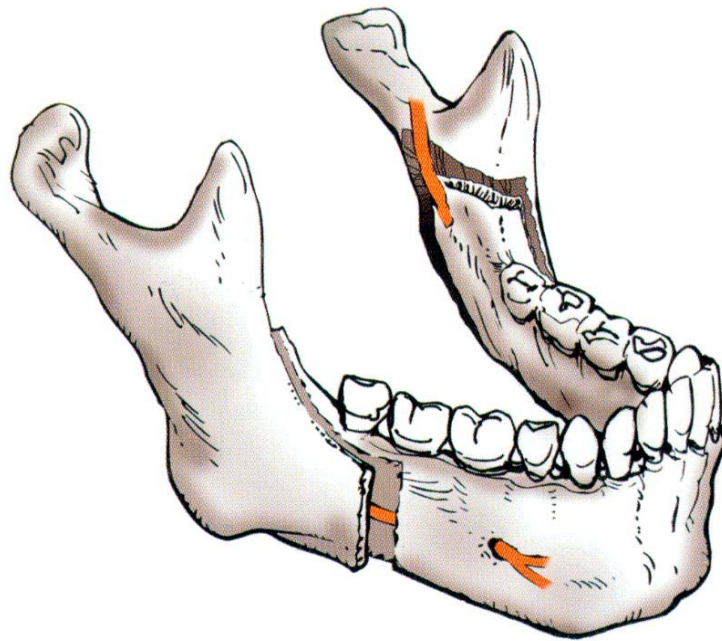


**Complications related to mandibular advancement  
by bilateral sagittal split osteotomy:  
a retrospective study of 132 patients**

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the degree Master of Science in Dentistry

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Illustration on front page: from Westermarck 1999

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## Summary

**Purpose:** The aim of the present study was to evaluate intraoperative and postoperative complications associated with bilateral sagittal split osteotomy (BSSO), and to analyse whether complications were associated with age at operation and patient's satisfaction with the result. An additional objective was to analyse whether nerve damage during surgery was related to persistent neurosensory disturbance in the facial skin.

**Sample:** 132 patients with skeletal Class II malocclusion operated between 1990 and 2002 with BSSO for advancement of the mandible participated in the study. Surgery was performed at Department of Maxillofacial Surgery Ullevaal University Hospital, and all subjects were followed for 3 years at Department of Orthodontics, University of Oslo.

**Methods:** Intra- and postoperative complications were assessed from the medical records. Neurosensory function and patient's satisfaction with outcome were assessed from clinical examination and patient's response in questionnaires 3 years after surgery. Associations between variables were analyzed by Chi square test, Fisher exact test or t- test.

**Results and Conclusions:** The inferior alveolar nerve was inadvertently injured in 36 sides (14%), suboptimal splits occurred in 15 sides (6% of the sides, 11% of the patients), 18 patients (14%) experienced postoperative infection, and osteosynthesis was removed in 10 patients (8%). Three years after operation, 76% of the patients reported not having normal sensation and 15% reported the alterations in sensibility to be distressing during daily life. Age had no significant effect on the prevalence of complications with exception of distress related to sensory disturbance. Dissatisfaction tended to increase among patients experiencing complications, but the only statistically significant relationship was observed among subjects reporting distress because of their altered sensation. Registration of visible nerve injury during surgery was significantly reflected in the degree of neurosensory disturbances.

## Introduction

Bilateral sagittal split osteotomy (BSSO) is a well documented standardized and relatively safe operation to correct jaw deformities such as mandibular retrognathism. The surgical procedure consists of bilateral osteotomies of the mandible, in which the angulus area is exposed by intraoral incisions and split in a near sagittal plane on both sides. The distal segments are then slid relative to the proximal segments and fixed with screws or plates. The inferior alveolar nerve enters the mandibular foramen at the medial side of the ramus, courses through the mandibular body and innervates teeth and associated structures. A terminal branch, the mental nerve, exits at the mental foramen and innervates the skin of lip and chin.

During the procedure the inferior alveolar nerve is invariably damaged as evidenced by initial, complete anaesthesia in the distribution of the mental nerve followed by prolonged or permanent sensory deficits in the area of its distribution. The relative roles of direct mechanical trauma and indirect trauma (vascular compromise, oedema, etc.) is not known.

