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Maintenance of a deep bite prior to surgical mandibular advancement

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SUMMARY Adult patients with a Class II skeletal base are often treated by a combined orthodontic and surgical approach. Advancement of the mandible, most often including a bilateral sagittal split osteotomy (BSSO), is preceded by orthodontic alignment and frequently the curve of Spee is levelled. When the chin is prominent, there is a risk of accentuating this as a result of surgery. An option to prevent this is to maintain a deep curve of Spee before surgical advancement. This will result in an opening rotation of the mandible during surgery and thus, a less prominent chin.

The aim of this study was to compare, retrospectively, two orthodontic treatment approaches in patients treated by a BSSO. In one group (4 males, 20 females; mean age pre-surgery 29.3 years), the deep bite was maintained (deep bite group) while in the other (3 males, 10 females; mean age pre-surgery 27.1 years) the overbite was normal prior to surgery (level group). Lateral skull radiographs were taken before orthodontic treatment (T0), prior to surgery (T1), and at the end of treatment (T2). Differences between the groups as measured on lateral skull radiographs at T1 and T2 were analysed and quantified using an independent *t*-test.

The results showed that soft tissue pogonion moved significantly further forward in the level than in the deep bite group ($P < 0.05$). Lower anterior face height and the cranial base-mandibular plane angle increased more in the deep bite than in the level group ($P < 0.05$ and $P = 0.001$, respectively).

The maintenance of a deep bite prior to mandibular advancement surgery induces an opening rotation of the mandible reducing chin prominence and increasing lower anterior face height post-surgically.

Introduction

In adult patients with skeletal Class II anomalies, a combined orthodontic and surgical approach is often necessary to obtain a satisfactory treatment outcome. The combined aim of the orthodontist and surgeon is to establish a good dental occlusion, optimal function, and harmonious facial aesthetics. Generally, the dentition is aligned prior to mandibular advancement and the surgical procedure to advance the mandible is most frequently a bilateral sagittal split osteotomy (BSSO). The post-surgical chin position is an important factor to consider in treatment planning. If the dentition is levelled in the pre-surgical orthodontic phase, the mandible will merely move horizontally during surgery, guided by the occlusal plane. This moves the chin point maximally forward, which is undesirable in patients with an already prominent chin. There is a risk of accentuating a prominent chin, which may necessitate further camouflage surgery, such as a reduction genioplasty or a Le Fort I osteotomy with dorsal impaction (Jacobs and Sinclair, 1983; Poulton and Ware, 1985; McCollum *et al.*, 1989). Maintaining a deep curve of Spee in the pre-surgical orthodontic phase has been suggested in order to prevent the chin from being brought further forward (Zetz *et al.*, 1984; Tuinzing *et al.*, 1989, 2005; Mommaerts *et al.*, 2004). The possible influence of this procedure on chin prominence and lower profile changes has not previously been determined. Therefore, the aim of the present study was to quantify the differences in chin point prominence and lower anterior face height after pre-surgical levelling of the bite (creating an overbite less than or equal to 3 mm) as opposed to maintaining a deep overbite (greater than 3 mm) prior to BSSO.

Subjects and methods

Subjects

The records of all skeletal Class II patients who had undergone orthodontic treatment combined with orthognathic surgery from November 1992 until November 2002 were assessed. All were treated orthodontically by one orthodontist (MWJB) and underwent surgery in the Oral and Maxillofacial Surgery Department of the University Medical Center Groningen.

Patient records were included according to the following inclusion criteria: skeletal Class II anomaly; (non-growing) adult patient; orthodontic treatment followed by BSSO and no other surgical interventions; lateral skull radiographs with clear soft tissue representation available before orthodontic treatment (T0), prior to surgery (T1), and at the end of treatment (T2); availability of orthodontic treatment records; and BSSO preferably performed by same surgeon (JJ).

From a total of 190 Class II combined orthodontic surgery-treated cases, 37 subjects (7 males, 30 females) met the inclusion criteria. The radiographs taken at T0 were used to confirm Class II severity.

Two groups were formed on the basis of the depth of the vertical overbite on the tracing at T1. When the overbite was equal to or less than 3 mm at T1, the patients were assigned to the 'level' group and those with a vertical overbite of more than 3 mm to the 'deep' bite group.

