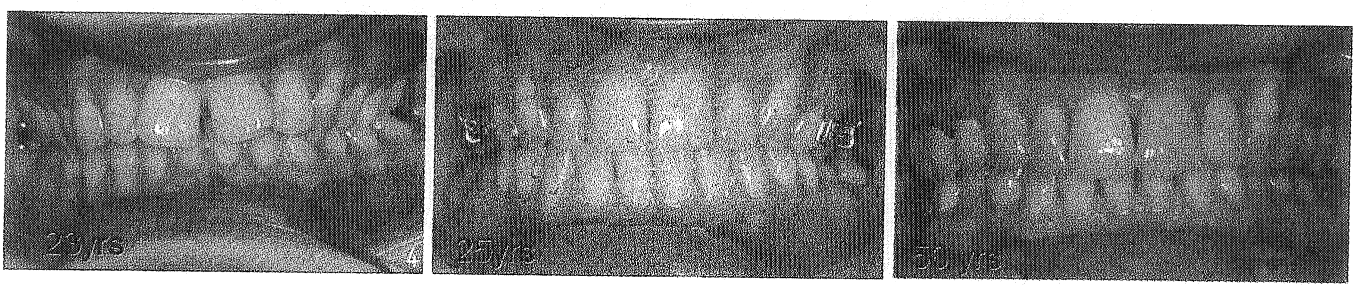


Fig 1 D The frontal intra-oral view shows correction and relapse of overbite but no relapse of the distal angulation of the upper centrals nor of the rotations of the upper anteriors 10 years after retention.

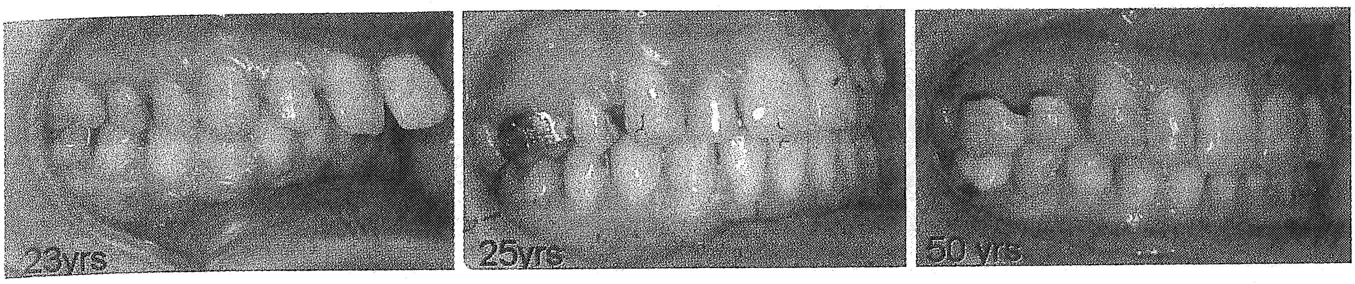


Fig. 1E the right side intra-oral view shows that treatment included removal of the 14 and 24. After treatment at 50 years there appears a reversed curve in the upper arch and slight retroclination of the upper anteriors, abnormalities that were absent before treatment.

Fig 2 A , B and C show the development of a Class II 1 patient that had combined orthodontic-surgical treatment with a BSSO, before treatment at the end of active treatment and 10 years later at 30 years (6 years out of retention).

Figure 2A shows that the soft tissue profile improved during treatment, little post treatment change taking place

Figure 2B, the frontal view, shows an improvement of the lower face.

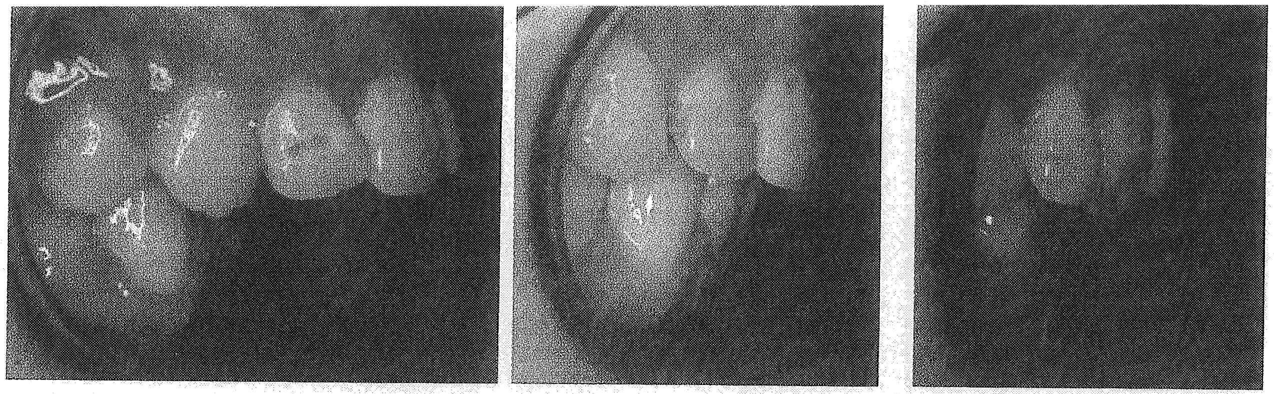


Fig 2C shows the development of overbite and overjet and of the protrusion of the upper anteriors. The overjet changed from 15 to 4 mm during treatment and the overbite from 6 to 3mm. After treatment overjet and overbite showed relapse of respectively 2 and 4 mm. moreover a post treatment increase of retroclination of upper anteriors can be observed.

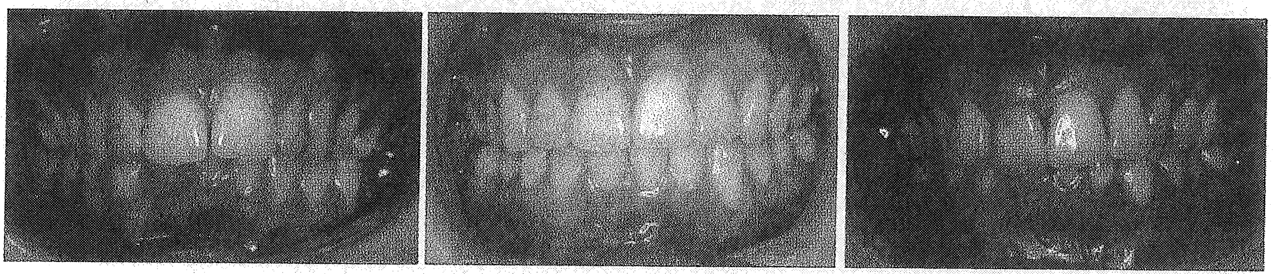


Fig 2 D The frontal intra-oral view shows correction and relapse of the asymmetric overbite but no relapse of the (small) central diastema, the upper laterals that originally show distal rotation show post treatment mesial rotation at 30 years, 6 years out of retention.

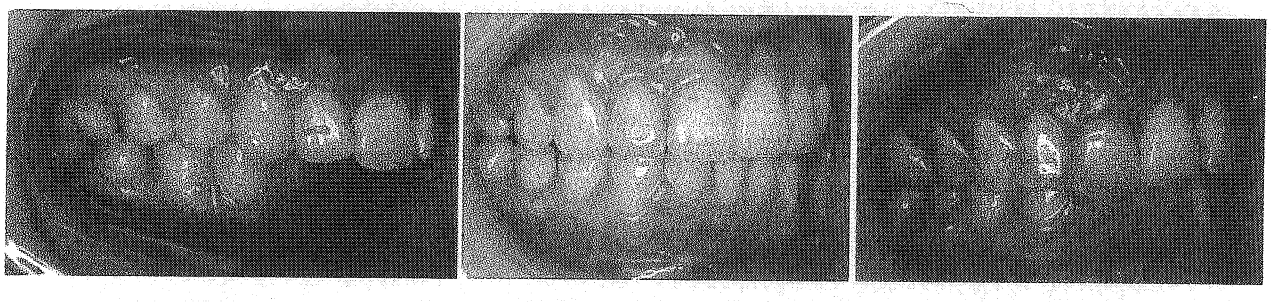


Fig. 2E The right side intra-oral view shows that treatment also included removal of the 14 and 24. After treatment at 30 years there appears a relapse of the reversed curve in the upper arch and retroclination of the upper anteriors an abnormality that was absent before treatment. However the overjet showed only limited relapse.

Fig 3 A and B compare both preceding patients.

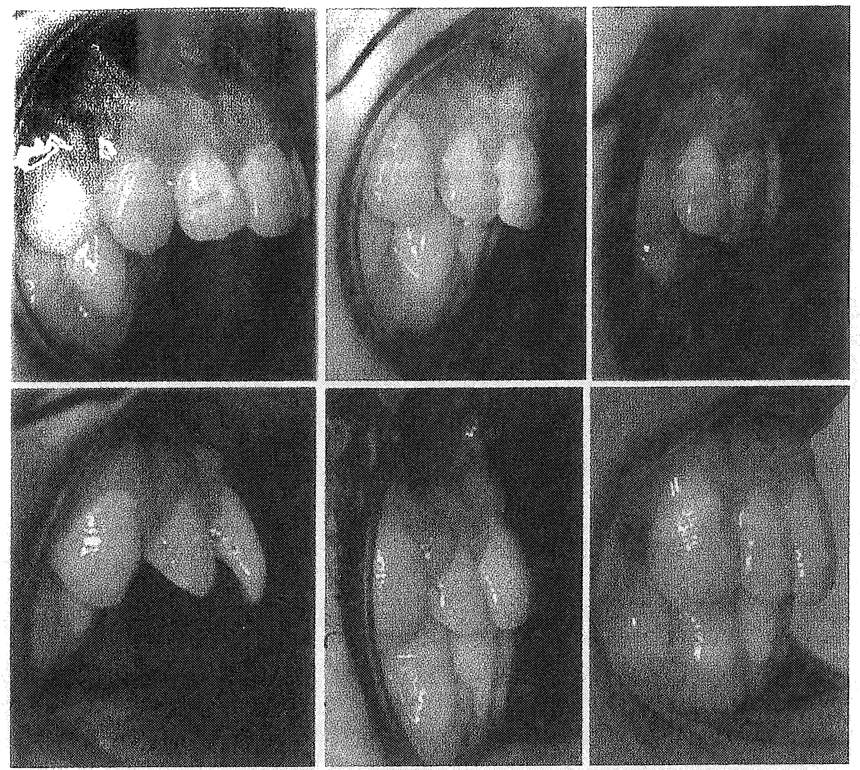


Fig 3 A shows some interesting long term similarities: uprighting of upper anteriors, more relapse of overbite compared to overjet and development of a reversed curve of Spee in the upper arch.

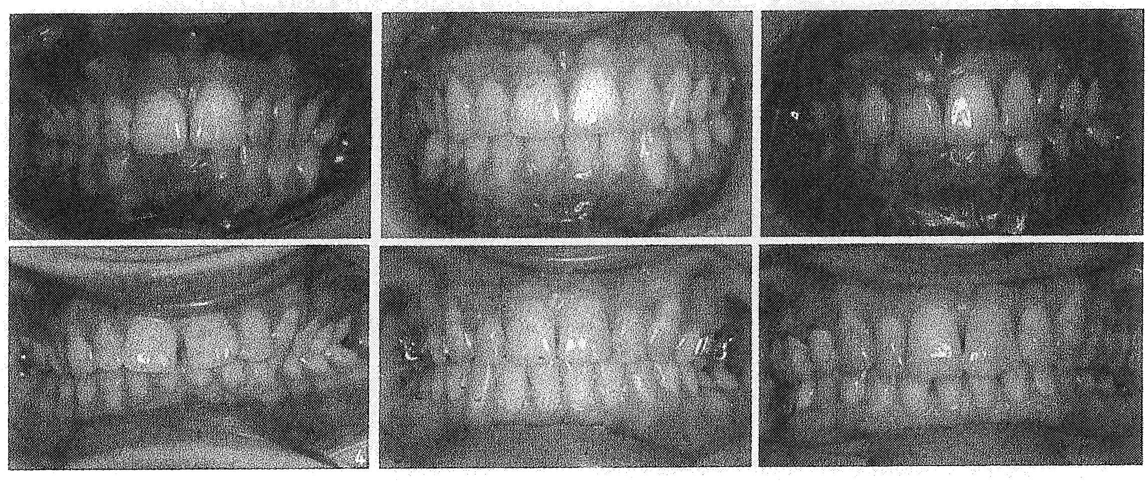


Fig 3 B both frontal views also show relapse of the overbite and post treatment development of a reversed curve of Spee in the upper arch. In these cases individual tooth positions in the upper arch show developments differing from relapse. Besides some relapse both cases seem to develop towards a Class II 2

The active surgical orthodontic treatment actually involves two phases, one before surgery and one between surgery and end of active treatment. The first phase often involves correction of dento-alveolar compensation and correct alignment of dental arches. Ideally in the second phase only minor tooth movement should be necessary. But these tooth movements have not been thoroughly studied yet.
During the second phase adaptation to the new skeletal pattern is attained. The tooth movements involved in this last phase could be in a different direction than before surgery depending also on skeletal changes occurring after surgery. As the pre- and post surgical tooth movements and their effects on post treatment stability were not studied up to now, an effort was made to assess them and find a relation with post treatment development.
Considering the way correction was achieved one could assume that skeletal relapse plays a major role in the surgical group, however if much dental movement was also involved this could confound the total relapse image.
In the non surgical group one could assume that post treatment relapse would be almost entirely dental. But in adults skeletal changes can take place (Behrents 1985) . During treatment mainly as a consequence of vertical movement of molars and afterwards although rather slowly by development and growth changes that can amount to several millimeters throughout the years. In both groups one can also expect some dental compensation to take place for the post treatment skeletal changes.
In view of the foregoing observations it seems reasonable to look for inter relations between post treatment dental and skeletal changes.
The hypothesis was that in the surgical group less dental movement would be necessary and more dental stability would be achieved, moreover in the surgical group the dental positions would approximate more the ideal positions than in the non surgery group as no or much less compensatory movement or positioning would be necessary. At the same time the surgery group should show more changes and more improvement in the soft tissue profile.
Relapse in the surgical group should be mostly skeletal, possibly accompanied by some dental compensation. In the non surgery group relapse should be mostly dental although skeletal changes could play a small role.

Aim

This longitudinal cephalometric retrospective investigation was based on long term records of originally comparable adult Class II 1 patients who had undergone either combined orthodontic surgical treatment or only orthodontic (camouflage) treatment. The goals where:

1. To compare original features, treatment result and long term morphology in orthodontic and surgery patients.
2. To evaluate pre- and post- surgical dental movements.
3. To evaluate and compare long term cephalometric changes and stability after

orthodontic correction and after orthodontic-surgical correction.

4. To find interrelations between post treatment changes that may provide some back ground information on post treatment developments and relapse

MATERIAL AND METHODS

Out of the files of the department of orthodontics of ACTA successfully treated adult patients originally showing a Class II 1 were selected .

Selection criteria were:

Availability of a full set of records: pretreatment (T1), at the end of active treatment (T3) and at least 3 years after treatment(T3).

The minimum age at T1 for women was 16.6 years and for men 19.1 years.

At T1 (pretreatment) the overjet was larger than 4 mm. there was no open bite, and the molar occlusion was at least 0.25 bicuspid width Class II on both sides. There were no dentofacial deformities no severe periodontal problems and no severe prosthetic cases at any time point.

Table 1. Demographics: age and post-treatment period in years and gender

	Orthodontics only			*Surgery*		
		N=21			*N=43*	
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	29.5	9.1	17.4-46.2	25.7	7.1	16.6-47.6
End of active treatment (T2)	32.6	9.2	19.2-49.3	29.0	7.1	20.1-50.0
Long term (T3)	44.3	7.8	31.1-59.8	37.2	8.5	23.4-65.2
Post-treatment period (T2-T3)	11.7	3.5	6.5-25.2	08.2	2.2	3.1-20.3
Male/Female		10/11			12/31	

Only significant differences between the groups for Male/Female

With these criteria it was possible to select 43 surgical cases and 21 orthodontic cases. It was also possible to collect presugical records of 28 surgical cases that underwent a BSSO osteotomy. All patients were treated between 1976 and 2001 at the department of orthodontics ACTA by graduate students or staff members. Surgery was performed at the department of oral surgery at the hospitals of the Fee University of Amsterdam (VUMC) or the University of Amsterdam (AMC), only 3 oral surgeons were involved.