Although the bilateral sagittal split operations is a common and safe procedure several complications have been reported including nerve injury,<sup>1-13</sup> excessive bleeding,<sup>14</sup> suboptimal splits,<sup>2,11</sup> infections,<sup>1,2,7,15-18</sup> bone necrosis,<sup>19</sup> temporomandibular joint (TMJ) problems,<sup>2,6,20-22</sup> dysphagia,<sup>23</sup> and psychological problems.<sup>24</sup> Nerve injury with resultant neurosensory disturbance is considered to be the main complication of this procedure. As stated above, the exact mechanisms underlying the nerve injury is complex and unknown,<sup>1,5,8,10,12,13,25,26</sup> but several possibilities have been discussed including surgical technique<sup>5,12,26</sup> and age.<sup>5,12,27,28</sup>

In the past decades patient centered health care has been emphasized as an important factor in evaluating treatment outcome.<sup>29,30</sup> Several long-term studies have shown that the majority of patients are satisfied after orthognathic surgery.<sup>29,31-34</sup> It has been observed that patients reporting dissatisfaction after orthognathic treatment have in common occurrence of unanticipated postsurgical events.<sup>35,36</sup> The importance of proper information about the treatment, including postoperative complications, for patient satisfaction has also been stressed by several authors.<sup>33, 35, 36</sup>

## **Aim**

The aim of the present study was to evaluate intra- and postoperative complications associated with surgical advancement of the mandible by bilateral sagittal split osteotomy (BSSO), and to analyse whether occurrence of complications was associated with age at operation and patient's satisfaction with outcome.

Another objective was to analyse whether recorded nerve injury during surgery was related to persistent sensory disturbances in the lip and chin area.

## **Materials and Methods**

### **Subjects**

The material consisted of patients with skeletal Class II malocclusion and mandibular retrognathism. They all underwent mandibular advancement surgery (BSSO) at the Department of Maxillofacial Surgery, Ullevaal University Hospital, Oslo in the period between February 1990 and September 2002. All received pre- and postoperative orthodontic treatment carried out by local practicing orthodontic specialists or postgraduate students under supervision. The dental and skeletal movements were planned by a university team of surgeons and orthodontists. All patients were followed for 3 years after the operation at the Department of Orthodontics, University of Oslo.

Information was collected from the medical records at the Department of Maxillofacial Surgery and records and questionnaires from the Department of Orthodontics. The latter is part of a protocol where the short- and long-term outcomes of the treatment are systematically reviewed. Data collected at the final 3-year review is included in the present study.

Of 135 consecutively operated patients who attended the 3-year review, three were excluded because the medical records were not available in the archives at the Department of Maxillofacial Surgery. Of the 132 subjects who constituted the sample 83 (62.8%) were women and 49 (37.1%) were men. One case with simultaneous genioplasty was included in the study, but there were no cases of concomitant maxillary osteotomies. Three patients had a history of trauma to the jaw and face area. None of the patients had a record of neurosensory disturbance in the inferior alveolar nerve (IAN) prior to surgery.

## **Surgical technique**

A team of 6 senior surgeons were involved in the treatment. In addition, several resident surgeons participated. The patients were operated according to a modified Obwegeser bilateral sagittal split osteotomy (BSSO). After completion of the split, the distal segment was repositioned in the planned position. Before fixation, the mandibular and maxillary dental arches were wired together. The bony segments were fixed using 3 bicortical screws (Salzburg system, Leibinger/ Howmedica, Germany) at each osteotomy site in the majority of the patients (92.4 %) In the remaining cases miniplates (Leibinger/Howmedica, Germany) alone or along with bicortical screws were used. Following fixation, the wiring was released and the occlusion and the position of the condyles were checked. The patients received standard regimens with antibiotics and glucocorticoids (see Appendix).

## **Data collected from the surgical charts**

Nine variables were defined from the data which was collected from the medical records.

These variables were classified into one of two main categories: intraoperative complications (3 variables) and postoperative complications (6 variables).

### Intraoperative complications

#### 1. Excessive bleeding (rupture of vessel)

*no excessive bleeding*

*excessive bleeding*

#### 2. Suboptimal split

*successful split*

*suboptimal split (right side / left side / both sides)*

*bad split (right side / left side / both sides)*

#### 3. Visible lesion or injury to the inferior alveolar nerve (IAN):

*no visible lesion*

*visible lesion with sustained continuity (right side / left side / both sides)*



*total transsection (right side / left side / both sides)*

*uncertain (right side / left side / both sides)*

#### Postoperative complications

1. Surgical site infection (recorded for right and left side separately)

*no infection*

*infectio*

2. Removal of osteosynthesis

*no removal*

*removal (right side / left side / both sides)*

3. Pseudarthrosis

*no pseudarthrosis*

*pseudarthrosis (right side / left side / both sides)*

4. Reoperation within 1 month

*no reoperation*

*reoperation*

5. Pain related sensory changes

*no pain related sensory changes*

*pain related sensory changes*

6. Visit at the out-patient clinic after being dismissed from hospital

*no visit*

*one or more visits*

#### **Data collected from orthodontic charts and questionnaires 3 years after surgery**

##### Mapping area of sensory disturbances.

During the clinical examination 3 years after surgery, information about nerve injury was collected by mapping out the affected area. The skin was lightly touched by a cotton wisp which was moved across the area until the patient stated the sensation to be normal. The size of the affected area was recorded in cm<sup>2</sup>.