The resulting study sample consisted of 24 subjects (4 males, 20 females) with a deep bite that was maintained during surgery and 13 subjects (3 males, 10 females) with a normal overbite prior to surgery. The mean age at T1 in the deep bite group was 29.3 years (range 15.8–53.0 years) and 27.1 years (range 17.2–37.1 years) in the level group. The radiographs at T2 were taken an average of 18.0 months (range 4–63 months) after T1 in the deep bite group and after 11.6 months (range 5–22 months) in the level group.

Cephalometric analysis

Conventional radiographs taken at T0, T1, and T2 of all patients were scanned with a digital scanner (Canon Epson Expression 1680 pro; Seiko Epson Corp., Nagano-Ken, Japan). Registration was performed in Viewbox (Version 3.1.1.7© dHal Software, Kifissia, Greece). Tracings were made on the T1 and T2 lateral skull radiographs by one examiner (FOdC) in a darkened room.

The measurements were performed using the reference grid from the soft tissue analysis of Legan and Burstone (1980). For this analysis, a horizontal plane (HP) was constructed by drawing a line through nasion 7 degrees from the sella–nasion line. Perpendicular to this horizontal line a vertical reference line (VP) was constructed through glabella. The landmarks and distances used in this study as well as the angular and linear measurements are presented in Figure 1. For superimposition, both radiographs (T1 and T2) were orientated with maximum coincidence of the cribriform plate, trabecular pattern of the superior portion of the ethmoid bone, and the lower portion and anterior wall of the sella turcica. Nasion and sella points were then transferred from the T1 radiograph to the T2 tracing. In this manner, the HP/VP reference grid that was created was identical on the T1 and T2 tracings. Structure-based differences caused by treatment and/or growth could be measured and described with reference to this grid. Linear distances were measured either parallel to the horizontal plane or parallel to the vertical plane so treatment changes were represented as a horizontal or vertical vector. The mean treatment change of the variables was calculated by subtracting the outcomes at T2 from T1.