Table 2. Surgery cases

BSSO		20	
BSSO	+ chin	5	25
BSSO + LeFort I		6	
BSSO + LeFort I + chin		7	13
	LeFort I	2	
	LeFort I + chin	3	5
		Total:	43

All patients were treated with full fixed appliances with and without extractions. Most of the patients in both groups had also worn al lot of Class II elastics. Of the surgical cases 50 % were out of retention and 50% still wore bonded retainers in lower and/or upper anteriors. The non surgical cases were all at least 3 years out of retention.
56 landmarks were digitized with a GTCO digitzer (CTCO Corp) which was connected to a 486 DX 333 PC (Hewlett and Packard). Most landmarks were defined according to Riolo and Steiner. The measurements are shown in table 3

Table 3. Cephalometric landmarks, reference lines and measurements

ANS to Menton	Distance in mm beween anterior nasal spine and Menton
Sp. Pl. /Mand plane	Angle between the line anterior nasal spine to posterior nasal spine and the line between menton and mandibluar antegonial notch
Gonion angle	Angle between the line connecting articulare and the posterior border of the mandibular ramus and the tangent to the lower border of the mandible
ANB	Angle between the line connecting nasion and subspinale (pointA) and the line connecting nasion and supramentale (point B)
Wits	Distance between the projections of subspinale (point A) and supramentale (point B) on the occlusal plane
Overjet	Distance between incisal ridges of upper and lower anteriors parallel to occlusal plane
overbite	Distance between incisal ridges of central upper and lower anteriors perpendicular to occlusal plane
– 1 to Menton	Distance between incisal ridge of central lower anteriors and Menton
+1 to Spina Plane	Distance between incisal ridge of central lower anteriors and the line connecting anterior and posterior nasal spine
– 1 to NB (mm)	Distance between the line connecting nasion and supramentale (point B) and the most prominent convexity of the labial surface of the central lower anteriors
– 1 to NB (°)	Angle between the line connecting nasion and supramentale (point B) and the line connecting apex and incisal ridge of central lower anteriors
– 1 to point D // Mand. Pl.	Distance between the incisal ridge of the central lower anteriors and the centre of the cancellous bone area of the symphysis (point D) parallel to the tangent to menton and the lower border of the mandible

−1 to NA (mm)	Distance between the line connecting nasion and subspinale (point A) and the most prominent convexity of the labial surface of the central upper anteriors
+1 to NA (°)	Angle between the line connecting nasion and subspinal (point A) and the line connecting apex and incisal ridge orf central upper anteriors
+1 to point A // Sp. Pl.	Distance between the incisal ridge of the upper central anteriors and subspinale (point A) parallel to the line connecting posterior and anterior nasal spine
T-Angle	Angle between the line connecting subnasale (deepest point between upper lip and pronalsale) and soft tissue pogonion and the perpendicular tot the frankfurter horizontal plane
Mento-labial sulcus depth	Distance between the deepest point between labrale inferior (most prominent point of the lower lip) and soft tissue pogonion and the line touching soft tissue pogonion and labrale inferior
Upper to lower lip difference	Distance between the most prominent points of upper an lower lip (labrale superior and labrale inferior as defined by the tangent to upper and lower lip) measured perpendicular to the line connecting subnalsale and soft tissue pogonion
Nasolabial angle	Angle between the tangent from subnasale to the columella and the tangent from subnasale touching the upper lip

The Viewbox program was used for registration and storage of landmark coordinates and calculation of the measurements.
Tracing and digitizing process of the cephalograms was repeated by an independent observer for 30 tracings. The time span between these independent tracings was at least 2 weeks. Correlation coefficients for repeated measurements were calculated to test for interobserver variability Students ‘t tests were performed between the first and second group of recordings to detect any systematic difference between the first an second tracings of this error study . For all statistical analyses the confidence level $p < 0.05$ was considered significant

Results

ERROR STUDY

Correlation coefficient below 0.90 was only found for the distance +1 incisal to Spina Plane (0.87). For the other measurements correlation coefficients were above 0.90. No significant differences ($p < 0.001$) were found between the first and second group of measurements.

Table 4. Overjet (mm)

	Orthodontics only			Surgery		
	N=21			N=43		
	Mean	S.D.	Range	Mean	S.D.	Range
Initial (T1)	6.6	2.1	4.3-11.4	10.4	2.6	4.1-15.6
End of active treatment (T2)	3.3	1.3	0.8-5.9	3.2	1.0	1.5-6.1
Long term (T3)	4.1	1.1	2.2-6.2	4.1	1.2	1.6-7.1
Treatment changes (T1-T2)	−3.3	2.7	−10.5-−1.6	−7.1*	2.6	−12.2-−0.2
Post treatment changes (T2-T3	−0.8	1.1	−0.6-3.5	0.8	0.9	−0.6 - 4.0

* Significant differences between the groups $p < 0.001$

Table 4 shows the development of the overjet in the groups studied. Before and after treatment no significant differences were found between de surgery and non surgery group. The average pretreatment overjet in the surgery group (10.4mm) is somewhat larger than in the non surgery group (6.6mm.), the difference however was not significant. The only significant difference was found between the overjet changes during treatment, the surgery group exhibiting a significant larger overjet reduction.
The average post treatment and long term overjet as well as the post treatment overjet changes are almost equal for both groups, even the ranges are similar although somewhat larger in the surgery group. Table 5 shows that frequencies of post-treatment stability (changes smaller or equal to 1mm) are comparable for both groups, larger post treatment increases in overjet (1-4mm) occur somewhat more frequent in the non surgery group.

Table 5. frequency of post treatment overjet changes

	Orthodontics only	Surgery
	N=21	N=43
−1 mm to + 1 mm	57%	
−0.5 mm to + 1 mm		63%
+1 mm to + 4 mm	43%	37%

Table 6. Overbite (mm)

	Orthodontics only			*Surgery*		
		N=21			*N=43*	
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	4.7	2.0	2.1-9.8	5.8	3.3	0.0-11.7
End of active treatment (T2)	1.5	0.9	−0.4-3.3	1.4	1.3	− 1.5-3.9
Long term (T3)	3.1	1.4	0.5-6.1	2.5	1.6	0.1-6.7
Treatment changes (T1-T2)	−3.2	2.0	−7.5-−0.2	−4.4	3.1	−10.5-1.7
Post treatment changes (T2-T3	1.6	1.1	−0.4-3.3	1.1	1.4	− 2.1-4.3

* Significant differences between the groups $p < 0.05$

Table 6 shows the development of the overbite in the groups studied. Before and after treatment no significant differences were found between de surgery and non surgery group.

The average post treatment and long term overbite as well as the post treatment overbite changes are almost equal for both groups, the ranges are similar although always larger in the surgery group. Table 7 shows that frequencies of post-treatment stability (changes smaller or equal to 1mm) are larger in the surgery group (58% versus 38% in the non surgery group). The frequency of post treatment overbite increases of 2mm. and more is larger in the non surgery group (41% versus 6 %).

Table 7. frequency of post treatment overbite changes

	Orthodontics only	*Surgery*
	N=21	*N=43*
2 mm and more reduction		2%
− 1 mm to + 1 mm	36%	58%
+ 1 mm to + 2 mm	19%	34%
+ 2 mm to + 3 mm	36%	
+ 3 mm and more	5%	6%

Table 8. Angle ANB

	Orthodontics only			Surgery		
	N=21			N=43		
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	3.5	3.2	−5.8-9.5	6.5	2.9	1.3-14.3
End of active treatment (T2)	3.3	3.4	−5.9-9.5	4.1	3.1	−2.2-12.3
Long term (T3)	3.2	3.2	−5.2-9.0	4.6	3.2	−1.3-13.5
Treatment changes (T1-T2)	−0.2	1.0	−1.8-1.9	−2.4	1.8	−7.3- 1.6
Post treatment changes (T2-T3	−0.1	0.7	−1.2-1.2	0.5*	1.1	−3.0- 4.1

* Significant differences between the groups $p < 0.05$

Table 8 shows the development of the ANB angle in the groups studied. Before and after treatment no significant differences were found between de surgery and non surgery group. Even average changes during treatment did not differ significantly. The only significant difference was found between the average post treatment changes, showing an increase of 0.5 ° in the surgery group and almost no change in the non surgery group.

According to angle ANB before treatment the non surgery group includes at least one skeletal Class III case and the surgery group at least one skeletal Class I case.

The range was very large in both groups at all time points. The surgery group showed also a large range in changes during and after treatment. In the surgery group even during treatment increase of Angle ANB was possible, after treatment in this group increase or decrease of 3° to 4° was possible.

Table 13 shows the frequency of changes during and after treatment in the surgery group. In 33 cases (76%) the angle ANB was reduced. A number of these cases (10)(23 %) showed some relapse, increase of Angle ANB. In 32 cases (74%) however ANB angle changed less than 1 ° which may be considered stable.

Table 9. Wits (mm)

	Orthodontics only N=21			Surgery N=43		
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	2.9	3.9	−7.0-7.4	8.9*	3.3	0.6-15.1
End of active treatment (T2)	1.1	3.7	−5.2-8.9	1.1	3.4	−9.1- 7.6
Long term (T3)	1.4	4.0	−8.0-9.2	2.2	3.1	−5.2-10.3
Treatment changes (T1-T2)	−1.8	3.4	−7.5-2.9	−7.8*	2.8	−14.3-−1.9
Post treatment changes (T2-T3	0.3	1.6	−2.8-3.5	1.2	1.6	−1.8- 5.0

*significant differences between the groups p<0.001

Table 9 shows the development of the WITS value in the groups studied. Before treatment the surgery group shows a significant larger value indicating a more severe Class II skeletal pattern. After treatment and long term no significant differences between the mean values were found.

Average change during treatment was significantly larger for the surgery group but there was no significant difference between the post treatment changes.

According to Wits before treatment the non surgery group includes at least one skeletal Class III case and the surgery group at least one skeletal Class I case.

Post treatment, according to Wits, both groups include skeletal Class III cases

The range for the mean values and for the changes was very large and very comparable in both groups at all time points.

Table 13 shows the frequency of changes during and after treatment in the surgery group. In al 43 cases the Wits was reduced more than 1 mm. Almost half of these cases (22)(51 %) showed some relapse, increase of Wits. In 4 (9%) cases however Wits continued to decrease post treatment. 17 (39%) cases remained stable changing less than 1mm

Table 10. Lower face heigt: ANS-Menton (mm)

	Orthodontics only			*Surgery*		
	N=21			*N=43*		
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	72.0	7.1	56.4-82.5	68.9	7.9	55.0-82.1
End of active treatment (T2)	72.2	6.6	59.1-81.5	70.9	6.5	58.7-81.0
Long term (T3)	71.6	7.2	58.0-80.8	69.8	6.9	57.3-80.4
Treatment changes (T1-T2)	0.2	1.2	−1.7-2.6	1.9	3.4	−5.3- 9.4
Post treatment changes (T2-T3	−0.7	1.0	−2.5-1.4	−1.0	1.3	−4.1- 3.2

No significant differences between the groups for any variable

Table 10 shows the development of the lower face height in the groups studied. No significant differences were found between the mean pretreatment, post-treatment and long term values neither between the average changes during treatment and post treatment changes.

The range was very similar at all 3 time points. Apparently both groups included short face and long face cases.

The range for the changes during and after treatment was much larger for the surgery group.

During treatment in the surgery group lower face height changes varied between a reduction of 5.3 mm to an increase of 9.4mm but even in the non surgical group there was a range between 1.7 mm decrease and 2.6 mm increase. Post treatment in the surgery group changes between 4.1mm decrease and 3.2 mm increase were observed, for the non surgery group changes between 2,5mm reduction and 1.4 mm increase were found.

Table 11 shows the frequencies of changes during treatment. In the non surgery group the majority (72%) of the lower face heights remains almost stable (between −1 and +1mm) versus 23 % in the surgery group. Small increases (14%) and decreases (14%) take place in the non surgery group. In the surgery group large reductions are scarce, increases of 3 to 6mm were found in 32% and increases between 6 and 10 mm in 16 %. 72% of the surgery cases increased during treatment and 18 % of the surgery case changed 5mm or more during treatment.

Table 12 shows the frequencies of post treatment changes in lower face height. Stability is more frequent in the non surgery group (68% versus 42% in the surgery group). Large changes and increases are scarce. In the surgery group 1-2mm reduction was found in 40%, changes larger than 2 mm were found in only 10 % of the surgery group (5% increase and 5 % decrease).

Table 13 shows the frequency of changes during and after treatment in the surgery group. In 24 cases (56%) the LFH was increased and in 10 cases (23%) decreased during treatment. Most of the cases that had an LFH increase during

18 (43%)cases remained stable. In 2 cases LFH continued to increase post treatment.

Table 11. frequency of Lower Face Height (ANS-Menton) changes during treatment

	Orthodontics only *N=21*	*Surgery* *N=43*
2 mm reduction		2%
−1 mm to − 2 mm	14%	7%
−1 mm to + 1 mm	72%	23%
+1 mm to + 3 mm	14%	23%
+3 mm to + 6 mm		32%
+6 mm to + 10 mm		16%

Table 12. frequency of post treatment Lower Face Height (ANS-Menton) changes

	Orthodontics only *N=21*	*Surgery* *N=43*
3 mm to 4mm reduction		5%
2 mm to 3 mm reduction	14%	8%
1 to 2 mm reduction	14%	40%
−1 mm to + 1 mm	68%	42%
+1 mm to + 3 mm	4%	
+2 mm to + 4 mm		5%

Table 13. Frequency of skeletal changes during treatment and post treatment changes in the surgery group. No change means changes between +1mm and −1 mm or between −1° and +1°

	Increase during treatment	No changes during treatment	Decrease during treatment	Increase post treatment	No changes post treatment	Decrease post treatment	Relapse	Ongoing movement
ANB Angle	2	8	33	10	32	1	10	0
Wits	0	0	43	22	17	4	22	3
LFH	24	9	10	2	18	23	15	5
Sp P1 mandP1	31	5	7	18	15	10	14	10
Gonion angle	40	0	3	17	8	18	23	12

Table 14: Intermaxillary divergence: Spina Plane / Mand. Plane ( )

	Orthodontics only N=21			*Surgery N=43*		
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	25.6	9.4	9.9-39.6	24.9	9.6	0.2-42.6
End of active treatment (T2)	25.4	8.9	12.7-40.0	28.2	7.1	9.9-41.3
Long term (T3)	25.6	9.5	11.0-40.2	28.7	8.0	1.2-42.2
Treatment changes (T1-T2)	−0.2	1.7	−5.1-3.1	3.2	4.4	−8.0-10.3
Post treatment changes (T2-T3	0.3	1.8	−2.6-4.1	0.5	1.7	−2.6- 4.2

No significant differences between the groups for any variable

Table 14 shows the development of the intermaxillary divergence in the groups studied. No significant differences were found between the mean pretreatment, post-treatment and long term values neither between the average changes during treatment and post treatment changes.

The range was very similar at all 3 time points. The range for the changes during treatment was much larger for the surgery group.

Apparently both groups included hypo- and hyperdivergent cases.

During treatment in the surgery group divergence changes varied between a reduction of 8 degrees to an increase of 10 degrees but even in the non surgical group there was a range between 5 degrees decrease and 3 degrees increase. Post treatment in both groups changes between 2.6 degrees decrease to 4.2 increase were observed.

Table 13 shows the frequency of changes during and after treatment in the surgery group. In 31 cases (72%) the divergence was increased and in 7 cases (16%) decreased during treatment. 14 cases (32 %) showed some relapse ,decrease or increase of divergence. In 10 (23%) of the cases divergence decreased and in 18(42%) cases increased after treatment. 10 (23%) cases showed continuing post treatment movement and 9 of these cases showed increase of divergence during and after treatment

Table 15. Gonion Angle

	Orthodontics only			Surgery		
		N=21			N=43	
	Mean	S.D.	Range	Mean	S.D.	Range
Initial (T1)	123.8	9.8	101.1-139.8	124.9	7.6	103.1-143.1
End of active treatment (T2)	123.9	10.1	100.9-139.9	135.6*	9.3	113.2-154.6
Long term (T3)	124.3	9.9	101.0-140.6	135.1*	8.6	113.6-155.2
Treatment changes (T1-T2)	0.1	1.8	−2.9-2.7	10.7*	6.3	−3.2-23.4
Post treatment changes (T2-T3	0.4	1.4	−2.2-2.7	−0.5	3.6	−9.6-11.5

* significant differences between the groups $P < 0.01$

Table 15 shows the development of the Gonion angle in the groups studied. No significant differences were found between the average pretreatment values neither between the average post treatment changes.
The range for the changes during treatment was much larger for the surgery group.
During treatment the gonion angle in the surgery group increased on average 10.7 degrees with a range between an reduction of 3 to an increase of 23 degrees.
During treatment the significant increase of 10.7 degrees in the surgery group lead to a significantly larger post treatment and long term gonion angle (compared to the non surgery group) that was also above the normal/ ideal dimensions.
Average post treatment changes did not differ significantly between the groups However the range in post treatment changes in the surgery group varied from a reduction of 9.6 to an increase of 11.5 degrees.
Table 13 shows the frequencies of changes during and after treatment in the surgery group. During treatment the Gonion angle increased in 40 cases and was decreased in only 3 cases. 93% of the surgery cases increased during treatment but 7% decreased during treatment
Postreatment the gonion angle increased in 17 and decreased in 18 cases. 23 cases showed relapse and 12 cases ongoing movement which were all cases with ongoing increase of the gonion angle.