### Temporomandibular joint dysfunction

Patients reporting symptoms related to the temporomandibular joint were examined for signs of dysfunction. The dysfunction was classified as no problem, slight/moderate, or severe.

### Treatment outcome

The questionnaires which were distributed during the clinical examination addressed attitudes to the treatment and treatment outcome. The questions (Q1 to Q5) applied in the present study are presented below (response alternatives in parenthesis):

Q1: How would you describe the sensation in the face/lips at present?

*normal / not normal*

Q2: Does the impaired sensation cause you distress during daily life?

*no or minor / yes / not relevant (normal sensation)*

Q3: Are you satisfied with the result of treatment?

*yes / no*

Q4: If you are dissatisfied, what is the reason?

(Free text)

Q5: With your current experience, would you have decided to have this treatment?

*yes / no*

### **Statistical analyses**

Differences between subgroups were analysed by Chi-square test or Fisher exact test for categorical and ordinal variables, and by t-test for continuous variables.

## **Results**

### Age of patients

The patients' ages at time of surgery ranged from 15.7 to 60.5 years (mean 30.9 years  $\pm$  10.4 years). Distribution of subjects in various age groups is presented in Table 1. In order to investigate possible effects of age on occurrence of complications this variable was dichotomized:  $< 30$  years ( $n = 70$ , 53%),  $\geq 30$  years ( $n = 62$ , 47%). There was no statistically significant difference in age between genders.

### Period of surgery

Possible trends related to time of operation were analyzed by defining three 4-year periods; 1990-94 ( $n = 43$ ), 1994-98 ( $n = 43$ ), and 1998-2002 ( $n = 46$ ).

## **Intraoperative complications**

### Excessive bleeding

Excessive bleeding was recorded in 4 out of 132 patients. One case was caused by lesion of the facial artery, while the second case was caused by a similar lesion of another artery in the operating field. The third and forth cases were described as profuse bleeding with no visualization of the bleeding vessel.

### Suboptimal split

A total of 15 sides (5.7%) and 14 patients (10.6%) were subjected to suboptimal osteotomies. There were seven cases (2.6%) recorded as bad split; three sides with fracture of the lingual fragment, two sides with fracture of the buccal fragment and two sides where the term was used without clarifying the fragment in question. Eight sides (3.0%) were exposed to smaller fractures, of which two were fractures of the coronoid process and one was a fracture of the

anterior part of the proximal segment (Table 2). No association was observed between suboptimal splits and gender, age at operation, and the period of surgery.

#### Nerve injury

The number of patients with visible nerve injury during the operation is presented in Table 3. The IAN was visibly injured during surgery in 36 (13.6%) sides, of which 3 sides (in 3 patients) represented total transection of the nerve. In 204 sites (77.2%) there was no visible damage, which leaves 24 sites (9.1%) where the condition of the IAN did not appear clearly from the medical records. No significant differences in frequency of nerve injury were observed between genders, age at operation, and period of operation.

No intraoperative cardiovascular, allergic or other severe complications were recorded in the charts.

### **Postoperative complications**

#### Surgical site infection

Table 4 shows that infection occurred in 18 patients (13.6%). Among the 17 patients with unilateral infection, 10 had infection on right side and 7 on the left side. Eleven patients developed infection within 2 months and 7 patients developed infection after 2 months. No differences in rate of infection were observed between genders, age groups, and period of operation.

#### Reoperation

Four patients (3.0%) were reoperated within one month. The causes were loosening of fixation screws in one case, poor occlusion in another, infection in a third and the forth needed additional surgery after a bad fracture.

### Failure/removal of osteosynthesis

Ten patients experienced failure of osteosynthesis (unilateral in 7 and bilateral in 3 patients). The most prevalent cause of failure with following removal was infection (6 patients) followed by prominent Salzburger screws (2 patients). In one patient removal was due to loosening of screws with pain, but no infection, and in one subject osteosynthesis was removed in conjunction with a pseudarthrosis operation.