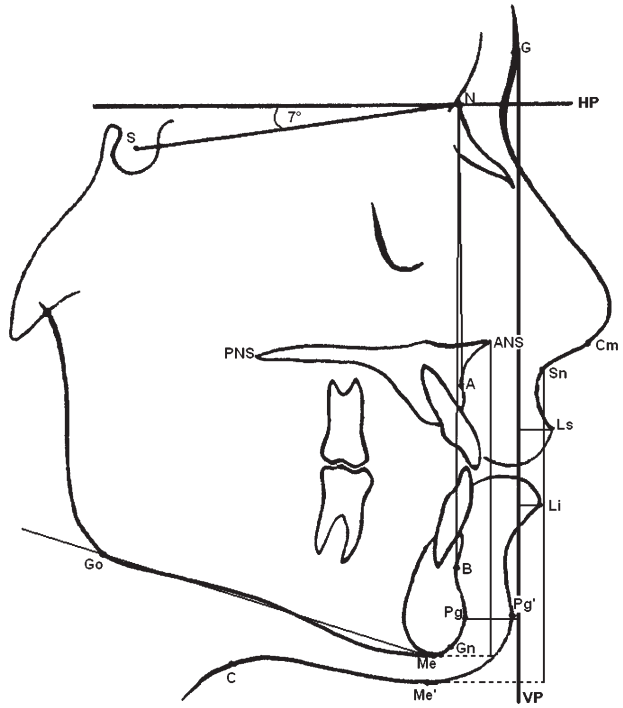

Figure 1 Landmarks used in the study and measurements. Lanmarks: A, point-A; ANS, anterior nasal spine; B, point-B; Cm, columella; G, glabella; Gn, gnathion; Go, gonion; HP, horizontal plane; 7 degrees from SN-line through nasion (Legan and Burstone, 1980); Li, labrale inferior; Ls, labrale superior; Me, menton; Me', soft tissue menton; N, nasion; Pg, pogonion; Pg', soft tissue pogonion; PNS, posterior nasal spine; S, sella; Sn, subnasale; VP, vertical plane; perpendicular to HP through glabella; (Legan and Burstone, 1980). Measurements: SNB (°), antero-posterior position of the mandible; ANB (°), sagittal relationship maxilla/mandible; Wits (mm), sagittal relationship maxilla/mandible to the occlusal plane; Overjet (mm), distance of the upper incisor edge to the lower incisor buccal surface; Overbite (mm), distance of the upper incisor edge to the lower buccal incisor edge; SN/GoGn (°), vertical relationship cranial base/mandibular plane; PP/GoGn (°), vertical relationship between the spinal plane/mandibular plane; APFH index, anterior posterior face height ratio(S–Go/N–Me); AFH index, anterior face height index parallel to VP(ANS–Me/N–Me // VP); LAFH, lower anterior face height parallel to the VP [ANS–Me // VP (mm)]; stLAFH, soft tissue lower anterior face height parallel to the VP [Sn–Me' // VP (mm)]; Pg–VP // HP (mm), chin protrusion parallel to the HP; Pg'–VP // Hp (mm), soft tissue chin protrusion parallel to the HP; Ls–VP // HP (mm), upper lip protrusion parallel to the HP (UL–VP); Li–VP // HP (mm), lower lip protrusion parallel to the HP (LL–VP).

Reliability

To determine intraexaminer reliability, 10 randomly chosen radiographs from the sample were retraced by the same examiner after a 6 week interval.

Statistical analysis

For reliability testing, a paired *t*-test was used to analyse the difference between measurements using the Statistical Package for Social Sciences (SPSS Inc., Chicago, Illinois, USA version 12). Group consistency at T1 was assessed by applying an independent *t*-test to all variables and comparing the deep bite with the level group. Comparison of changes during treatment between the groups (T2–T1) were likewise analysed using an independent *t*-test.

Results

Reliability

There were no significant differences between the two tracings ($P > 0.05$). The standard error of the mean ranged from 0.12 mm for overjet to 0.33 mm for Wits (Houston, 1983).

Cephalometric analysis

At T1, there was a significant difference in overbite ($P < 0.001$) between the deep bite and the level groups (Table 1). Likewise, there were significant differences in lower anterior face height (LAFH; $P < 0.01$), soft tissue LAFH ($P < 0.01$), and anterior face height index ($P < 0.05$).

Changes between T1 and T2 in the deep bite group were compared with changes in the level group (Table 2). The change in overbite was significantly different ($P < 0.001$) between the groups. In the deep bite group, there was a 3.2 mm reduction compared with a 0.2 mm reduction in the level group. Soft tissue pogonion moved 2 mm further forward in the level group than in the deep bite group ($P < 0.05$). Hard tissue pogonion also moved 2 mm further forward but this was not significantly significant ($P = 0.07$). The angle formed between sella–nasion and the mandibular plane angle (SN–GoGn) increased 2.1 degrees more ($P = 0.001$) and the palatal plane–mandibular plane (PP–GoGn) angle increased 1.9 degrees more in the deep bite group ($P = 0.001$). The anterior to posterior face height ratio decreased significantly more in the deep bite group ($P < 0.01$). The mean LAFH increased by 2.2 mm in the level group while this was 3.7 mm in the deep bite group ($P < 0.05$).

No significant differences could be found in sagittal movement of the upper or lower lips.

Table 1 Pre-surgery differences between the groups.

Measurement	Deep bite (SD) *n* = 24	Level bite (SD) *n* = 13	Significance
SNB (°)	75.2 (±3.3)	73.7 (±5.3)	ns
ANB (°)	6.5 (±2.6)	7.6 (±2.3)	ns
Wits (mm)	8.0 (±3.0)	8.0 (±4.1)	ns
Overjet (mm)	8.4 (±1.6)	7.9 (±2.9)	ns
Overbite (mm)	6.3 (±1.6)	1.5 (±1.1)	$P < 0.001$
SN/GoGn (°)	29.6 (±5.7)	34.1 (±10.9)	ns
PP/GoGn (°)	22.8 (±4.9)	28.9 (±10.1)	ns
APFH index	67.3 (±5.0)	64.9 (±8.9)	ns
AFH index	56.1 (±2.3)	58.3 (±1.6)	$P < 0.05$
LAFH (mm)	67.8 (±4.9)	73.1 (±3.4)	$P < 0.01$
stLAFH (mm)	67.2 (±5.1)	72.0 (±3.0)	$P < 0.01$
Pg–VP (mm)	−11.2 (±7.1)	−17.0 (±13.2)	ns
Pg'–VP (mm)	1.6 (±7.3)	−3.6 (±12.3)	ns

ns, non-significant.