Table 16. Vertical dimension symphysis and lower dento-alveolar area: -1-Menton (mm)

	Orthodontics only			Surgery		
	N=21			N=43		
	Mean	S.D.	Range	Mean	S.D.	Range
Initial (T1)	45.0	5.6	34.1-55.5	44.0	4.7	33.9-54.8
End of active treatment (T2)	43.4	5.0	33.0-52.3	42.1	4.3	33.9-48.9
Long term (T3)	43.5	5.2	33.5-52.5	42.2	4.3	33.4-49.1
Treatment changes (T1-T2)	−1.7	1.9	−5.4-0.7	−1.9	3.0	−8.6- 4.8
Post treatment changes (T2-T3	0.1	0.9	−1.7-1.8	0.1	0.7	−1.6- 1.6

No significant differences between the groups for any variable

Table 17. Vertical dimension symphysis and lower dento-alveolar area: −1-Menton (mm)

	Surgery		
	N=28		
	Mean	S.D.	Range
Presurgical change	−1.4	2.1	−5.9-2.8
Postsurgical change	0.2	2.2	−4.0-5.1
Treatment changes	−1.2	2.8	−8.6-4.8
Post treatment changes	0.1	0.7	−1.6-1.6

Table 16 and 17 show the development of the distance between the incisal ridge of the lower anteriors and menton in the groups studied. No significant differences were found between the mean pretreatment, post-treatment and long term values neither between the average changes during treatment and post treatment changes. Both groups include individuals with dimensions beyond the normal range.

The range was very similar at all 3 time points. The range for the changes during treatment was much larger for the surgery group.

Throughout time mean changes in both groups were very small.

During treatment an almost equal reduction was found in both groups.

During treatment changes in the surgery group varied between a reduction of 8.6mm to an increase of 4.8mm. but even in the non surgical group there was a range between 5.4mm. decrease and 0.7mm. increase. Post treatment both groups showed changes between 1.6mm decrease to 1.6mm increase.

Table 17 shows the surgery subgroup with measurements just before surgery. On average most intrusion takes place before surgery, the range however shows that as well as before as after surgery several mm. of extrusion or intrusion were possible.

Table 18 shows that the frequencies of changes during and after treatment were comparable for both groups. In the surgery group in the majority 25(58%) of the lower anteriors were intruded, 5 (12%) were extruded and 13 (30%) remained stable. In the non surgery group this was the case in respectively 11(52%), 0, and 10 (48%).

The average amount of change was comparable but the frequency of changes was larger in the surgery group.

After treatment 36 (84%) of the lower anteriors in the surgery group and 18 (86%) in the non surgery group remained stable. After treatment in both groups a small percentage showed increase or decrease of this variable, leading to relapse or ongoing movement.

Table 19 shows that in the subgroup with records before surgery many combinations of pre- and post surgical movements were possible, however in most cases (14)(50%) pre surgical intrusion was observed,

36% remained stable and 14 % showed extrusion.

After surgery no more movement was necessary in 12 (43%) of the cases, post-surgically mostly extrusion was performed (10 cases –36%). In this subgroup 22 cases (78%) showed long term stability .Comparing pre- and post surgical movements 14% didn't show any change pre and post surgically (00), 11% showed ongoing movement (++ or ––) and 25% showed reverse movements (+– or –+) the remaining cases (50%) showing only movement in the first or second faze

Table 18. Frequency (%) of dental changes during treatment and post treatment changes. No change means changes between +1mm and -1 mm or between -1° and +1°

	Increase during treatment	No changes during treatment	Decrease during treatment	Increase post treatment	No changes post treatment	Decrease post treatment	Relapse	Ongoing movement
–1/menton surg.	12	30	58	12	84	5	10	5
–1/menton non surg.	0	48	52	9	86	5	5	5
+1 to Sp P1 surg.	30	53	17	16	65	19	7	14
+1 to Sp P1 non surg.	14	24	62	24	76	0	24	0
–1 to NB (mm) surg.	56	32	12	0	79	20	21	0
–1 to NB (mm) non surg.	24	57	19	0	67	33	5	0
–1 to NB (°) surg.	89	2	9	23	28	49	53	16
–1 to NB (°) non surg.	57	28	14	14	33	52	38	9
+1 to NA (mm) surg.	9	19	72	17	72	12	7	28
+1 to NA (mm) non surg.	5	19	76	24	62	14	14	14
+1 to NA (°) non surg.	16	12	72	37	28	35	49	12
+1 to NA (°) non surg.	67	0	33	24	14	62	57	24

Table 19. Frequency of positive and negative dental changes before surgery and between surgery and the end of active treatment also included are frequencies of post treatment changes (N=28 subgroup BSSO). No change (0) means changes between +1mm and -1 mm or between -1° and +1°

Pre- and post-surg.change	−1 to Menton	+1 toSP P1	−1 to NB (mm)	−1 to NB (°)	+1 to NA (mm)	+1 to NA (°)
−−	2	0	0	3	2	5
−0	7	5	5	1	12	4
−+	5	3	5	7	4	8
0−	2	0	0	0	0	0
0 0	4	3	3	1	4	0
0+	4	1	2	1	2	0
+−	2	7	5	6	3	4
+0	1	6	5	2	0	2
++	1	3	3	7	1	5
No changes surg- end tr.	12	14	13	4	16	6
No post tr. change	22	23	19	2	15	10
Post tr. increase	2	04	1	12	5	5
Post tr. decrease	4	1	8	14	7	13

+1 TO SPINA PLANE

Table 20. Vertical dimension anterior maxilla and upper dento-alveolar area: +1-Spina Plane (mm)

	Orthodontics only N=21			Surgery N=43		
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	31.8	2.7	26.2-35.4	29.9	3.2	22.5-35.7
End of active treatment (T2)	30.4	2.3	26.3-34.5	30.3	3.5	21.9-36.6
Long term (T3)	31.1	2.6	26.4-35.5	30.2	3.5	22.2-36.8
Treatment changes (T1-T2)	−1.4	2.0	−4.5-3.2	0.4	1.6	−2.6- 6.6
Post treatment changes (T2-T3	0.7	0.9	−0.6-2.5	−0.1*	0.9	−2.5- 1.7

* significant differences between the groups $p < 0.001$

Table 20 and 21 show the development of the distance between the incisal ridge of the upper central anteriors and spina plane in the groups studied. No significant differences were found between the average pretreatment, post-treatment and long term values neither between the average changes during treatment. Throughout time mean changes in both groups were very small.

Table 21. Vertical dimension anterior maxilla and upper dento-alveolar area: +1-Spina Plane (mm)

	Surgery N=28		
	Mean	*S.D.*	*Range*
Presurgical change	0.5	1.7	−3.4-3.3
Postsurgical change	−0.2	1.5	−4.0-2.9
Treatment change	0.3	1.5	−2.5-3.6
Post treatment changes	0.8	−1.2	−2.1-2.1

According to statistics the post treatment eruption of upper anteriors in the non surgery group of 0.7 mm was significantly larger than the minimal change of –0.1 mm in the surgery group.

The range was very similar at all 3 time points. The range for the changes during and after treatment was very similar in both groups.

During treatment in the surgery group changes varied between a reduction of 2.6mm to an increase of 6.6mm. but even in the non surgical group there was a range between 4.5mm decrease and 3.2 mm. increase.

No significant difference between the groups at all time points. Both groups include individuals with dimensions beyond the normal range. During treatment somewhat more (but not significant) intrusion was found in the non surgery group. Throughout time changes in both groups were small

Table 21 shows the numbers for the surgery subgroup with measurements just before surgery.

Very small changes pre- and post surgery with a large range in both fazes.

On average some extrusion takes place before surgery, the range however shows that as well as before as after surgery several mm. of extrusion or intrusion were possible.

Table 18 shows that the frequencies of changes during and after treatment were comparable for both groups. In the surgery group in the majority 23(53%) of the upper anteriors remained stable, 13(30%) were extruded and 7 (17%) were intruded. In the non surgery group this was the case in respectively 5(24%), 3 (14%), and 13 (62%).The frequency of changes was larger in the non surgery group.

After treatment 28 (65%) of the upper anteriors in the surgery group and 16 (76%) in the non surgery group remained stable.

After treatment in the surgery group 7 (16%) cases showed eruption and 8 (19%) showed "intrusion" In the non surgery group this was respectively 5(24%) and 0. Real relapse was found in 3(7%)of the surgery cases and in 5 (24%) of the non surgery cases. In the surgery group 6 (14%) showed ongoing movement (3 with intrusion and 3 with extrusion), moreover 4 cases without changes during treat-

ment showed intrusion (2) and eruption (2) after treatment. In the non surgery group no such movements were observed.
Table 19 shows that in the subgroup with records before surgery many combinations of pre- and postsurgical movements were possible, however in most cases(16 –57%) presurgical increase in distance was observed.
35 % showed presurgical intrusion 14% remained stable and 36 % showed extrusion. Post surgically 50% remained stable and in 7 (25%) cases the distance was increased and in 7 (25%) cases it was decreased. In this subgroup 23 cases (82%) showed long term stability.
Comparing pre- and post surgical movements 11% didn't show any change pre and post surgically (00), 11% showed ongoing movement (++ or −−) and 11% showed reverse movements (+− or −+) the remaining cases (67%) showing only movement in the first or second phase.

-1 TO NB (MM)

Table 22. Sagittal position of lower anteriors within the lower facial area: -1-NB (mm)

	Orthodontics only			*Surgery*		
		N=21			*N=43*	
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	5.8	2.2	−0.2-10.5	5.5	2.8	−0.5-11.4
End of active treatment (T2)	6.1	1.5	3.6- 9.1	6.8	2.9	3.2-14.2
Long term (T3)	5.7	1.6	2.9- 8.0	6.4	2.7	1.6-12.7
Treatment changes (T1-T2)	0.3	1.6	−1.7- 3.8	1.3	2.0	−3.2- 5.8
Post treatment changes (T2-T3	−0.4	0.8	−2.2- 0.8	−0.4	0.8	−2.7- 0.9

No significant differences between the groups for any variable

Table 23. Sagittal position of lower anteriors within the lower facial area: -1-NB (mm)

	Surgery		
		N=28	
	Mean	*S.D.*	*Range*
Presurgical change	−0.1	2.7	−5.4-4.0
Postsurgical change	0.8	1.8	−2.6-5.5
Treatment change (T1-T2)	0.7	3.0	−4.5-8.0
Post treatment changes (T2-T3)	−0.8	3.0	−12.0-1.2

Table 22 and 23 show the development of the distance between the most prominent labial surface of the lower anteriors and supramentale (B) perpendicular to the line NB in the groups studied. No significant differences were found between the average pretreatment, post-treatment and long term values neither between the average changes during and after treatment.
The range was very similar at all 3 time points. The range for the changes during and after treatment was very similar in both groups.
Both groups include individuals with dimensions beyond the normal range.
Throughout time mean changes in both groups were very small.
During treatment in the surgery group changes varied between a reduction of 3.2 mm to an increase of 5.8mm in the non surgical group there was a range between 1.7 mm decrease and 3.8 mm. increase. During treatment there was a small mean protrusion. After treatment there was a mean small relapse of 0.4mm in both groups with a range between 2.7 mm proposition and 0.9 mm retroposition.
Table 23 shows the numbers of the surgery subgroup with measurements just before surgery. On average pre and post surgery changes were very small, the range however shows that as well as before as after surgery several mm. of propostion or retroposition were possible.
Table 18 shows the frequencies of changes during and after treatment
In the surgery group in the majority 24 (56%) the lower anteriors were moved forward during treatment, in 5 (12%) they moved backward and in 14 (32%) they remained stable. In the non surgery group this was the case in respectively 5 (24%), 12 (57%), and 4 (19%).
After treatment 34 (79%) of the lower anteriors in the surgery group and 14 (67%) in the non surgery group remained stable.
After treatment in the surgery group 9 (20%) cases showed reduction in the distance between lower anteriors and NB In the non surgery group this was 7 (33%).
In both groups no post treatment increase of the distance was observed neither ongoing movement was found.
Real relapse was found in 9 (21%) of the surgery cases and in 1 (5%) of the non surgery cases. In the non surgery group 4 cases without movement during treatment showed spontaneous post treatment retrusion of the lower anteriors.
Table 19 shows that in the subgroup with records before surgery many combinations of pre- and postsurgical movements were possible, however in 13 (46%) presurgical proposition was induced and in 10 (36%)cases presurgical retroposition was achieved, 18% remained stable.
11% didn't show any significant pre or post surgical movement.
After surgery no more movement was necessary in 13 (36%) of the cases, postsurgically in 10 (36%) cases the lower anteriors were moved anteriorly and in 5 (18%) posteriorly. In this subgroup 19 cases (68%) showed long term stability.
Comparing pre- and post surgical movements 11% didn't show any change pre and post surgically (00), 11% showed ongoing movement (++ or ––) and 28% showed reverse movements (+– or –+) the remaining cases (60%) showing only movement in the first or second phase.

Table 24. Sagittal angulation of lower anteriors within the lower facial area: -1-NB (°)

	Orthodontics only N=21			Surgery N=43		
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	24.5	7.5	5.7-35.1	22.8	7.4	5.0-35.6
End of active treatment (T2)	28.9	5.6	17.4-40.9	29.5	7.0	17.6-49.1
Long term (T3)	27.2	6.4	16.1-40.0	28.3	6.6	15.3-46.1
Treatment changes (T1-T2)	4.4	7.2	−6.7-25.4	6.7	6.5	−7.2-20.2
Post treatment changes (T2-T3	−1.7	3.2	−9.4- 2.8	−1.2	3.7	−12.0-5.8

No significant differences between the groups for any variable

Table 25. Sagittal angulation of lower anteriors within the lower facial area: -1-NB (°)

	Surgery N=281		
	Mean	*S.D.*	*Range*
Presurgical change	1.3	8.1	−16.0-15.5
Postsurgical change	1.8	7.5	−10.2-19.8
Treatment change	3.1	9.9	−24.2-20.2
Post treatment changes 2.8	−0.7	3.6	−10.8-6.0

Table 24 and 25 show the development of the angle between the central lower anteriors and the line NB in the groups studied. No significant differences were found between the average pretreatment, post-treatment and long term values neither between the average changes during and after treatment.
Both groups include individuals with dimensions beyond the normal range.
The range was very similar at all 3 time points. The range for the changes during and after treatment was very similar in both groups.
During treatment in the surgery group changes varied between a reduction of 7.2° to an increase of 20.2° in the non surgical group there was a range between 6.7 ° decrease and 25.4° increase. During treatment there was a small mean proclination. Treatment changes in both groups showed a very large range
After treatment there was a mean small relapse of 1.2° in the surgery group and of 1.7° in the non surgery group.
Table 25 shows the numbers of the surgery subgroup with measurements just before surgery. On average pre and post surgery changes were small, the range how-

ever shows that as well as before as after surgery 10 to 20 degrees of proclination or retroclination were possible.
Table 18 shows the frequencies of changes during and after treatment.
In the surgery group in the majority 38 (89%) the lower anteriors were proclined during treatment, in 4 (9%)were retroclined and in 1 (2%) cases remained stable. In the non surgery group this was the case in respectively 12 (57%), 3 (14%), and 6 (28%).
After treatment 12 (28%) of the lower anteriors in the surgery group and 7 (33%) in the non surgery group remained stable.
After treatment in the surgery group 21 (49%) cases showed retroclination. In the non surgery group this was 11 (52%) .
In the surgery group 10 (23%) cases showed post treatment proclination of lower anteriors in the non surgery group this was 3 (14%).
Relapse was found in 23 (53%) of the surgery cases and in 8 (38%) of the non surgery cases. Moreover 7 (16%) of the surgery cases and 2 (9%) of the non surgery cases showed post treatment ongoing proclination
The average amount of post treatment change was comparable but the frequency of changes was larger in the non surgery group. Retroclination occurred very frequently in both groups.
Table 19 shows that in the subgroup with records before surgery many combinations of pre- and postsurgical movements were possible, however in 15 (54%) presurgical proclination was induced and in 11 (39%)cases presurgical retroclination was achieved 7% remained stable.
Very small changes pre- and post surgery with a large range in both phases.
After surgery no more movement was necessary in 4 (14%) of the cases, postsurgically in 15 (54%) of the cases the lower anteriors were proclined and in 9 (32%) retroclined. In this subgroup 2 cases (7%) showed long term stability.
Comparing pre- and post surgical movements 4% didn't show any change pre and post surgically (oo), 36% showed ongoing movement (++ or ––) and 46% showed reverse movements (+– or –+) the remaining cases showing only movement in the first or second phase.
Table 26 shows the frequency of positions of lower central anteriors within the limits of normal to ideal (2-6mm and 20 to 30 degrees to NB).
Before treatment frequency of normal positions was lower in the surgery group (26% versus 38% in the non surgery group) at the end of active treatment some improvement to 33% was achieved in the surgery group, in the non surgery group there was a deterioration towards 29%. Post retention the surgery group showed an improvement to 40% normal to ideal positions which was better than before and after treatment. The non surgery group showed 33% normal to ideal post retention cases, somewhat below the frequency before treatment.