### Other complications

One patient had a hematoma when discharged from the hospital and one patient acquired a hematoma 4 days postoperatively. Two patients presented a complaint concerning intraoral scarring at the outpatient clinic, with surgical revision being done in one of the cases. One patient experienced difficulties swallowing and presented this complaint 8 years postoperatively.

According to the medical records pain related sensory changes were reported in 7 patients, 3 being noted early postoperatively (the term neuropathic pain was used in only one of the cases). In addition, 3 patients presented a complaint at the out-patient clinic about hypoesthesia in the lip and chin area.

### Number of visits in out-patient clinic

Thirty-five patients (26.5%) had one or more visits at the out-patient clinic after they had been discharged from the hospital. There were no significant differences between genders or age groups, although there was a tendency that visits increased with increasing age. Furthermore, of those patients being operated during the period 1998-2002, 41.3% visited the out-patient clinic compared to 18.6% of those being operated both during 1990-94 and 1994-98 ( $p = 0.019$ ). This was also reflected in an increased prevalence of suboptimal splits,

visible nerve injury, postoperative infection and removal of osteosynthesis, although neither showed a significant difference between time periods.

### **Clinical recordings and questionnaire data 3 years after surgery**

#### Temporomandibular joint dysfunction

At the 3-year follow-up problems related to the TMJ were recorded in 25 patients (19.8%) (Table 5) and occurred significantly more often among women than men (25.6% vs 10.4%,  $p = 0.037$ ).

#### Area of sensory disturbances

Area mapping showed that 19.2% reported normal sensory function while 80.8% experienced skin areas with impaired sensory function (Table 6). Clinical examination revealed that for the total sample the size of the area with persistent disturbed sensation ranged from 0 to 33.0 cm<sup>2</sup> (mean 9.8 cm<sup>2</sup>  $\pm$  8.4 cm<sup>2</sup>). No significant difference was found in the mean size of the area between genders, age at operation (dichotomized < 30 years,  $\geq$  30 years), or time period for operation.

#### Subjectively reported disturbance in sensory function

Normal sensibility was reported by 24.2% of the subjects, while the remaining 75.8% had some degree of disturbances (Table 7).

#### Subjective distress related to sensory impairment

Subjective distress related to the nerve injury was reported by 15% (table 8). A higher rate of subjects older than 30 years reported this disability compared to the younger group below 30 years (17.7% vs 5.7%  $p = 0.030$ ).

#### Patient satisfaction with the treatment outcome

Sixteen subjects (12.1%) indicated in the questionnaires that they were not satisfied with the treatment result (Table 9). A tendency to higher rate of women reporting dissatisfaction with the result compared to men was observed. The difference did, however, not reach a statistically significant level. No significant association was found between satisfaction and age at time of operation.

From the patients' answers the reason for dissatisfaction could be categorized in one of 4 groups; displeasure about dental appearance and/or occlusion (n = 4), TMJ related problems (n = 4), impaired sensation (n = 3) and relapse (n = 2).

#### Re-election of treatment

Based on their experiences 81.1% of the subjects reported that they would have gone through the same surgical procedure one more time, 13.6% would not, while 5.3% were not sure (Table 10).

#### **Relationship between complications and patient's satisfaction with result**

None of the recorded intra- or postoperative complications showed statistically significant association with patients' report about satisfaction/dissatisfaction 3 years after surgery. However, there was a tendency towards dissatisfaction among patients with experience of suboptimal splits, postoperative infection, removal of osteosynthesis and/or had visited the out-patient clinic after being discharged from the hospital.

There were relatively more dissatisfied patients among those who reported persistent impaired sensation, but neither the subjectively reported sensory function nor the clinically assessed size of the affected area showed a significant relationship to satisfaction/dissatisfaction.

A significantly increased frequency of dissatisfied individuals was observed among those who reported distress caused by altered sensation ( $p = 0.020$ ) (Table 11).

#### Satisfaction and temporomandibular joint dysfunction

A significant relationship was found between dissatisfaction with treatment outcome and temporomandibular joint dysfunction. Of the 16 dissatisfied patients (Table 9) 10 reported temporomandibular joint problems ( $p = 0.000$ ). The remaining 15 patients who reported tempormandibular joint problems were satisfied with the treatment

#### **Relationship between nerve injury during surgery and persistent sensory dysfunction 3 years after operation**

A significant relationship existed between patient's report about sensory function in the questionnaire and the size of the area with impaired sensation as assessed clinically at the 3-year review. The mean area among those who reported impaired sensation was  $12.6 \text{ cm}^2 (\pm 7.6 \text{ cm}^2)$  compared to  $1.4 \text{ cm}^2 (\pm 3.6 \text{ cm}^2)$  among those who expressed that they had normal sensation ( $p = 0.000$ ).