Table 2 Treatment change differences between completion of treatment (T2) and pre-surgery (T1) in the level and deep bite group.

Difference T2–T1	Group	Mean (±SD)	Significance
SNB (°)	Level	2.7 (1.3)	ns
	Deep	2.6 (0.9)	
ANB (°)	Level	−2.7 (1.3)	ns
	Deep	−2.6 (1.1)	
Wits (mm)	Level	−5.1 (2.9)	ns
	Deep	−6.2 (1.5)	
Overjet (mm)	Level	−4.8 (3.0)	ns
	Deep	−5.0 (1.8)	
Overbite (mm)	Level	−0.2 (1.4)	$P < 0.001$
	Deep	−3.2 (2.5)	
SN/GoGn (°)	Level	0.9 (0.9)	$P = 0.001$
	Deep	3.0 (1.9)	
PP/GoGn (°)	Level	1.2 (0.9)	$P = 0.001$
	Deep	3.1(1.9)	
APFH index	Level	−1.9 (1.2)	$P < 0.01$
	Deep	−3.3 (1.6)	
AFH index	Level	0.8 (0.4)	$P < 0.05$
	Deep	1.3 (0.8)	
LAFH (mm)	Level	2.2 (1.5)	$P < 0.05$
	Deep	3.7 (2.2)	
stLAFH (mm)	Level	2.4 (1.5)	$P = 0.05$
	Deep	3.8 (2.1)	
Pg–VP (mm)	Level	−4.7 (2.4)	ns
	Deep	−3.1 (2.5)	
Pg'–VP (mm)	Level	−5.2 (3.1)	$P < 0.05$
	Deep	−3.2 (2.5)	
UL–VP (mm)	Level	0.1 (1.2)	ns
	Deep	0.3 (1.2)	
UL–VP (mm)	Level	3.2 (3.0)	ns
	Deep	2.3 (2.1)	

ns, non-significant.

Discussion

Maintenance of a deep curve of Spee is a common procedure performed in order to prevent the chin from being brought too far forward in patients treated by a BSSO (Zetz *et al.*, 1984; Tuinzing *et al.*, 1989, 2005; Mommaerts *et al.*, 2004).

The results of the current study confirmed that after surgery and completion of treatment, there was less forward movement of the chin when a deep bite was maintained prior to BSSO compared with a normal overbite. Additionally, the deep bite group demonstrated a significant increase in LAFH and a more marked opening rotation of the mandible. The explanation for this phenomenon lies in the fact that when the deep bite is maintained during orthodontic therapy, the mandible will not only move forward during surgery but, because of the deep bite, will also rotate downwards and backwards (Rubenstein *et al.*, 1991). Following surgery, the dentition will only have contact in the incisor region and at the second molars. The open bite in the premolar region is then closed within a few months using vertical elastic traction (Zetz *et al.*, 1984).

Several studies have investigated cephalometric changes after BSSO and found an increase in LAFH in patients with a low mandibular plane angle (Mobarak *et al.*, 2001; Berger *et al.*, 2005). Additionally, compared with medium and high angle cases, less forward movement of the chin point was found (Mobarak *et al.*, 2001). The pre-surgical orthodontic techniques, however, were not specified in these studies.

A significant drawback of the present investigation is that due to differences in magnification, pre-treatment (T0) lateral skull radiographs could not be used to perform linear cephalometric measurements. Therefore, changes occurring during the pre-surgical orthodontic phase (T0–T1) could not be quantified.

Levelling of the lower curve of Spee with continuous archwire mechanics is known to induce an opening rotation of the mandible as a result of (pre)molar extrusion (Levin, 1991; Parker *et al.*, 1995; Weiland *et al.*, 1996). It therefore may be argued that the opening rotation occurs in the pre-surgical orthodontic phase when the curve of Spee is levelled with continuous archwire mechanics. At the end of treatment, this would result in similar chin prominence and increase in LAFH, irrespective of the pre-surgical orthodontic technique. Further studies, including measurement of cephalometric changes occurring during pre-surgical orthodontic treatment, are needed to confirm the possible beneficial effects of maintaining a deep curve of Spee prior to BSSO on chin prominence and LAFH.

Conclusions

Maintenance of a deep bite prior to surgical mandibular advancement induces an opening rotation of the mandible reducing chin prominence and increasing LAFH post-surgically.

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