Table 26. Frequency (%) of cases with upper and lower central anteriors positioned at the same time within the normal to ideal limits between 2mm and 6 mm and between 20° and 30° to respectively NA and NB.

	T1	T2	T3
+1/NA mm and° surgery	7	26	19
+1/NA mm and° non surgery	5	38	33
−1/NB mm and° surgery	26	33	40
−1/NB mm and° nonsurgery	38	29	33

+1 TO NA (MM)

Table 27 Sagittal position of upper anteriors within the mid facial area: +1-NA (mm)

	Orthodontics only			*Surgery*		
		N=21			*N=43*	
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	7.3	3.5	3.1-18.0	6.5	3.1	−1.7-12.7
End of active treatment (T2)	5.0	3.3	−0.6-16.9	4.6	2.3	0.7- 9.7
Long term (T3)	5.2	2.9	0.4-15.8	4.6	2.5	−0.2-10.8
Treatment changes (T1-T2)	−2.3	2.2	−6.7-1.6	−1.9	2.8	−6.5-10.3
Post treatment changes (T2-T3	−0.8	1.0	−1.2- 1.9	−0.1	1.5	−5.3- 4.1

No significant differences between the groups for any variable

Table 28. Sagittal position of upper anteriors within the mid facial area: +1–NA (mm)

		Surgery	
		N=28	
	Mean	*S.D.*	*Range*
Presurgical change	−1.4	3.1	−7.0- 7.0
Postsurgical change	−0.1	1.8	−5.2- 3.3
Treatment change	−1.5	3.2	−7.4-10.3
Post treatment changes	−0.3	1.4	−5.3-1.8

Table 27 and 28 show the development of the distance between the most prominent labial surface of the upper central anteriors and subspinale (A) perpendicular to the line NA in the groups studied. No significant differences were found between the average pretreatment, post-treatment and long term values neither between the average changes during and after treatment.

The range was very similar at all 3 time points. The range for the changes during and after treatment was larger for the surgery group.
During treatment in the surgery group changes varied between a reduction of 6.5 mm to an increase of 10.3 mm in the non surgical group there was a range between 6.7 mm decrease and 1.6 mm. increase. During treatment there was a small mean backward movement in both groups. After treatment mean changes in both groups were minimal. The range however shows that in surgery group post-treatment forward movement of 4.1mm to backward movement of 5.3mm was possible in the non surgery group this range was between 1.2 mm backward movement and 1.9 mm forward movement.
Table 28 shows the numbers of the surgery subgroup with measurements just before surgery. On average pre and post surgery changes were very small, the range however shows that as well as before as after surgery several mm. of forward and backward movement were possible.
Table 18 shows the frequencies of changes during and after treatment
In the surgery group in the majority 31 (72%) the upper anteriors were moved backward during treatment in 4 (9%) were moved forward and in 8 (19%) cases they remained stable. In the non surgery group this was found in respectively 16 (76%), 1 (5%), and 4 (19%).
After treatment 31 (72%) of the upper anteriors in the surgery group and 13 (62%) in the non surgery group remained stable.
After treatment in the surgery group 5 (12%) cases showed backward movement and 7(17%) cases showed forward movement. In the non surgery group this was 3 (14%) and 5 (24%).
Real relapse was found in 3 (7%) of the surgery cases and in 3 (14%) of the non surgery cases. Post treatment ongoing backward movement was observed in 5 (24%) of the surgery group and 3 (14%) of the non surgery group
Table 19 shows that in the subgroup with records before surgery many combinations of pre- and postsurgical movements were possible, however in
18 (64%) presurgical backward movement was induced and in 4 (14%)cases presurgical forward movement was achieved, (9) 21% remained stable.
After surgery no more movement was necessary in 16 (57%) of the cases, postsurgically in 7 (25%) cases the upper anteriors moved forward and in 5 (18%) moved backward. In this subgroup 15 cases (53%) showed long term stability. Comparing pre- and post surgical movements 14% didn't show any change pre and post surgically (oo), 11% showed ongoing movement (++ or ––) and 25% showed reverse movements (+– or –+) the remaining cases (50%) showing only movement in the first or second phase.

Table 29. Sagittal inclination of upper anteriors within the mid facial area: +1-NA (°)

	Orthodontics only			Surgery		
	N=21			N=43		
	Mean	S.D.	Range	Mean	S.D.	Range
Initial (T1)	23.5	12.2	−2.3-50.2	26.6	10.3	−2.4-42.9
End of active treatment (T2)	23.0	11.7	−2.4-52.9	20.8	8.9	1.7-37.2
Long term (T3)	21.5	9.9	0.2-46.2	20.7	8.7	5.7-40.8
Treatment changes (T1-T2)	−0.5	12.0	−25.0-22.8	−5.8	10.6	−20.1-36.8
Post treatment changes (T2-T3	−1.5	4.6	−9.7- 9.6	−0.2	4.2	−16.5- 8.5

No significant differences between the groups for any variable

Table 30. Sagittal inclination of upper anteriors within the midfacial area: +1–NA (°)

	Surgery		
	N=28		
	Mean	S.D.	Range
Presurgical change	−3.9	12.3	−23.4-28.1
Postsurgical change	1.0	4.9	−12.2- 9.2
Treatment change	−2.7	12.0	−20.1-36.8
Post treatment changes	−1.7	4.1	−16.5- 5.9

Table 29 and 30 show the development of the angle between the central upper anteriors and the line NA in the groups studied. No significant differences were found between the average pretreatment, post-treatment and long term values neither between the average changes during and after treatment.
The range was very similar at all 3 time points. The range for the changes during and after treatment was very similar in both groups.
During treatment in the surgery group mean retroclination(5.8 °) was larger than in the non surgery group (0.5°) the difference however was not significant. In the surgery group changes during treatment varied between a retroclination of 20.1° to an proclination of 36.8° in the non surgical group there was a range between 25.0 ° proclination and 22.8° retroclination. After treatment there was a mean small increase of retroclination of 1.5°in the non surgery group, the surgery group on average remained almost stable. The ranges show that post treatment changes of at least 8 degrees proclination or retroclination were possible in both groups.

Table 30 shows the numbers of the surgery subgroup with measurements just before surgery. On average presurgery changes were a retroclination of 3.9 °, post surgery an average procliantion of 1° was found. The range however shows that before surgery proclination of 28°to retroclination of 23°was possible post surgically the range was between 12° retroclination and 9° proclination.
Table 18 shows the frequencies of changes during and after treatment
In the surgery group in the majority 31 (72%) the uppper anteriors were retroclined, 7 (16%)were proclined and 5 (12%) cases remained stable. In the non surgery group this was the case in respectively 7 (33%), 14 (67%), and 0
The average amount of change was somewhat larger in the surgery group but the frequency of changes was larger in the non surgery group. Proclination occurred more frequently in the non surgery group.
After treatment 12 (28%) of the upper anteriors in the surgery group and 3 (14%) in the non surgery group remained stable.
After treatment in the surgery group 15 (35%) cases showed retroclination. In the non surgery group this was 13 (62%) .
In the surgery group 16 (37%) cases showed post treatment proclination of upper anteriors in the non surgery group this was 5 (24%).
Relapse was found in 21 (49%) of the surgery cases and in 12 (57%) of the non surgery cases . Moreover 5 (12%) of the surgery cases and 5 (24%) of the non surgery cases showed post treatment ongoing retroclination.
Table 19 shows that in the subgroup with records before surgery many combinations of pre- and postsurgical movements were possible, however in 11 (39%) presurgical proclination was induced and in 17 (61%)cases presurgical retroclination was achieved, 0% remained stable.
After surgery no more movement was necessary in 6 (21%) of the cases, postsurgically in 13 (46%) cases the upper anteriors were proclined and in 4 (14%) retroclined. In this subgroup 6 (21%) cases showed long term stability.
Comparing pre- and post surgical movements no case showed no change pre and post surgically (00), 35% showed ongoing movement (++ or ––) and 43% showed reverse movements (+– or –+) the remaining cases (22%) showing only movement in the first or second phase.
Table 26 shows the frequency of positions of upper central anteriors within the limits of normal to ideal (2-6mm and 20 to 30 degrees to NA).
Before treatment frequency of normal positions was low in both groups (5-7%) at the end of active treatment improvement to 26% was achieved in the surgery group, in the non surgery group there was an improvement towards 38%. Post retention the surgery group showed a deterioration to 19% normal to ideal positions which was better than before treatment. The non surgery group showed 33% normal to ideal post retention cases somewhat below the frequency at the end of active treatment.

Table 31: Soft tissue profile: T-Angle subnasale-softpogonion/ perpendicular to FFH

	Orthodontics only			Surgery		
		N=21			*N=43*	
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	9.6	5.1	−1.4-20.1	13.5*	6.5	1.2-28.9
End of active treatment (T2)	8.5	5.3	−1.9-21.1	8.7	5.9	−2.7-21.8
Long term (T3)	7.0	5.9	−3.7-20.8	7.9	6.6	3.3-24.0
Treatment changes (T1-T2)	1.0	2.1	−5.2- 3.6	−4.8	4.2	−14.7- 7.0
Post treatment changes (T2-T3	−1.5	2.6	−8.7- 3.4	−0.7	6.7	−16.5-15.7

* significant differences between the groups $p < 0.01$

Table 31 shows the development of the angle between the tangent to subnasale and soft pogonion and the perpendicular tot the frankfurter horizontal plane.
The only significant difference was the larger pretreatment T-angle in the surgery group (13.5°) versus 9.6 ° in the non surgery.
Furthermore no significant differences were found between the average post-treatment and long term values neither between the average changes during and after treatment
The range for the changes during and after treatment was larger for the surgery group.
During treatment in the surgery group changes varied between a reduction of 14.7 °to an increase of 7.0 °in the surgical group, in the non surgical group there was a range between 5.2° decrease and 3.6 °increase. During treatment average change was a mean decrease of 4.8° in the surgery group and 1.0° increase in the non surgery group. After treatment there was still a small decrease in both groups. The range in the surgery group was very large, between a decrease of 16.5° and an increase of 15.7°

Table 32. Soft tissue profile: Mento-labial sulcus depth (mm) perpendicular to tangent lower lip –soft pogonion

	Orthodontics only			*Surgery*		
		N=21			*N=43*	
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	6.4	1.3	4.0-9.5	7.0	1.7	3.3-13.4
End of active treatment (T2)	5.8	1.5	1.4-9.2	5.8	1.3	2.7- 9.7
Long term (T3)	5.7	1.3	3.1-8.2	5.7	1.8	2.6-11.4
Treatment changes (T1-T2)	−0.6	1.3	−4.0-2.1	−1.3	1.5	−4.2- 2.0
Post treatment changes (T2-T3	−0.1	1.0	−1.7-2.3	−0.1	2.1	−5.1- 4.4

No significant differences between the groups for any variable

Table 32 shows the development of the mento-labial sulcus depth measured perpendicular to the tangent lower lip – soft pogonion.
No significant differences were found between the average pretreatment, post-treatment and long term values neither between the average changes during and after treatment.
The range for the changes after treatment was larger for the surgery group.
During treatment in the surgery group changes varied between a reduction of 4.2 mm to an increase of 2.0 mm in the surgical group, in the non surgical group there was a range between 4mm. decrease and 2.1mm. increase. During treatment average change was a mean small decrease of 1.3mm in the surgery group and 0.6mm in the non surgery group. After treatment both groups on average remained almost stable.The range in the surgery group was larger, between a decrease of 5.1mm and a increase of 4.4mm.

Table 33. Soft tissue profile: Upper to lower lip difference perpendicular to sub-nasale-softpogonion (mm)

	Orthodontics only			Surgery		
	N=21			N=43		
	Mean	S.D.	Range	Mean	S.D.	Range
Initial (T1)	1.0	1.9	−1.5-5.6	2.0	2.5	−3.2-6.9
End of active treatment (T2)	0.7	1.5	−1.6-4.0	0.7	1.6	−2.5-4.4
Long term (T3)	0.7	1.5	−1.8-4.5	0.9	1.6	−2.4-6.2
Treatment changes (T1-T2)	−0.3	1.2	−2.7-2.0	−1.3	2.1	−6.0-5.7
Post treatment changes (T2-T3	0.0	1.0	−2.6-2.0	−0.1	2.2	−4.8-6.5

No significant differences between the groups for any variable

Table 33 shows the development of the upper to lower lip difference measured perpendicular to the tangent subnasale – soft pogonion.
No significant differences were found between the average pretreatment, post-treatment and long term values neither between the average changes during and after treatment.
The range for the changes during and after treatment was larger for the surgery group.
During treatment in the surgery group changes varied between a reduction of 6.0 mm to an increase of 5.7 mm in the surgical group, in the non surgical group there was a range between 2.7m. decrease and 2.0mm. increase. During treatment average change was a mean small decrease of 1.3mm in the surgery group and 0.3mm in the non surgery group. After treatment both groups on average remained almost stable.The range in the surgery group was larger, between a decrease of 4.8mm and an increase of 6.5mm.

Table 34. Soft tissue profile: Nasolabial angle

	Orthodontics only			*Surgery*		
	N=21			*N=43*		
	Mean	*S.D.*	*Range*	*Mean*	*S.D.*	*Range*
Initial (T1)	111.3	9.3	86.4-124.6	105.7	30.8	87.4-130.5
End of active treatment (T2)	112.9	11.4	85.8-140.8	113.1	10.2	89.1-135.3
Long term (T3)	112.1	11.6	83.0-133.4	112.5	10.9	86.0-137.3
Treatment changes (T1-T2)	1.6	8.8	−15.5-21.5	7.5	9.9	−12.0- 21.5–
Post treatment changes (T2-T3	−0.8	8.1	−30.5-15.5	−0.6	12.7	−28.9- 36.0

No significant differences between the groups for any variable

Table 34 shows the development of the nasolabial angle. No significant differences were found between the average post-treatment and long term values neither between the average changes during and after treatment.
The range for the changes during and after treatment was very similar for both groups.
During treatment in the surgery group changes varied between a reduction of 12.0 °to an increase of 21.5 °in the surgical group, in the non surgical group there was a range between 15.5° decrease and 21.5 °increase. During treatment average change was a mean increase of 7.5° in the surgery group and 1.6° increase in the non surgery group. After treatment there was still a small decrease in both groups. The range in the surgery group was very large , between a decrease of 28.9° and an increase of 36.0°, but also in the non surgery group large post treatment changes were possible : between a decrease of 30.5° and an increase of 15.5°.

Table 35: Significant correlations (p < 0.001) between post treatment changes

		Orthodontics only N=21 Correlation	Surgery N=28 Correlation
Overjet	WITS	–	0.411
	–1 to NB (mm)	–0.570	–
	–1 to NB (°)	–0.627	–0.536
Overbite	+1 to SP P1 (mm)	0.547	–
	ANS-Menton	–	–0.600
ANB Angle	+1 to NA (mm)	–0.758	–0.849
	+1 to NA (°)	–0.557	–0.432
WITS	+1 to NA (mm)	–	–0.344
	–1 to Menton perp FFH	–0.586	0.395
ANS-Menton	Sp P1 / Mand P1 (°)	–	0.441
	–1 to Menton	–	0.366
	+1 to SP P1 (mm)	–	0.366

Table 35 shows the correlations between post treatment changes of the most relevant dental and skeletal variables.
Overjet changes in the non surgery group were strongly correlated to changes in sagittal position of the lower central anteriors. Post treatment increase in overjet in the non surgery group is related to retroclination and posterior movement of lower anteriors. In the surgery group overjet changes are correlated to changes in Wits and inclination of lower anteriors. Post treatment increase in overjet in the surgery group is related to increase in Wits and retroclination of lower anteriors.

Fig 4 shows the development of a Class II 1 patient that had combined orthodontic-surgical treatment with a BSSO, before treatment at the end of active treatment and 20 years later at 30 years (6 years out of retention).

Figure 4A shows that the soft tissue profile improved during treatment, little post treatment change taking place.