Registration of visible nerve injury during surgery was significantly reflected in the clinically assessed ( $p = 0.029$ ) and subjectively reported sensation ( $p = 0.01$ ) as well as the increased distress felt because of sensory impairment (Chi-square = 7.222;  $df = 2$ ,  $p = 0.027$ ) (Tables 12 and 13). Visible nerve injury was however not reflected in any increased dissatisfaction.



### **Relationship between other complications and sensory impairment 3 years after surgery**

None of the patients who experienced postoperative infection ( $n = 18$ ) reported normal sensation at the final 3 year check-up, a tendency that proved significant ( $p = 0.01$ ). There was, however, no relationship between infection and size of area with sensory impairment. No other complication was significantly related to persistent sensory dysfunction. However visits to the out- patient clinic showed a significant connection to distress caused by sensory impairment ( $p = 0.001$ ).

## Discussion

### Neurosensory disturbance

The most common complaint after bilateral sagittal split osteotomy was neurosensory disturbances. The peripheral neural basis of normal cutaneous sensation is relatively well understood. The afferent fibers that innervate the skin provide the central nervous system with neural representations of the external world that vary in intensive (total numbers of active fibers and action potentials), temporal (timing of action potentials), spatial (patterns of activity across fibers) and modal (distribution of activity between fibre classes) structure. Any factors that affect the intensive or temporal response properties of individual afferent fibres, the spatial structure of the afferent population discharge, the balance of activity between fibre classes or the central mechanisms that operate upon the peripheral neural representations will affect a subject's sensory experience and perceptual capacity.<sup>37</sup>

In the present study 75.8% of the subjects reported disturbances in cutaneous sensation after 3 years. According to a literature study by Schreuder et al. in 2007, long standing (one year postoperatively) neurosensory disturbance has been reported with an incidence ranging from 0 to 75%.<sup>38</sup> The wide range of incidences reported is probably due to lack of standardised and reliable methods for evaluating and defining neurosensory disturbance.<sup>8</sup> It may also reflect that the nerve injuries in patients undergoing sagittal split osteotomy are not homogenous. It is more likely that some nerve fascicles sustained neurapraxia (temporary blockage of axon potential conduction without axonal degeneration), some sustained damage like that which occurs in crush (axonal degeneration and regeneration with connective tissue guidance to the original site of innervation), some like that which occurs in transection and some that sustained a mixture of these lesions.

The sagittal split osteotomy has been used as a clinical model for evaluation of nerve regeneration in humans.<sup>37</sup> A battery of psychophysical tests in which the neural mechanisms underlying performance are understood, have been used to study the basis of recovery following nerve injury.

It is understandable that modern neurophysiological methods and current understanding of neural coding mechanisms not have reached most orthodontists and oral and maxillofacial surgeons working in the field of nerve injury after orthognatic surgery. This is illustrated by the frequent use of two-point discrimination tests and area mapping which appears to be less sensitive than subjective magnitude estimation. It has been shown that Pacinian receptors are activated by mechanical stimuli at great distances, and therefore poorly controlled mechanical stimuli in the middle of a denervated region might activate mechanoreceptors in distant, normally innervated tissue regions, confusing both patient and observer to draw the wrong conclusion about the somatosensory state of the tested area.<sup>37</sup> This is illustrated by the different results found in evaluating nerve injuries after orthognatic surgery. Some authors have found higher incidence of sensory disturbance with subjective evaluation<sup>3</sup> compared to objective assessments, while others found the opposite.<sup>39</sup> Objective measurements have in some studies been found to correlate well with subjective sensation.<sup>12</sup> In the present study mapping of the area was performed. 80.2% was found to have an area with reduced sensitivity. Subjectively reported disturbances in sensory function were reported by 75.8%. The correlation between these two methods were significant ( $p = 0.000$ ).

The most important parameter in evaluating the extent and degree of neurosensory disturbances in the present study appears to be the subjective evaluation. Subjective distress related to the nerve injury was reported by 15%. This is in line with Blomquist et al who found that constant discomfort was reported by 14 % of the patients.<sup>11</sup>

Among those reporting distress due to sensory impairment, there was a greater frequency of patients aged  $\geq 30$  years at the time of operation. However, we did not find a significant correlation between age and prevalence of reported sensory dysfunction as found in many previous reports.<sup>5, 12, 27, 28</sup> This relationship has been explained by the influence of age on recovery from nerve injury and the better ability for young individuals to adapt to the new pattern of sensory impulses.<sup>40</sup>

### Nerve damage

Westermarck et al. reported in 1998 an incidence of 33% sides with visible nerve injury and Ylikontiola et al. in 2000 reported an incidence of 40%.<sup>5,28</sup> In comparison, the incidence of visible nerve damage recorded in this material is quite low (13.6% of the sides), although one must keep in mind that in 12 (9 % of the sides) the charts were not clear on the condition of the IAN (Table 3).