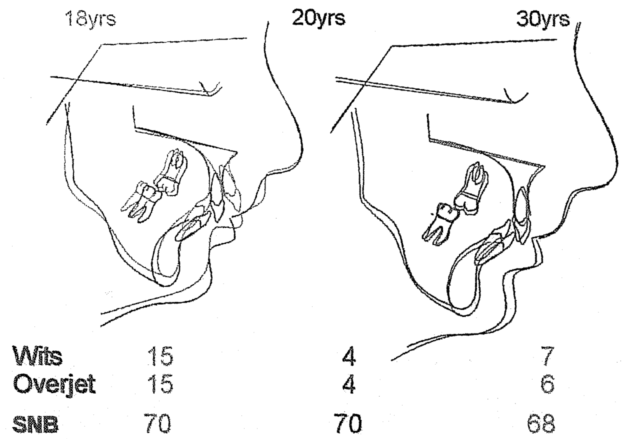


Fig 4 B shows superimposed tracings depicting a considerable reduction of overjet and Wits value during treatment. There is also a post treatment increase of wits value and overjet confirming the findings of correlation and regression analyses. An interesting observation is that despite extensive surgery the sagittal position of the anterior part of the mandible treatment is constant, the angle ANB hardly changing.

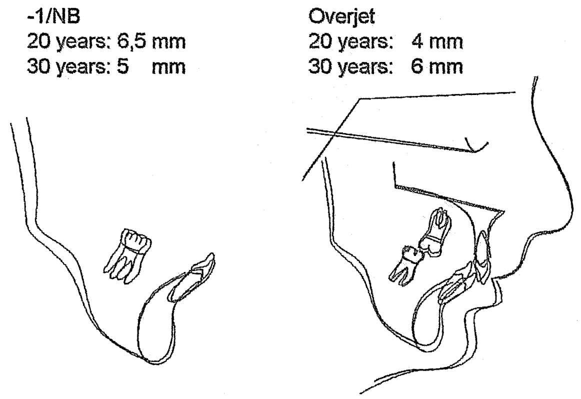


Fig 4C shows a superimposition of the same patient illustrating the relation between position changes of lower anteriors and overjet changes. Post treatment overjet increase occurs concomitantly with dorsal movement of lower anteriors as was also shown in the correlation analysis.

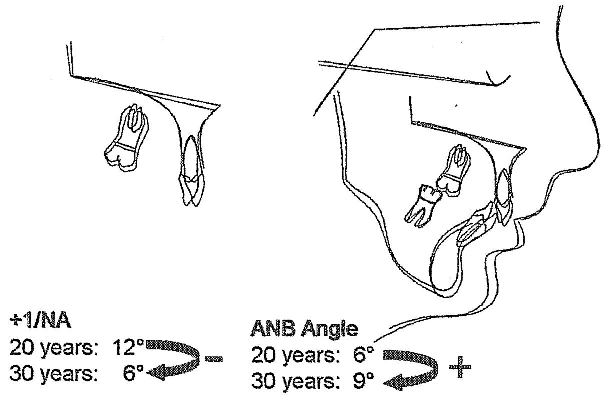


Fig 4 D shows another superimposition of the patient in fig 4A. After treatment the mandible moved somewhat backward (see angle SNB fig. 4B) increasing the angle ANB at the same time the upper anteriors tilted backward 6 degrees compensating for the increasing sagittal discrepancy between maxilla and mandible as was shown in the correlation analysis.

Figure 5 A, B and C show the development of a Class II 1 patient that had combined orthodontic-surgical treatment with a BSSO LeFort I osteotomy and chin augmentation, before treatment at the end of active treatment and 10 years later at 48 years (still with bonded retainers).

Figure 5A shows that the soft tissue profile improved during treatment, little post treatment change taking place.

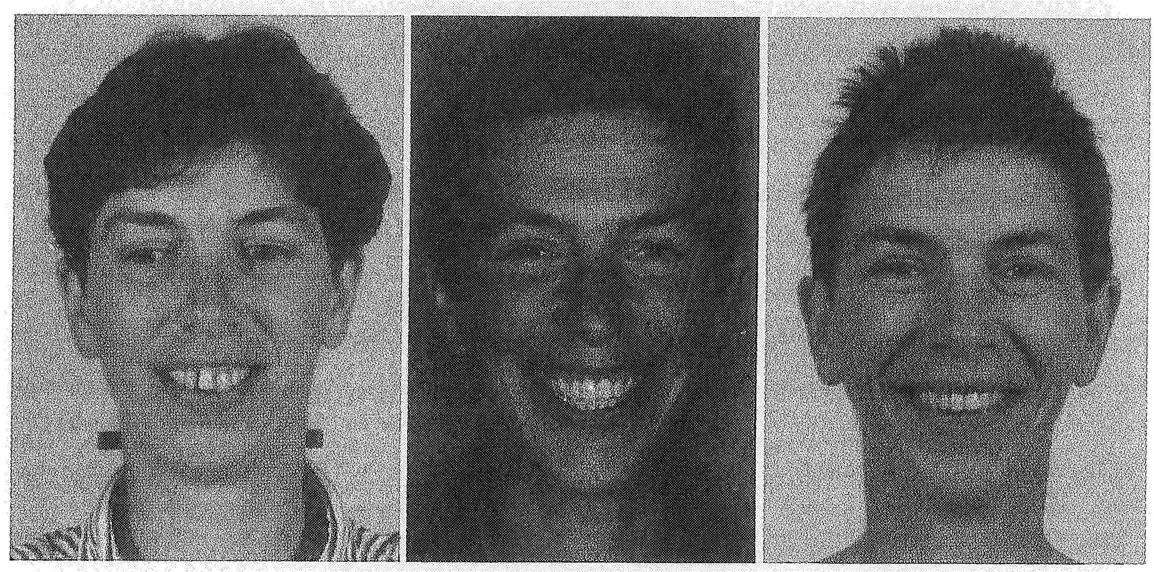


Fig 5B, the frontal view, shows mainly improvement of the smile.

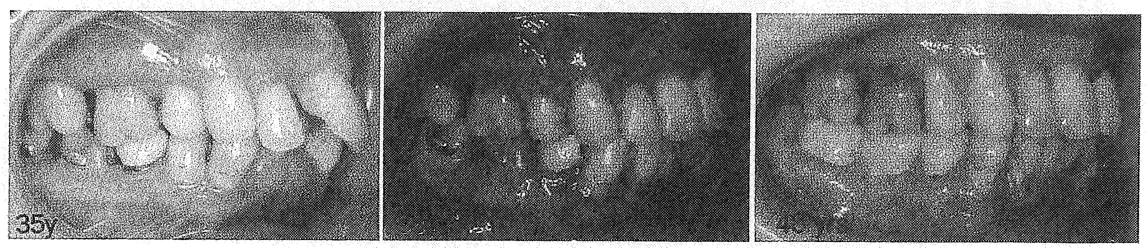


Figure 5C – The right side intra-oral view shows that originally there was a Class II occlusion of 3/4 bicuspid with and an overjet of 12 mm, moreover the 14 and 24 were missing. Treatment also included removal of the 34 and 44. At the end of active treatment almost a Class I occlusion was achieved with a normal overbite and overjet.
Long after treatment at 48 years there appears a relapse of the overjet (3 to 5 mm) and overbite (2 to 4 mm) and there was a Class II of 1/2 bicuspid width.

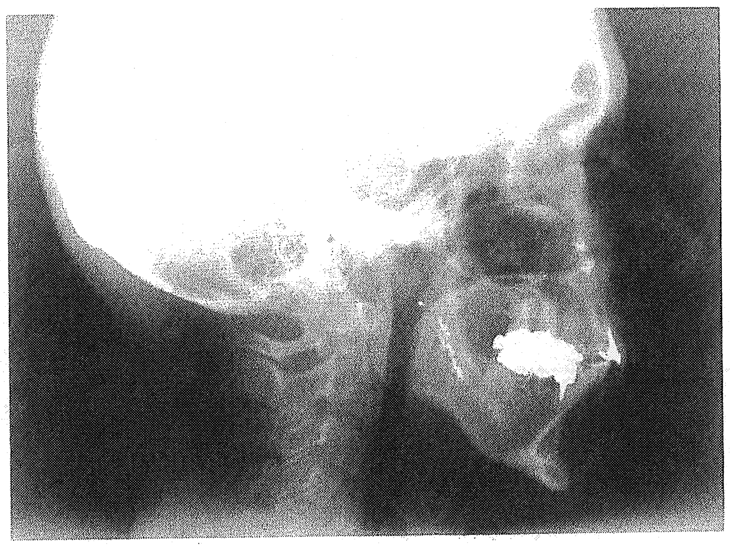


Fig 5 D A cephalomgram at 48 years showing the rigid fixation in both jaws together with the chin addition.

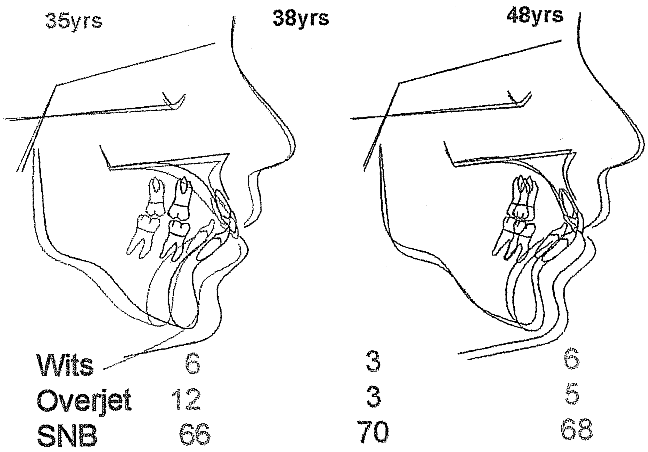


Fig 5 E shows superimpositions of the same patient. The patient had significant forward reposition of the mandible during surgery. However some post treatment relapse was observed as shown by the post treatment decrease of angle SNB and increase of Wits value, the overjet increase accordingly as was also shown in regression and correlation analyses.

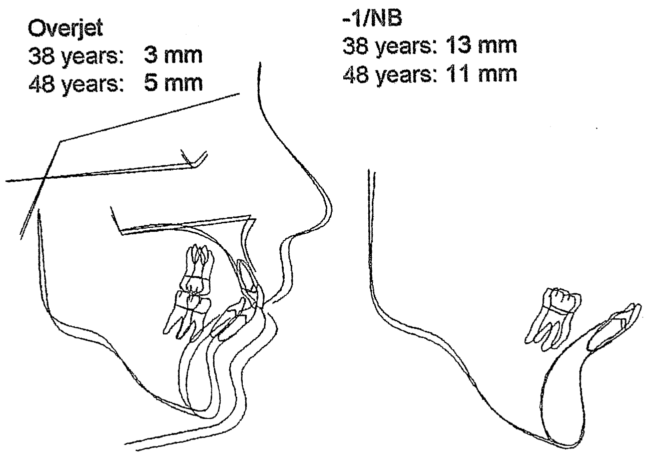


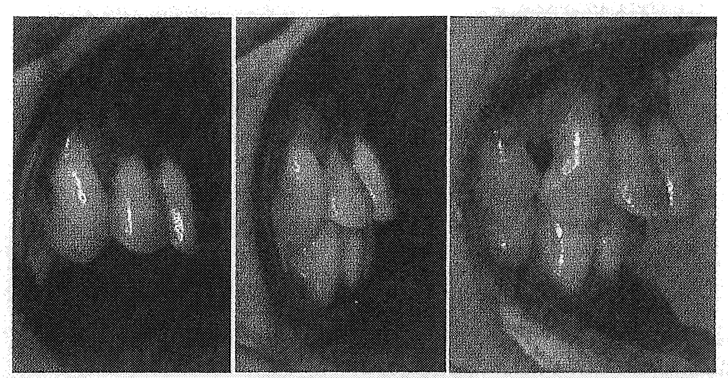
Fig 5 F Superimpositions of the same patient as in figures 5A and 5B show that post treatment overjet increase was related to simultaneous dorsal movement of lower anteriors as was also shown by regression and correlation analyses.

Overbite changes in the non surgery group were strongly correlated to changes in vertical position of upper central anteriors within the maxilla. Post treatment increase in overbite in the non surgery group is related to eruption of upper anteriors. In the surgery group overbite changes are correlated to changes in lower face height and no dental variables seem to be involved. Post treatment increase in overbite in the surgery group is related to decrease in lower face height.

Fig 6 A, B and C show the development of a Class II 1 patient that had combined orthodontic-surgical treatment with a BSSO, before treatment at the end of active treatment and 8 years later at 41 years (3 years out of retention).

Figure 6A shows that the soft tissue profile improved during treatment, post treatment change involved deepening of the mentolabial sulcus and decrease nasolabial angle.

Fig 6B, the frontal view, shows mainly advancement of the mandible in the lower face.



	30yrs	33yrs	41 yrs
overjet	11	3	6
overbite	9	2	4.5

Fig 6C shows the development of overbite and overjet and of the protrusion of the upper anteriors. The overjet changed from 11 to 3 mm during treatment and the overbite from 9 to 2mm. After treatment overjet and overbite showed relapse of respectively 3 and 2.5mm. moreover a post treatment decrease of proclination of upper anteriors can be observed.

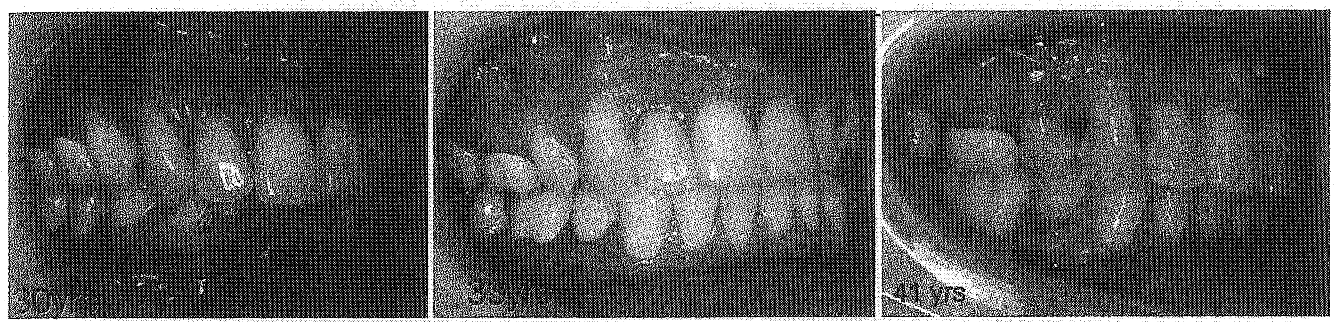


Fig. 6D The right side intra-oral view shows that before treatment 14 and 24 were already missing treatment also included removal of the 45 and 35. Pretreatment a Class II occlusion of 3/4 bicuspid width was present together with a reversed curve in the upper arch. At the end of treatment at 33 years a class I occlusion with normal overbite and overjet was achieved. Post treatment at 41 years there appears a relapse of the reversed curve in the upper arch and the occlusion was a Class II of 1/2 bicuspid width.

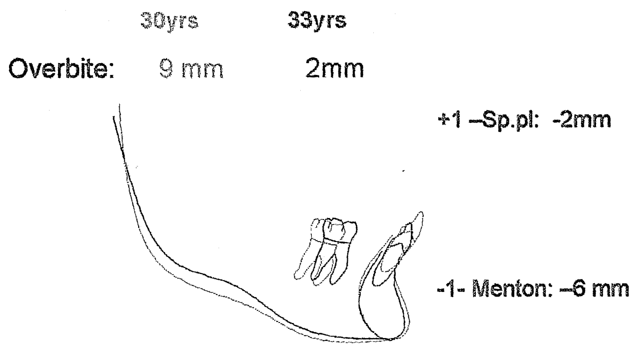


Fig 6E Shows superimpositions of the same patient depicting a comparatively large amount of intrusion of upper and lower anteriors during active treatment. The overbite was more corrected by dental movement than by skeletal changes.

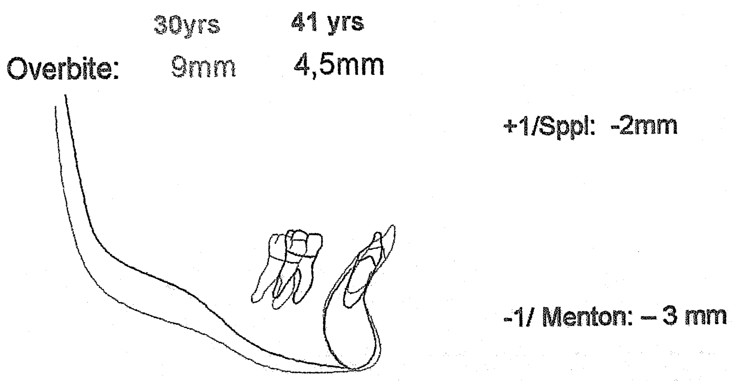
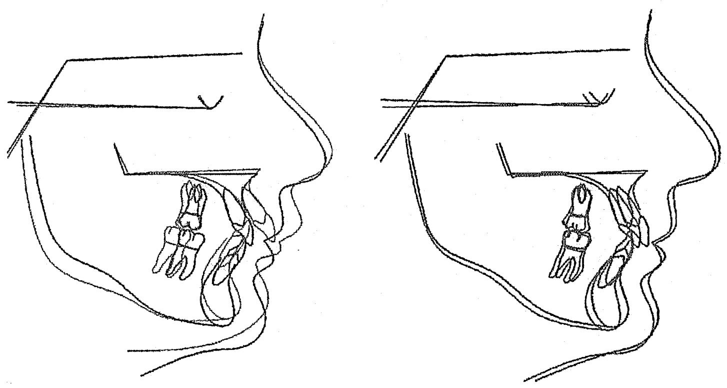


Fig 6 F Shows superimpositions of the same patient depicting overall changes during and after treatment comparing this superimposition with the one in figure 6E reveals that the intrusion of the upper anteriors is maintained and that lower anteriors show a relapse of 50% erupting 3 mm after treatment. This corresponds with the regression analysis that showed that overbite relapse in the surgery group is associated mostly with eruption of lower anteriors.



Age	30yrs	33yrs	41yrs
Overbite	9mm	2mm	4,5mm
-1/Menton	41mm	35mm	38mm
-1/NB°	31°	32°	21°
ANS Ment.	67mm	70mm	69 mm

Fig 6G shows overall superimpositions of changes during and after treatment of the patient of figure 6A., 8 years after treatment the intrusion of upper anteriors was still stable but the intruded lower anteriors had erupted 3mm. In this patient the lower face height remained almost stable after treatment. Overbite relapse was related to uprighting and eruption of lower anteriors.

Fig 7 A , B and C show the development of a Class II 1 patient that had combined orthodontic-surgical treatment with a BSSO, before treatment at the end of active treatment and 15 years later at 55 years (5 years out of retention).

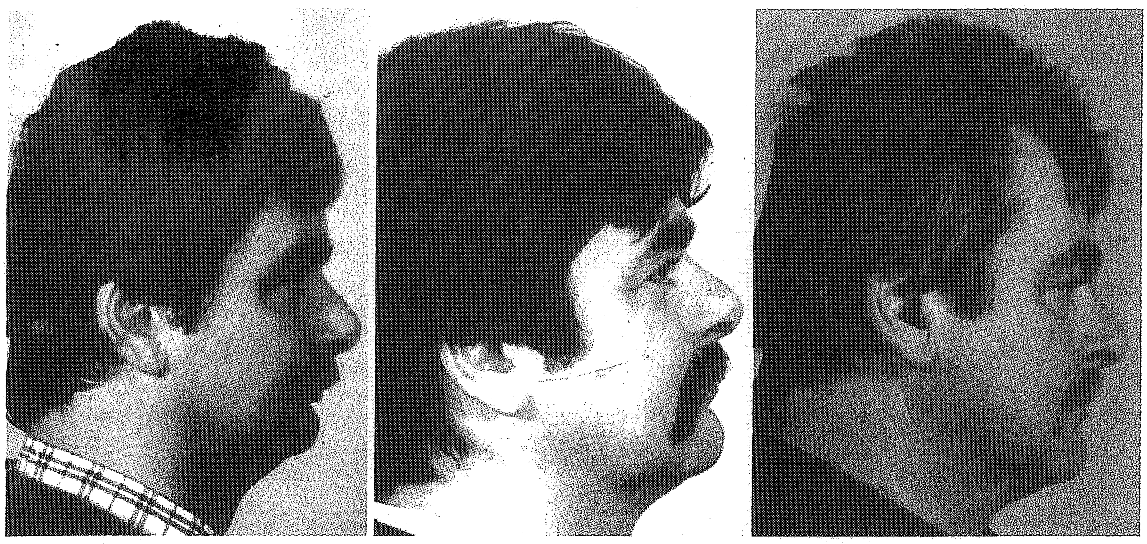


Figure 7A shows that the originally extreme short face profile soft tissue profile improved during treatment, post treatment change seems to involve flattening of chin and mentolabial sulcus and decrease of nasolabial angle.

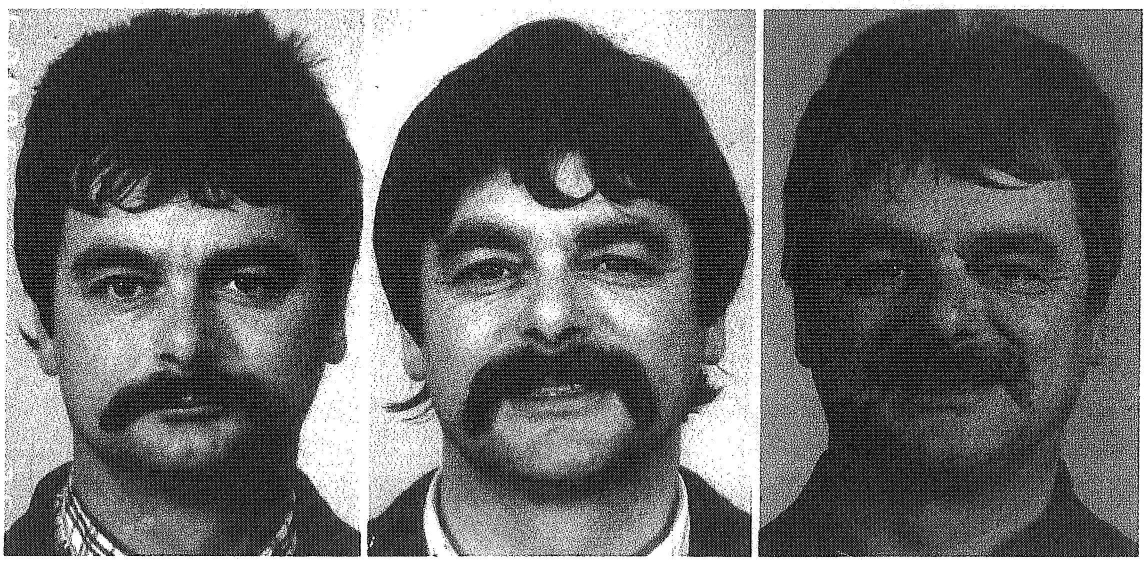


Fig 7B, the frontal view, shows mainly elongation of the lower face and advancement of the mandible that was maintained after treatment.

Fig 7C shows the development of overbite and overjet and of the proclination of the upper anteriors. Pretreatment there was a large overjet (5mm) despite the retroclination of the upper anteriors. The overjet changed from 5 to 3 mm during treatment and the overbite from 11 to 2mm. After treatment overjet and overbite showed relapse of respectively 1 and 3mm. moreover a post treatment decrease of proclination of upper anteriors can be observed.

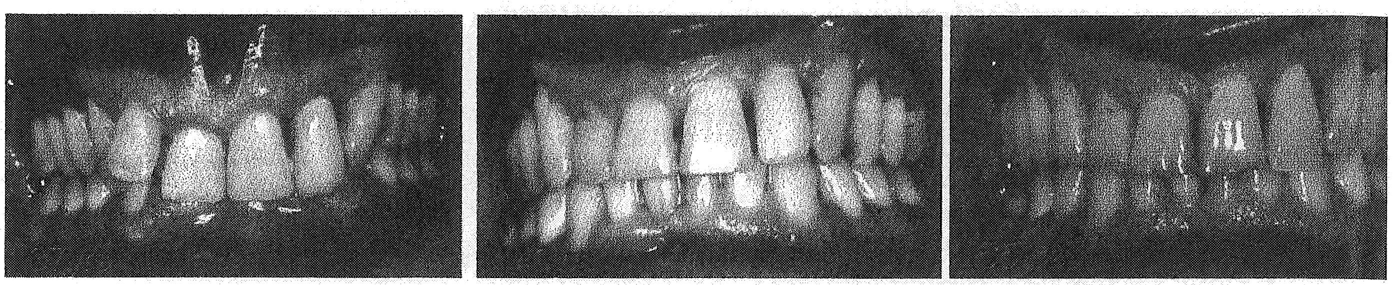


Fig. 7D the frontal intra-oral view shows pretreatment a large overbite, and spacing and irregularities of the upper incisors. 5 years after retention 15 years after treatment 25% relapse of the overbite was found, correction of irregularities and supraposition of upper anteriors was fairly stable.

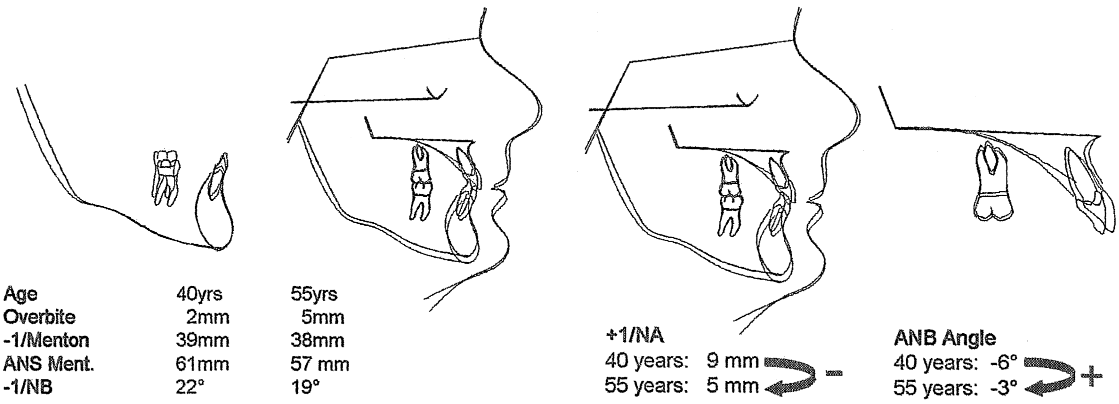


Fig 7E Shows superimpositions of the same patient depicting a Post treatment decrease in lower face height of 4 mm (during treatment there was an increase of 6mm) , lower anteriors showed some uprighting and intrusion (during treatment they moved forward 4mm an 25 degrees). In this case the overbite relapse seems to be mostly related to decrease in lower face height as was also confirmed by regression and correlation analysis. Superimpositions of tracings of the same patient in fig 7 E show a post treatment increase of angle ANB from -6 to –3 degrees at the same time upper anteriors show a kind of compensatory change moving 4 mm backward as was confirmed in the correlation analysis.

Angle ANB changes in both groups are strongly negatively correlated to position and inclination of upper anteriors. Post treatment increase in ANB angle is related to retroclination and dorsal reposition of upper anteriors.
In the surgery group the Wits value is negatively correlated to the sagittal position of upper anteriors, increase in Wits value is related to backward movement of the upper anteriors.
In both groups increase of Wits value is associated with increase of dento-alveolar height (-1 to Menton) of lower anteriors.
In the surgery group post treatment changes in lower face height (ANS-Menton) are related to the intermaxillary divergence, and the basal and dento-alveolar height in mandible (-1 to Menton and +1 Sp Pl). Post treatment increase in lower face height is associated with increase in dento-alvelolar height in both jaws.

Regression analyses

Table 36. Regression analysis with post treatment overbite change in the only orthodontics group as dependent variable

Model	*R*	*R square*	*Adjusted for R square*	*Std. Error of the Estimate*
1	0.547	0.299	0.266	1.14287
2	0.778	0.605	0.566	0.87893
3	0.957	0.917	0.904	0.41406

1. Predictors: (constant), +1 to SP. Pl. T2-T3
2. Predictors: (constant), +1 to SP. Pl. T2-T3, ANS-Menton T2-T3
3. Predictors: (constant), +1 to SP. Pl. T2-T3, ANS-Menton T2-T3 –1 to Menton T2-T3

Table 36 shows the outcome of the regression analysis for the non surgery group with the post treatment change in overbite as dependent variable. Originally all dental and skeletal variables were entered as independent variables. As shown by R square in this subgroup the post treatment changes in overbite are explained or predicted for almost 92% by post treatment changes in only 3 variables. The contribution of these 3 variables is almost equal; the distance between the incisal ridge of upper central anteriors and spina plane (+1 to Sp Pl perpendicular to spina plane) for 30%, the distance between the incisal ridge of lower central anteriors and mandibular plane (-1 to Mand Pl perpendicular to mandibular plane) for 31%, and lower face height (ANS to Menton) also for 31% amounting together to 92%.

Table 37. Regression analysis with post treatment overbite change in the surgery group as dependent variable

Model	*R*	*R square*	*Adjusted for R square*	*Std. Error of the Estimate*
1	0.600	0.360	0.348	1.18244
2	0.821	0.674	0.661	0.85194
3	0.940	0.883	0.876	0.51542

1. Predictors: (constant), ANS -Menton T2-T3
2 Predictors: (constant), ANS-Menton T2-T3, +1 to Sp.Plane T2-T3
3 Predictors: (constant), ANS-Menton T2-T3, +1 to SP. Pl. T2-T3, –1 to Menton T2-T3

Table 37 shows the outcome of the regression analysis for the surgery group with the post treatment change in overbite as dependent variable. Originally all dental and skeletal variables were entered as independent variables. As shown by R square in this subgroup the post treatment changes in overbite are explained or predicted for almost 90% by post treatment changes by only 3 variables. The contribution of these 3 variables is: lower face height (ANS to Menton) also for 36% the distance between the incisal ridge of upper central anteriors and spina plane (+1 to Sp Pl perpendicular to spina plane) for 31%, the distance between the incisal ridge of lower central anteriors and mandibular plane (-1 to Menton) for 21% together amounting to 88%.

Table 38. Regression analysis with post treatment overjet change in the only orthodontics group as dependent variable

Model	*R*	*R square*	*Adjusted for R square*	*Std. Error of the Estimate*
1	0.724	0.524	0.501	0.75967
2	0.825	0.681	0.649	0.63701
3	0.873	0.762	0.724	0.56512

1. Predictors: (constant), +1 to Point A // SN T2-T3
2. Predictors: (constant), +1 to Point A // SN T2-T3, –1 to point D // Mand. Pl.T2-T3
3. Predictors: (constant), +1 to Point A // SN T2-T3, –1 to point D // Mand. Pl.T2-T3, Angle ANB T2-T3

Table 38 shows the outcome of the regression analysis for the non surgery group with the post treatment change in overjet as dependent variable. Originally all dental and skeletal variables were entered as independent variables. As shown by R square in this subgroup the post treatment changes in overbite are explained or predicted for 76% by post treatment changes in only 3 variables. The contribution of these 3 variables is: the distance between the incisal ridge of upper central anteriors and subspinale parallel to spina plane (+1 to A //Sp Pl)for 52% , the distance between the incisal ridge of lower central anteriors to point D parallel to mandibular plane (-1 to D // Mand Pl) for 16% , and Angle ANB for 8 % amounting together to 76%.

Table 39. Regression analysis with post treatment overjet change in the surgery group as dependent variable

Model	*R*	*R square*	*Adjusted for R square*	*Std. Error of the Estimate*
1	0.411	0.169	0.153	0.86957
2	0.494	0.244	0.214	0.83752
3	0.583	0.340	0.300	0.79028
4	0.685	0.469	0.426	0.71581
5	0.742	0.551	0.504	0.66536

1. Predictors: (constant), Wits T2-T3
2. Predictors: (constant), Wits T2-T3, –1 to NB T2-T3
3. Predictors: (constant), Wits T2-T3, –1 to NB T2-T3, +1 to point A // Sp. Plane T2-T3
4. Predictors: (constant), Wits T2-T3, –1 to NB T2-T3, +1 to point A // Sp. Plane T2-T3, ANB T2-T3
5. Predictors: (constant), Wits T2-T3, –1 to NB T2-T3, +1 to point A // Sp. Plane T2-T3, ANB T2-T3, +1 to NA (mm) T2-T3

Table 39 shows the outcome of the regression analysis for the surgery group with the post treatment change in overjet as dependent variable. Originally all dental and skeletal variables were entered as independent variables. As shown by R square in this subgroup the post treatment changes in overbite are explained or predicted for almost 56% by post treatment changes by 5 variables. The contribution of these variables is : Wits value for 17%, angle ANB for 13% , the distance between the incisal ridge of upper central anteriors and subspinale parallel to spina plane (+1 to A //Sp Pl)for 10 % , the distance between the most prominent part of the crown of the upper central incisors to the line NA (+1 to NA mm) for 9% , the distance between the most prominent part of the crown of the lower central incisors to the line NB (-1 to NB mm) for 7% amounting to a total of 56%.

Discussion

SKELETAL PATTERN , OVERJET AND OVERBITE

This study involved a mix of cases with BSSO, BSSO and LeFort I or BSSO and chin correction. As the main issue was to study development after combined surgical -orthodontic correction of Class II 1 cases in general this approach was considered acceptable.