Nerve encounter with resultant neurosensory disturbance can occur both during and after the operation. The IAN can be damaged by medial protecting retractors, when sawing of the bone, splitting with chisels, on advancing the distal fragment or as a result of direct injury or compression by rigid fixation.<sup>10, 12, 25</sup> The nerve can also be injured in an indirect manner by immediate postoperative haematoma or oedema.<sup>3</sup> All these potential ways of nerve damage could explain why patients have neurosensory dysfunction despite the fact that the IAN seems unharmed intraoperatively.

According to Bell, Proffit and White the incidence of nerve injury with SSRO cannot be minimized greatly by good surgical technique, but the severity of the damage can be minimized<sup>1</sup>. Many authors have found that surgical skill significantly influences the incidence of postoperative neurosensory disturbance.<sup>5, 12, 26</sup>

The wide range of surgeons (6 senior surgeons and a number of surgeons in training), 1-2 participating in one operation, without indicating which side was operated by whom, made it difficult to analyse the operator variable. Instead, the year of the operation was used as a less specific measurement to correlate to nerve encounter and other complications. No significant relation of occurrence of visible nerve injury and the date of operation was found.

It could be argued that the categories for degree of nerve injury used are too wide. The cause of this lies in the ambiguous terms used in the medical records when describing the condition of the nerve. Another shortcoming of this study is that the clinical assessment of sensation does not discriminate between sides. Westermarck et al. (1998) found a significant correlation between increasing degree of intraoperative nerve encounter and increasing severity of nerve dysfunction<sup>5</sup>, an observation supported by other authors.<sup>3,12</sup> This is in line with the findings in this study, which showed that visible nerve injury resulted in an increased area of sensory disturbance and self reported sensory impairment.

### Excessive bleeding

Troublesome bleeding was encountered in four patients. This was controlled by local measures and no one needed blood transfusions. Previous studies also indicate that severe intraoperative bleeding is very rare.<sup>2, 6, 11</sup>

### Suboptimal splits

Bad splits usually involve the lingual part of the distal segment. Martis found an incidence of 1.93% of such fractures<sup>2</sup> and Panula, Finne and Oikarinen reported an occurrence of 2% of bad splits<sup>6</sup>. Bothur and Blomqvist reported difficult splits in 8.8 % of the sides and bad splits in 1.3 %.<sup>11</sup> In this material some kind of fracture occurred in 6% of the sides, 3 % being recorded as bad splits (including the proximal segment as well as the distal).

### Surgical site infection

All the patients received prophylactic antibiotics for two days. Wound infections related to the immediate postoperative course were few. Infection within two months postoperatively occurred in 11 subjects (8%) and after two months in 7 subjects (5%, totally 13%) This is in accordance with other studies suggesting infection rates in the range of 10-15 %.<sup>7, 17</sup>

### Failure of osteosynthesis

Removal of osteosynthesis was performed in 8 % of the patients, a prevalence which is in agreement with previous reports.<sup>41</sup> The most prevalent cause of removal was infection, a finding also supported by previous studies.<sup>41-43</sup> Routinely asymptomatic titanium screws or miniplates are not removed, in spite of some controversy on the subject.<sup>44</sup>

### Visits to out-patient clinic

There was an increase in visits to the out- patient clinic observed in patients operated during the period 1998-2002 compared to those being operated both during 1990-94 and 1994-98 ( $p = 0.019$ ). This could reflect an increased awareness of the patients with regards to their health as a result media focus on medical issues and adverse outcomes of treatment. Another possibility is operator dependent, with a shift in surgeons, as there was an increased prevalence of intra- and postoperative complications in 1998-2002. The difference in prevalence of complications between the groups was not significant. As mentioned the use of these year groups this is a rather inaccurate measurement.

### Temporomandibular joint function

At the 3- year follow-up problems related to the TMJ were recorded in 25 patients (20%) and occurred significantly more often in women. This is in line with frequency of signs and symptoms of TMD in the general population, and cannot be viewed as a complication of the operation.<sup>45</sup> Several authors have concluded that orthognathic surgery has a positive impact

on TMJ dysfunction.<sup>20-22</sup> However, both improvement and appearance of new signs and symptoms have been reported after orthognathic surgery.<sup>21, 22</sup> Unfortunately, in the present study no systematic recordings of the pretreatment TMJ situation were available.