Both samples were considered comparable, both involved hypo- and hyperdivergent cases and generally the range in skeletal patterns was similar.

Although the surgery and non-surgery groups didn't show significant occlusal differences they differed somewhat in skeletal pattern at least according to the Wits value. The Wits value was originally larger in the surgery group and also showed significantly more improvement during treatment. This could imply that the Wits value is more useful to distinguish severe and less severe sagittal skeletal problems. Moreover the Wits value probably is also more suitable to evaluate

treatment changes as only Wits showed significant reduction in the surgery group compared tot non surgery group changes.
In this project, contrary to many other papers on post surgical development traditional cephalometric measurements were used instead of applying a system of lines parallel and perpendicular to a base line, this was for the purpose of comparison with similar unoperated subjects.
Class II 1 Patients with only orthodontic (camouflage) treatment in general should have less severe problems than those treated surgically but in this sample patients were selected to comparable abnormality, it seems that according to statistical analysis this succeeds rather well as only the Wits value an d the correction of the overjet showed significant differences. Correspondingly also only the Wits value showed significantly more change during treatment. The pretreatment overjet was somewhat, although not significantly larger in the surgery group but reduction during treatment was significantly more in the surgery group.
The changes produced by surgical treatment showed much larger variation than in the non surgery group. This also includes the variation in pre- and post surgical orthodontic treatment. This greater amount of variation during treatment in the surgery group probably contributed to the greater variation in post treatment changes in the surgery group.
Pre and post surgical tooth movement shows a complex pattern, averages are very small but ranges and frequencies show that a lot of tooth movement occurs frequently in opposite directions, they indicate that in surgical cases much tooth movement takes place in several directions and at different moments. The consequences remain unclear although it may be possible that more movements lead to more post treatment instability. The lower anteriors exhibited a somewhat more consequent pattern with pre and post surgical forward movement. This result is in contradiction with the results of Douma et al (1991) who found that on average upper and lower anteriors were retroclined presurgically and proclined post surgically.
Cephalometrically both groups showed almost equal mean stability of overbite and overjet. Of the non surgery group 41% showed a relapse of the overbite of more than 2 mm according to statistical analysis this could mainly attributed to eruption of upper anteriors and for a small part by eruption of lower anteriors.
Of the surgery group 6% showed a relapse of the overbite of more than 2 mm according to statistical analysis this could mainly attributed decrease of lower face height and for a small part to eruption of upper and lower anteriors.
Of the non surgery group 43% showed a relapse of the overjet of more than 1 mm according to statistical analysis this could mainly attributed backward movement of lower anteriors and forward movement of upper anteriors.
Of the surgery group a comparable sized group of 37% showed a relapse of the overjet of more than 1 mm according to statistical analysis this could mainly attributed increase of Wits value and for a lesser extent backward movement of lower anteriors.
Because for the surgery group skeletal change rather than tooth movement was ex-

pected to be the major factor in reduction of the overbite and overjet, it is surprising that post treatment changes also involved al lot of tooth movement. Descriptive statistics have shown that actually the mean tooth movement in the surgery group was not differing from the tooth movement in the non surgery group. Moreover the range of most tooth movements during treatment was larger. Apparently surgery did not preclude extensive pre and or post surgical orthodontic tooth movement. Consequently rather large post treatment tooth movements could be expected with a large variation. Not only was the variation larger in the surgery group but post treatment dental movements were also more frequent in this group.

Although one might expect that post treatment tooth movement bears some relation with tooth movement during treatment this was not investigated in this project. Large dental movements during and after treatment in surgery patients were also described by Watzke et al (1990)

Post treatment skeletal changes are not always reflected in the occlusion as was described by Simmons et al (1992) and Miguel et al (1995).

Other authors also mentioned the possibility of dental compensation for skeletal relapse after surgery in Class II 1 patients (Ellis and Gall [1985], Scheerlinck et al [1994], Van Sickels et al [1988]) In this sample statistics also revealed dental compensations for post treatment skeletal changes in the surgery and in the non surgery group. Increase in ANB Angle and Wits value can be compensated by forward movement of lower anteriors and backward movement of upper anteriors in the non surgery group. In the surgery group increase of the skeletal Class II pattern can be mainly compensated for by backward movement of upper anteriors. In cases where the mandible shows a post treatment forward development the reverse is of course the case in both groups. Post treatment increase in lower face height in the surgery group can be compensated by eruption of upper and lower anteriors, decrease of the lower face height can be followed by some kind of compensating "intrusion" of upper and/or lower anteriors.

Not all the skeletal changes in this sample were in a relapse direction. Continuing forward development of the mandible was observed in both groups. 9% of the surgery cases and 10% of the non surgery cases showed post treatment decrease of Wits value of more than 1mm. In the surgery group this decrease could amount 5mm and in the non surgery 3.5mm. These data suggest that late growth in adults is not unlikely.

Continuing forward development was also observed by other authors often more frequently than in this sample (Van Sickels et al [1988], Simmons et al [1992], Rubens et al [1988], Kierl[1990]).

Besides forward movement of the mandible relapse or deterioration of the skeletal Class II pattern was also observed in both groups although in both groups Wits value and ANB angle remained fairly stable. In the surgery group in 23 % of the cases Wits increased more than 1 mm after treatment in the non surgery case this was 20%. This "relapse" could amount to 2 mm in the surgery group and to 3 mm in the non surgery group. Again one can observe that in many of these cases post treatment skeletal changes were compensated by dental movement.

Much larger relapse, up to 4-5mm was also found by other authors studying post surgery Class II cases(Blomqvist et al [1997] , Scheerlinck et al [1994], Simmons et al [1992],Watzke et al [1990],Kohn[11978],Kierl[1990]). Comparing to these results the sample involved in this study showed rather favorable results.
As for the lower face height no significant differences were found between the groups at any time point. Both groups were always within the normal range. On average there were no differences in changes during treatment. However according to frequencies 72% of the non surgery cases remained stable during treatment and this was only the case in 23% of the surgery patients. May be that the large amount of change during treatment was involved in this instability as 18 % of the surgery case changed 5mm or more during treatment
Considering the rather small differences between the groups before treatment one may wonder when and why surgery is considered the best option.
It was also found in this study that the percentage of patients with upper or lower anteriors in more or less ideal positions was below 50% and lower in the surgery group. It appears that surgery does not warrant a better position of upper and lower anteriors than non surgery compensation (table 20)
According tot the short and long term results it seems that other variables than those evaluated in this paper where involved in the decision.

DENTAL MOVEMENTS

During treatment the basal an dentoalveolar height of the symphysis (-1/ to menton) was reduced (meaning that lower anteriors were intruded) in 50% to 60 % of the surgical and non surgical cases. Extrusion was only found during treatment of 12 % of the surgical cases. Apparently intrusion, mostly related to some leveling of the curve of Spee is the movement of choice in the treatment in this sample of Class II whether surgical or non surgical. Extrusion of lower anteriors can be related to deepening f the curve of Spee as is sometimes desirable for backward rotation of the mandible during BSSO in cases with a large chin.
During treatment frequency of changes was larger in the surgery group.
Average pre- and post surgery changes were small with a very large range in both fazes with a large range in both fazes.
According to frequencies 50 % showed pre surgical intrusion 36% remained stable and 14 % showed extrusion. Post surgically 43% remained stable and 36 % increased (extrusion). 14% didn't show any significant pre or post surgical movement. Reverse pre- post surgical movements however only occurred in 7 % of the cases, indicating that treatment was rather efficient although not equally divide over the treatment period.
According to frequencies post treatment stability was very comparable between the groups 84 % in the surgery and 86% in the non surgery group also the frequency of other changes was very comparable. The surgery group didn't show more stability or less post treatment movement.

The distance of the incisal ridge of the lower central anteriors to the line NB (-1 to NB in mm.) showed during and after treatment on average almost equal small changes in both groups. According to frequencies 56% of the surgery cases and 24% of the non surgery cases showed forward movement during treatment. In the surgery group 12% and in the non surgery group 19% moved backward. In the non surgery group 57 % remained stable versus 32 % in the surgery group. Frequency of changes was larger in the surgery group and forward movement occurred most frequently even in the surgery group where skeletal correction would make this kind of dentoalveolar compensation unnecessary. An explanation may be the tendency to keep orthodontic treatment in surgery cases as simple as possible and resort to non extraction treatment leading to more forward movement of lower anteriors.

Average pre- and post surgery changes were small with a very large range in both phases with a large range in both phases.

According to frequencies 36 % showed pre surgical backward movement and 62 % showed forward movement. Post surgically 36% remained stable and 46% moved forward. 18% showed reversed movement pre- and postsurgically.

Presurgical backward movement is probably associated with extraction cases and post surgical forward movement might be related to compensation for early relapse of the Class II pattern.

Average post treatment changes in both groups were almost identical.

According to frequencies stability was comparable in both groups 79% in the surgery group versus 67% in the non surgery group.

Neither group showed post treatment forward movement of lower anteriors. The surgery group showed less backward movement (20%) versus the non surgery group (33%). Backward movement in the surgery group was mostly relapse of forward movement during treatment. In the non surgery group post treatment backward movement often occurred in patients that didn't show forward movement during treatment what can be considered as an unexpected movement.

Changes in the angle between the central lower anteriors and the line NB (-1 to NB, degrees); during treatment in both groups the lower anteriors were proclined. Treatment changes in both groups showed a very large range

According to frequencies 89% of the surgery cases and 57% of the non surgery cases showed proclination) during treatment. In the surgery group 9% showed retroclination, in the non surgery group this was the case in 14%. In the non surgery group 28 % remained stable versus 2 % in the surgery group. The average amount of change was comparable but the frequency of changes was much larger in the surgery group. Proclination occurred very frequently in both groups.

Pre- and post surgery changes were very small with a large range in both fazes.

According to frequencies 39 % showed pre surgical retroclination 7% remained stable and 54 % showed proclination. Post surgically 14% remained stable and 54% increased (proclination). 21% showed reversed pre- an post surgical movement.

Average post treatment changes in both groups were similar.

According to frequencies stability was comparable in both groups
28% in the surgery group versus 33% in the non surgery group.
Retroclination occurred in almost equal frequency in both groups 49% and 52%)
Proclination was more frequent in the surgery group (23% versus 14% in the non surgery group) Moreover the surgery group showed more unexpected movements. There was a tendency for more stability in the non surgery group
Post treatment the majority of the patients showed a tendency of retroclination and backward movement of lower anteriors independently of the movement during treatment or the treatment modality
At the end of active treatment and long term there were more surgery cases with an ideal to normal position of the central lower anteriors related to NB. This difference was not convincing meaning that surgery doesn't warrant a better (more ideal) position of the lower anteriors
The distance of the incisal ridge of the upper central anteriors to the line NA (+1 to NA) showed during and after treatment on average almost equal small changes in both groups. According to frequencies 72% of the surgery cases and 76% of the non surgery cases showed backward movement during treatment. In the surgery group 9% showed forward movement in the non surgery group this was the case in 5%. In the both groups 19% remained stable. The average amount of change was comparable but the frequency of changes was larger in the surgery group. The rather large frequency of backward movement in the surgery group, although unnecessary for dento-alveolar compensation, probably was related to reduction of excessive proclination in typical Class II 1 cases.
The pre- and post surgical change was small with a large range in both phases.
According to frequencies 64% showed pre surgical backward movement, 21% remained stable and 14% showed forward movement. Post surgically 35% remained stable and 25% moved forward. 11% showed reverse pre- and post surgical movement. Post surgical forward or backward movement could be related to early post surgical skeletal changes.
Average post treatment changes in both groups were small and similar with a large range in the surgery group. According to frequencies stability and frequency of unexpected movements was comparable in both groups.
Stability occurred in 72% of the surgery group versus 62% in the non surgery group. The surgery group showed less forward movement (17% versus the non surgery group 24%). Independently of the preceding treatment upper anteriors show similar post treatment behavior.
Changes in the angle between the central upper anteriors and the line NA (+1 to NA, degrees). During treatment a larger but insignificantly larger retroclination was found in the surgery group. During treatment both groups showed small average changes with a very large range.
According to frequencies 16% of the surgery cases and 67% of the non surgery cases showed proclination during treatment. In the surgery group 72% showed retroclination in the non surgery group this was the case in 33%. In the non surgery group 0% remained stable versus12 % in the surgery group. The average

amount of change was somewhat larger in the surgery group but the frequency of changes was larger in the non surgery group. Proclination occurred more frequently in the non surgery group. This is probably related to the torquing activities often applied during compensating backward movement of upper anteriors in non surgical adult Class II 1 cases. At the same time in the surgical cases more retroclination is possible in extreme Class II 1 cases where severe proclination has to be solved presurgically.

During active treatment on average pre surgical retroclination and small post surgical proclination with a large range in both phases was found.

According to frequencies 61% showed pre surgical retroclination and 39% showed proclination. Post surgically 21% remained stable and 46% showed proclination 14% showed reversed pre- and post surgical movement. Probably some torque was necessary during post treatment compensating backward movement of the upper anteriors.

Post treatment changes in both groups were similar, no significant difference with both groups showing a large range. According to frequencies stability was larger in the surgery group, 28% versus 14% in the non surgery group.

Retroclination occurred mostly in the non surgery group (62% versus 35% in the surgery group). This retroclination might be related to backward movement that compensates for the retroclination of the lower anteriors.

Moreover the non surgery group showed somewhat more unexpected movements. Proclination was more frequent in the surgery group (37% versus 24% in the non surgery group) this could be related to compensation in those cases with post treatment forward movement of the mandible and/or post treatment proclination of lower anteriors. At the end of active treatment and long term there were more non surgery cases with an ideal to normal position of the central upper anteriors related to NA. Surgery doesn't warrant a better (more ideal) position of the upper anteriors.

SOFT TISSUE PROFILE.

Changes and improvements or deterioration in soft tissue profile features showed confusing variation and almost no predictability. Although it was not part of this investigation there seems to be only a very weak correlation between dentoskeletal changes and soft tissue profile changes.

Pretreatment the T- angle was slightly larger in the surgery group. It might be possible that this small difference (4°) played a role in the indication for surgical treatment. On average the surgery group showed somewhat more (3.8°) improvement of the T-angle than the non surgery group. The large range in the surgery group is partly consequence of the inclusion of patients with positive or negative chin correction. However chin correction generally did not change the T-angle as much as expected. Even in the non surgery group improvement during treatment of the T-angle of 5° was possible.

After treatment on average in both group reduction of the T-angle continued. But there was a very large range in the surgery group increase or decrease of 15° to 20° was found, even in the non surgery group the range was between –8°and + 3°. Although in some cases this changes are partly related to skeletal change it appeared that changes in the soft tissue itself can play an important role in long term soft tissue profile changes. Flattening of the lips, backward movement of the subnasal area and thickening of the soft tissue pogonion can play a role (see figure 8, 9 and 10).

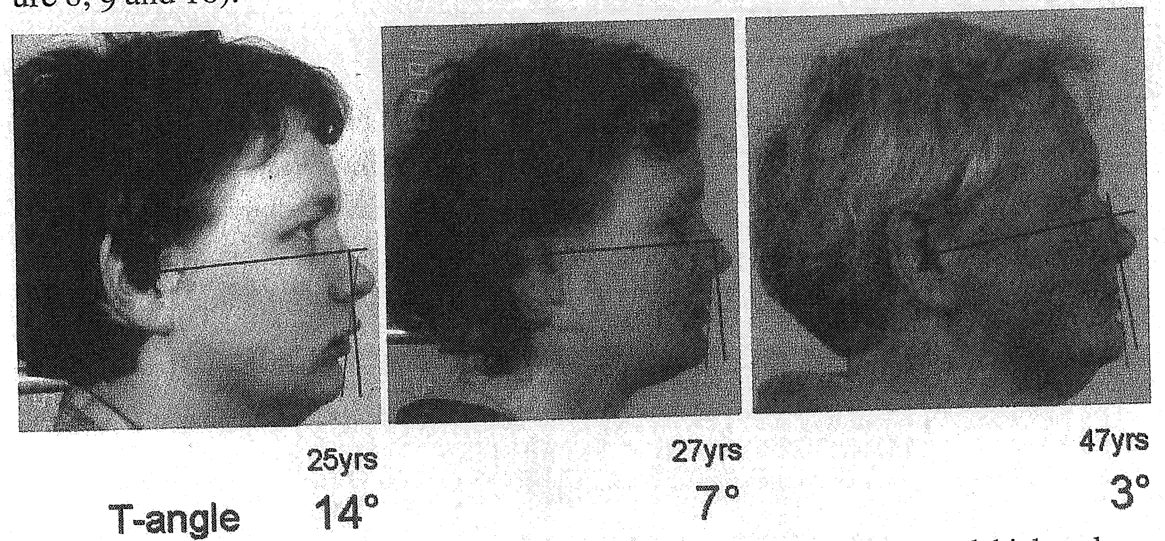


Fig 8A shows a patient treated with BSSO and LeFort I osteotomy. The nasolabial angle increased during treatment but decreased again considerably during the post treatment period.