#### Patient's satisfaction with the outcome

In modern medicine success of the treatment is not only dependent on clinical measures, but also on the quality of care apprehended by the patient. The majority of patients is satisfied with the result after orthognathic surgery<sup>29, 31-34</sup> and would re-elect operation based on their present experience.<sup>33, 46</sup> The frequency of satisfied patients in the present study (87%) as well as the rate of patients reporting willingness to make the same decision (86%) is in accordance with these previous studies. However, the frequency of satisfied subjects in this sample of patients treated by surgical mandibular advancement is lower than the overall rate of 93% satisfied among all patient (n = 741) receiving orthognathic surgery during the actual period (1990-2002) and being followed for 3 years.<sup>47</sup>

Of 16 dissatisfied patients, nine indicated that they would re-elect surgery based on their current experience, which indicates that the treatment had some positive impact on their lives although they were not overall satisfied with the result. Flanary et al 1985 found that surgical goal fulfilment didn't guarantee that the patient would re-elect the treatment.<sup>35</sup>

An interesting finding in this study was also that 13 of the satisfied patients would not re-elect surgery. This suggests differences in perception of the terms satisfaction and treatment result which can be comprehended in several dimensions such as the functional, aesthetic, psychological and social. Fulfilment of expectations is a contributing factor for patient satisfaction/dissatisfaction, and it has been found that patients with realistic expectations are more satisfied in long term<sup>36</sup>. The importance of proper presurgical preparation and advice

about complications has been highlighted by many authors.<sup>33, 35</sup> Careful patient selection is also an imperative.<sup>32, 36</sup>

Flanary et al 1985 found that one of the most important factors leading to dissatisfaction with surgery was the patient's experience of postoperative "surprises".<sup>33, 35</sup> Although not statistically significant, we found a tendency towards dissatisfaction when patients experienced postoperative complications. The results showed that the frequency of dissatisfied patients was significantly greater among those who reported distress because of altered sensation ( $p = 0.020$ ) (Table 12). Maurer et al 2002 also found that dissatisfaction was related to postoperative sensory function.<sup>46</sup>

The observation in the present study that women showed an increased tendency to dissatisfaction (not statistically significant) might be explained by an increased prevalence of TMJ problems compared to men ( $p = 0.037$ ), as postoperative TMJ problems were significantly related to dissatisfaction ( $p = 0.000$ ).



## Conclusions

Severe complications were rather rare in this study of 132 patients undergoing mandibular advancement with bilateral sagittal split osteotomy. With a low frequency of complications it is difficult to reveal significant associations, and larger samples might be needed to identify relationships between complications and variables such as patient satisfaction and sensory function.

- The most frequent intra- and postoperative complications observed:
  - The inferior alveolar nerve was visibly injured in 14% of the sides
  - Suboptimal splits was encountered in 6% of the sides (11% of the patients)
  - Postoperative infection occurred in 14% of the patients
  - Osteosynthesis was removed in 8% of the patients, mainly because of infection
- After being discharged from the hospital 27% of the patients visited the out-patient clinic.
- Three years after surgery 75% of the patients reported not having normal sensation and 15% of these indicated distress caused by the alterations in sensation.
- Registration of visible nerve injury during surgery was significantly reflected in the clinically assessed and subjectively reported sensation as well as the increased distress felt because of sensory impairment.
- Age had no significant effect on the prevalence of complications. However, distress caused by sensory disturbance was reported by a higher rate of subjects  $\geq 30$  years compared to those  $< 30$  years ( $p = 0.030$ ).
- There was a tendency to increased rate of dissatisfaction with treatment outcome among patients who experienced complications, although not statistically significant. The only

significant relationship observed was increased dissatisfaction among subjects reporting distress because of altered sensation.

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**Table 1.** Distribution of the 132 subjects (83 women, 49 men) according to age group.

	n	%
< 20 years	24	18.2
20-29 years	46	34.8
30-39 years	37	28.0
40-49 years	15	11.4
≥ 50 years	10	7.6

**Table 2.** Frequency of successful, suboptimal and bad splits among 132 subjects.

	n	%
Successful split	118	89.4
Suboptimal split, unilateral	6	4.5
Suboptimal split, bilateral	1	0.8
Bad split, unilateral	7	5.3
Bad split, bilateral	0	0

**Table 3.** Frequency of nerve injury during operation among 264 sides in 132 subjects.

	n	%
No visible injury	204	77,3
uncertain	24	9,1
Visible injury	36	13,6

**Table 4.** Frequency of patients with postoperative infection assessed among 132 subjects.

	n	%
No infection	114	86.4
Infection, unilateral	17	12.9
Infection, bilateral	1	0.8

**Table 5.** Distribution of patients with problems related to the TMJ assessed 3 years after surgery according to gender among 126 patients (data was missing for 6 subjects).