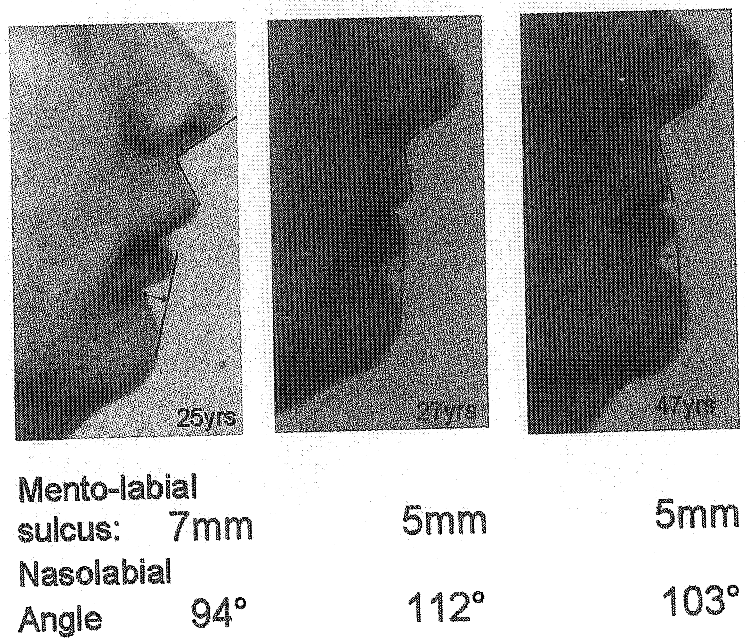


Fig 8 B shows that the same patient also displays a continuing decrease of the T angle during and after treatment.

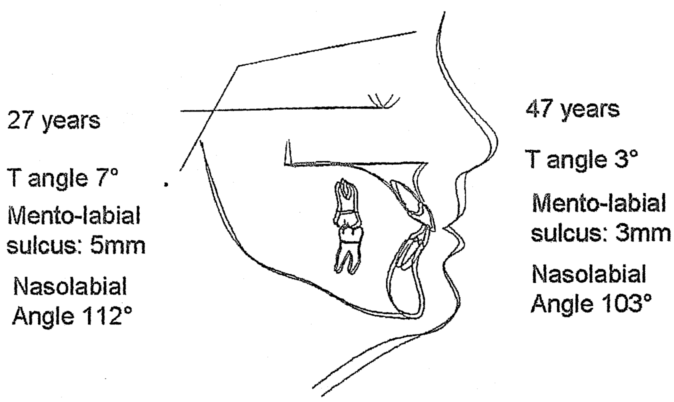


Fig 8 C shows the superimpositions of the post treatment and long term tracings of this patient. The changes are mainly explainded by changes in the soft profile itself, flattening of the lips related to decrease of the labiomental fold and backward movement of the subnasal area decreasing the T angle. With increasing age the lips seem to flatten and the labiomental fold seems to deepen, may be also some changes in the position of the columella do occur. After treatment the nasolabial fold deepens and the upper and lower lip flatten with age.

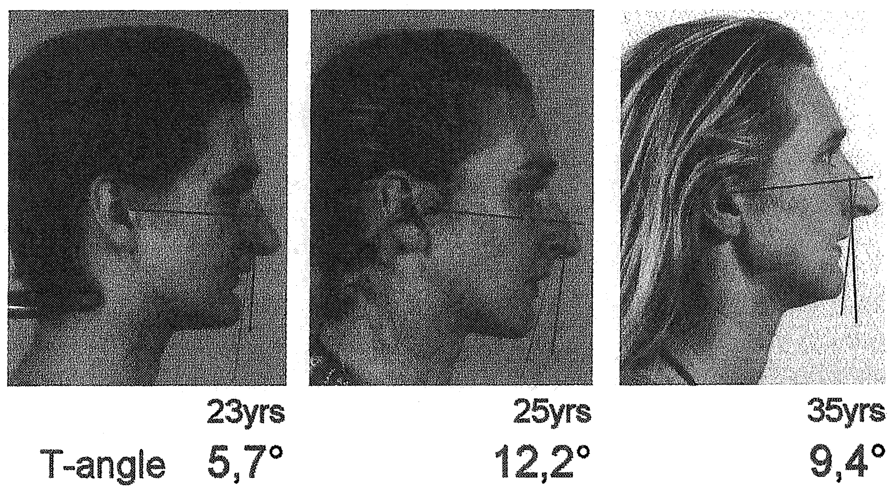


Fig 9 A shows a short face patient where improvement of the profile occurred together with increase of the T angle, after treatment the T-angle increased somewhat.

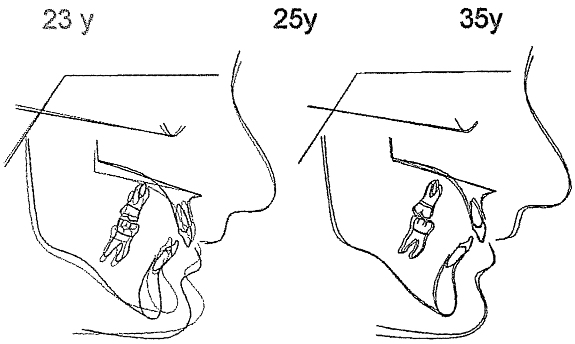


Fig 9 B Superimpositions show changes during and after treatment. Treatment involved BSSO, LeFort I osteotomy and chin reduction.

BSSO and downward repositioning of the maxilla resulted in mandibular posterior rotation , together with the chin reduction this resulted in increase of the T-angle and reduction of the concavity of the profile. In the 10 years after treatment changes occurred mostly in de subnasal area, leading to some decrease in T-angle .

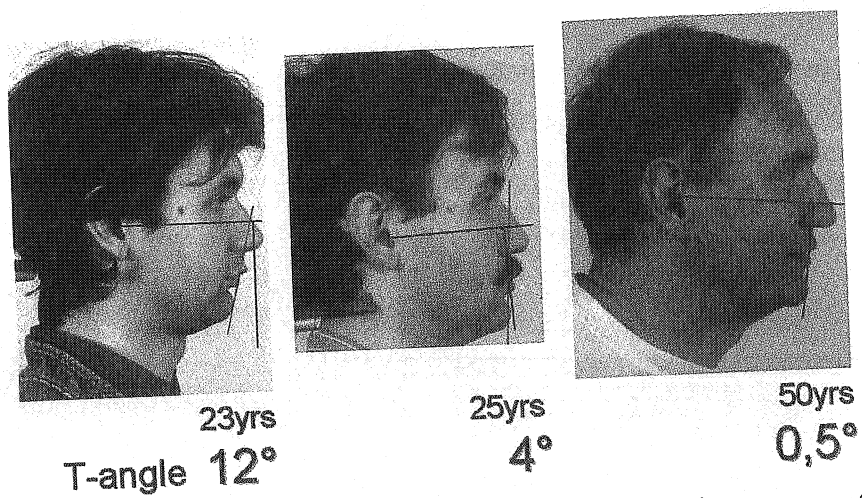


Fig 10 A Although this patient had only orthodontic treatment an improvement of the soft tissue profile an reduction of the T-angle was achieved.

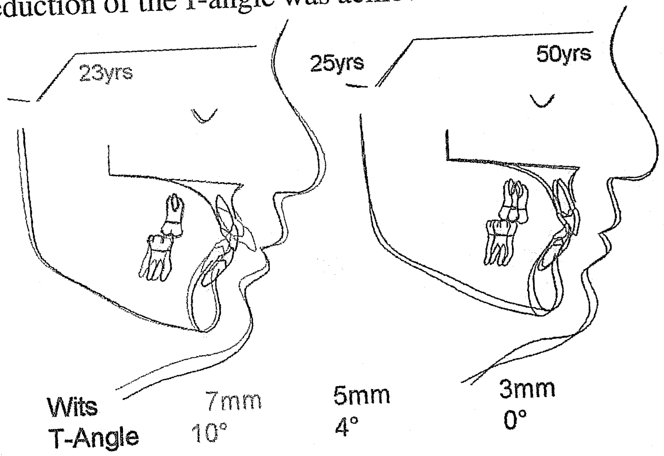


Fig 10 B Superimpositions show changes during and after treatment. During treatment the soft pogonion hardly changed but the sunbnasal area seemed to deepen, decreasing the T-angle 6 degrees. After treatment the soft pogonion increased in thickness and the subnasal area moved backward decreasing the T-angle even more .

The nasolabial angle and mentolabial sulcus depth did not show any pre- or post treatment difference between the surgery and non surgery group also the changes during treatment did not differ. In the non surgery group the nasolabial angle on average did not change during treatment, this was unexpected because treatment involved dorsal movement of upper anteriors. In the surgery group however this angle increased about 7° during treatment, this might be related to the somewhat larger retroclination of upper anteriors in this group. During and after treatment the range of changes was rather large from about +20° to about – 20° although on average the nasolabial angle shows post treatment stability.
As for the depth of the mentolabial sulcus there were no average pre- and post treatment differences. Also the mean changes during and after treatment were almost equal. Only the range in the post treatment changes in the surgery group was comparatively large, this may be related to the post treatment adaptation in patients with chin correction although large changes were also seen in surgery patients without chin correction (see fig 12). It seems that changes in the soft tissue profile during and after treatment occur at least partly independently of skeletal

changes although they might be a reaction to the skeletal changes. Again thinning of the lips, changes in the subnasal area and in the soft tissue pogonion could play an important role.
The apparently independent post treatment development of the soft tissue profile was also found by Will and West (1989). This authors could not find a relation between soft tissue profile changes and post treatment dentofacial relapse, even only 6 weeks after BSSO surgery.

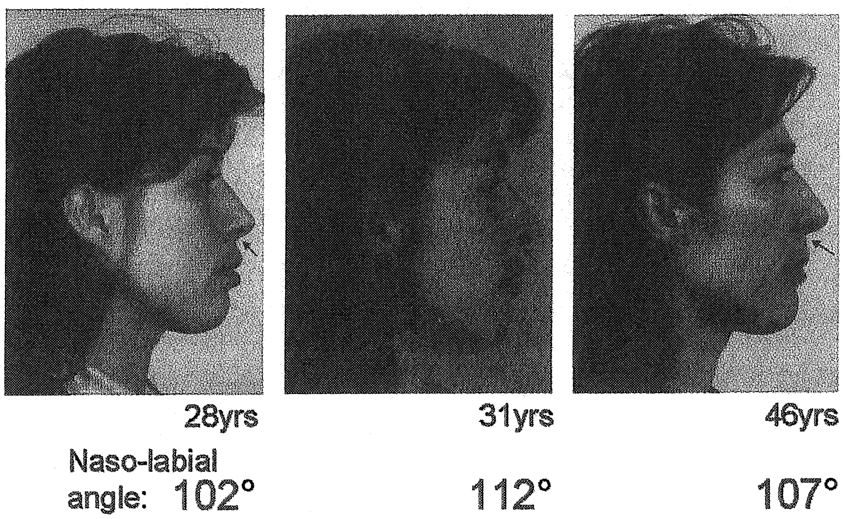


Fig 11 A This patient had only orthodontic treatment with extraction of 4 first bicuspids, during treatment the nasolabial angle increased 10 degrees after treatment it decreased 5 degrees. At any moment before and after treatment the nasolabial angle was within normal limits.

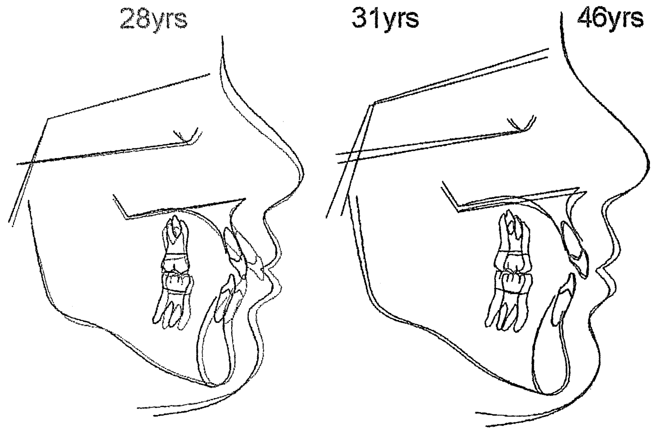


Fig 11 B Superimpositions show changes during and after treatment.
During treatment the soft tissue profile followed the extensive dental retrusive movement only for a small extent. After treatment the lips got thinner and the profile became flatter.

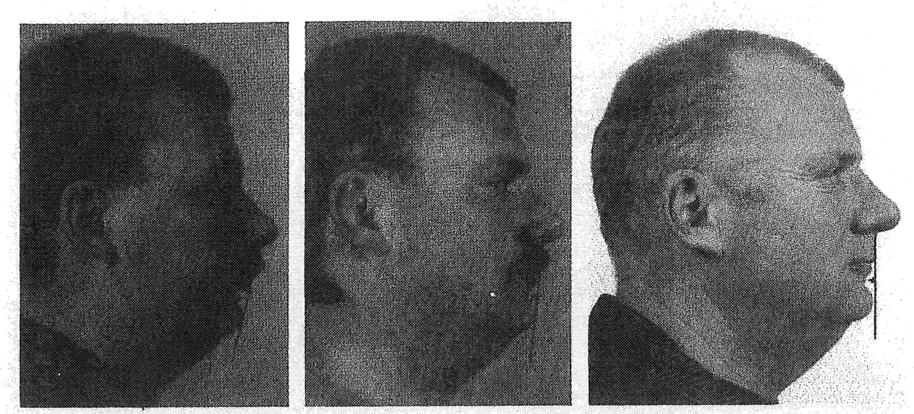


Fig 12 A This patient treated with BSSO showed decrease in labiomental fold during and after treatment.

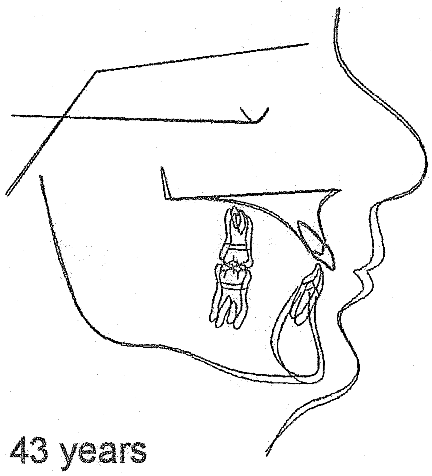


Fig 12 B Superimpostion of post treatment and longterm tracings show that despite some relapse of the skeletal correction the T-angle and labiomental sulcus continued to decrease. With increasing age the lips get thinner and curvatures in the soft tissue profile get flatter.

Conclusions

Generally differences between the means of both groups were small and the changes through time were also small for most variables.
Only the Wits value was originally larger in the surgery group.
Only overjet and Wits correction and Gonion change during treatment were significantly larger in the surgery group.
Lower face height shows frequent post treatment changes in the surgery group.
At the end of treatment and long term no significant difference for any variable was found.
During treatment comparatively much proclination or forward movement of lower anteriors occcurred in both groups.
In the non surgery group changes in sagittal position of upper and lower anteriors and for a very limited amount changes in sagittal skeletal pattern (angle ANB) are related to post treatment overjet changes.

In the surgery group changes in sagittal position of lower anteriors and changes in sagittal skeletal pattern (Wits angle, ANB) but also the sagittal position of upper and lower central anteriors are related to post treatment overjet changes .
In the non surgery group changes in vertical position of upper and lower anteriors and for 1/3 changes in the lower face height are related to changes in overbite.
In the surgery group post treatment overbite changes are related to changes in vertical position of upper and lower anteriors and for 1/3 by changes in the lower face.
Changes in sagittal skeletal pattern in both groups is followed by compensating movements of upper and lower anteriors.
In the surgery group post treatment changes in lower face height are associated with vertical compensatory movements of upper and lower anteriors.
In both groups there is a complex inter relation between post treatment retroposition of lower anteriors, proposition of upper anteriors and increase of dentoalveolar height of upper and lower anteriors.

Surgery did not lead to a more normal /ideal position of upper and lower anteriors neither at the end of active treatment neither long term.
Pre and post surgical tooth movement shows a complex pattern, averages are very small but ranges and frequencies show that a lot of tooth movement occurs often in opposite directions.
Post treatment changes and stability for the 2 groups were equally divided over different variables. Surgery does not seem to provide a better dental stability.
Many variables show a complex pattern of post treatment changes involving movement in 2 opposing directions leading to a small confusing mean change.
Soft tissue profile variables used in this study showed almost no differences between the 2 groups neither for the averages nor for the changes during and after treatment. Differences and changes in soft tissue profile didn't seem to justify a surgical intervention.

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