	Women		Men		Total	
	n	%	n	%	n	%
No problems	58	74.4	43	89.6	101	80.2
Slight/moderate	17	21.8	5	10.4	22	17.5
Marked/frequent	3	3.8	0	0	3	2.4
	78	100.0	48	100.0	126	100.0

Significant difference between genders: Chi-square = 4.330, df = 1, p = 0.037

**Table 6.** Distribution of patients according to size of area with sensory disturbance recorded 3 years after surgery. n = 130(data missing for 2 patients)

Area (cm <sup>2</sup> )	n	%
0 (normal sensation)	25	19.2
< 4	18	13.8
4 – 16	59	45.4
≥ 16	28	21.5
Total	130	100.0

**Table 7.** Distribution of answers to question about sensory function (Q1) reported among 132 patients 3 years after surgery.

	Normal sensation		Not normal		Total	
	n	%	n	%	n	%
Women	24	28.9	59	71.1	83	100.0
Men	8	16.3	41	83.3	49	100.0
Total	32	24.2	100	75.8	132	100.0

**Table 8.** Distribution of answers to question about distress related to sensory dysfunction (Q2) among the 100 patients reporting impaired sensation 3 years after surgery (patients reporting normal sensation(n=32) are excluded).

	No / minor		Yes		Total	
	n	%	n	%	n	%
Women	48	81.4	11	18.6	59	100.0
Men	37	90.2	4	9.8	41	100.0
Total	85	85.0	15	15.0	100	100.0

**Table 9.** Distribution of answers to question about satisfaction with treatment result (Q3) reported among 132 patients 3 years after surgery.

	Satisfied		Dissatisfied		Total	
	n	%	n	%	n	%
Women	70	84.3	13	15.7	83	100.0
Men	46	93.9	3	6.1	49	100.0
Total	116	87.9	16	12.1	132	100.0

**Table 10.** Distribution of answers to question about whether the individuals would have re-elected surgery based on their present experience (Q5) reported among 132 patients 3 years after surgery.

	Yes, re-elect surgery		No, not re-elect surgery		Not sure	
	n	%	n	%	n	%
Women	67	80.7	11	13.3	5	6.0
Men	40	81.6	7	14.1	2	4.1
Total	107	81.1	18	13.6	7	5.3

**Table 11.** Association between satisfaction/dissatisfaction with result (Q3) and reported distress caused by impaired sensory function (Q2) reported among 132 patients 3 years after surgery.

	Satisfied		Dissatisfied		Total	
	n	%	n	%	n	%
No / minor distress / not relevant	106	90.6	11	9.4	117	100.0
Distress	10	66.7	5	33.3	15	100.0
Total	116	87.9	16	12.1	132	100.0

Fisher exact test:  $p = 0.020$

**Table 12.** Size of area (mean value and SD) with clinically assessed sensory impairment 3 years after surgery among subjects with and without visible nerve injury as recorded intraoperatively (n = 132).

	n	Mean (cm <sup>2</sup> )	SD (cm <sup>2</sup> )
No visible injury	81	8.6	8.4
Visible injury or uncertain	49	11.9	8.0

t-test: p = 0.029

**Table 13.**

Frequency of patients reporting normal sensation and not normal sensation 3 years after surgery (Q1) among subjects with and without visible nerve injury as recorded intraoperatively (n = 132).

	Normal sensation		Not normal sensation		Total	
	n	%	n	%	n	%
No visible injury	26	31.7	56	68.3	82	100.0
Visible injury / uncertain	6	12.0	44	88.0	50	100.0
Total	32	24.2	100	75.8	132	100.0

Chi-square = 6.568, df = 1, p = 0.010



## Appendix

Regimens with antibiotics and glucocorticoids. If patients were allergic to penicillin erythromycin was given as the alternative

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Drug: day	Day of surgery	First p.o. day	Second p.o.
Penicillin	5 mill. I.E. x 3 i.v.	5 mill I.E. x 3 i.v.	
Erythromycin	250mg x 4 i.v.	250mg x 4 i.v.	
Methylprednisolone *	125 mg i.v. at start of surgery. 40 mg x 3 i.v.	40mg x 4 i.v.	40mg i.m.**

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• Solu- Medrol (Pfizer)
** Depo- Medrol (Pfizer)

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