The aim of this thesis was to investigate problems, obstacles, and complications arising from treatment using mandibular DO. Further specification for various indications as congenital, developmental, and acquired deformities of the mandible were analyzed separately.

This was performed by:

1. investigating the complications of mandibular DO in congenital deformities and introducing a general index for classification of complications (chapter 2)

2. investigating complications of mandibular DO in developmental deformities (chapter 3)

3. investigating complications of mandibular DO in acquired deformities (chapter 4)

General complications of mandibular distraction osteogenesis were studied, by:

4. investigating neurosensory disturbances of mandibular DO patients in comparison with conventional surgery for mandibular advancement (bilateral sagittal split osteotomy) (chapter 5)

5. investigating general complications, viz., symptomatic venous thromboembolism, of mandibular DO (chapter 6)

6. investigating general complications, viz., post-operative infections, of mandibular DO (chapter 7)

The use of distraction osteogenesis for transverse widening of the maxilla was performed by:

7. investigating complications of transpalatal (bone-borne) distraction osteogenesis of the maxilla (chapter 8)
“To err is human” (Alexander Pope). Unfortunately all surgeons face surgical complications, and this is particularly true for new techniques. DO is a relatively new technique that has evolved in many aspects terms of indications, distraction devices, and combination with other surgical techniques. Despite a large number of reports on mandibular DO, complications in the literature seem to be underreported\(^1\text{—}^3\). Publications involving large numbers of patients with varying skeletal deformities and complex surgery are widely available. We believe that by investigating these complications, the understanding of the implications of performing DO can increase and it might lead to reduction these errors.

Several general classification systems or indices have been made for DO\(^1\text{—}^2\). In this thesis, a new index for more detailed classification of complications in mandibular DO is proposed, based on six categories that focus on the impact of the complication and its further treatment or final results. The proposed complication index may be a helpful tool for classifying and analyzing complications related to MDO and for gaining insight into the actual impact thereof on the patient (chapter 2). Applying this index could provide a better understanding of the long-term effect of this type of treatment.

Another goal of our investigation was to obtain a better comprehension of complications in varying deformities. A Class II mandibular deformity (retrognathic mandible) in an adolescent could lead to (transient) neurosensory disturbance of the IAN, and yet never result in disk displacement, facial scarring, or facial nerve palsy in patients with congenital deformities. A patient with a congenital deformity faces different problems than a patient with acquired difficulties. This might seem obvious; nevertheless, studies involving large patients groups often do not differentiate these types of patient categories, so that comparisons are not made appropriately.
Congenital deformities

Surgery in young patients with congenital facial/mandibular deformities is expected to be challenging, due to their age, small posture, the severity of the deformity, and co-morbidity. Syndromic patients are at risk for more (severe) complications. To our knowledge, no specific reports on complications in this category are available. In the current literature, patient groups are heterogeneous and often undergo combined treatment in bimaxillary surgery; therefore, precise extraction of data on complications in mandibular DO is not always possible. In chapter 2, we attempted to isolate all mandibular DO for congenital mandibular deformities, such as microsomia, Pierre Robin sequence, and Treacher-Collins syndrome. In 21.2% of all patients, complications could be managed without surgical measures. In 5.3%, surgical intervention was required, and in 7.9%, the complication was permanent. Such challenges in patients with severe mandibular deformities are vector control (55/433) and permanent skeletal open bite (30/433); these occur frequently in patients with congenital deformities, and can lead to long-term functional problems. Some of the consequences of MDO that these patients have to face include permanent damage to teeth and follicles (14/433), the skin (26/433), facial nerve (23/433), and parotid gland (2/433).

Developmental deformities

DO in patients with Class-II mandibular hypoplasia and transverse mandibular hypoplasia are treated by mandibular lengthening and transverse widening. In chapter 3, the results of 32 articles reporting on 565 patients and a total of 211 complications (37.3%) are discussed. IAN neurosensory disturbances, minor infection, device failure, anterior open bite, permanent dental damage, and skeletal relapse were most frequently represented.

In 21.8% of all patients, complications could be managed without surgical measures. In 6.0%, surgical intervention was required and in 9.6%, the complications were permanent. This distribution is similar to that in the congenital group, with a slightly higher rate of permanent complications (2.0%), which was unexpected, since MDO in patients with congenital deformities is thought to be more challenging and is therefore expected to be prone to complications. The types of permanent complications seem to be less severe (damage to incisors, neurosensory disturbance of the IAN, resorption of the mandibular condyle, and skeletal relapse).
Acquired deformities

This group consisted of different types of mandibular DO, alveolar distraction osteogenesis (ADO), mandibular lengthening, DO in bone grafts, and bi-/trifocal transport disc DO for segmental mandibular defects (chapter 4). A high incidence of complications was seen in mandibular DO for acquired deformities (ADO 44.4%; residual group 43.9%).

In the ADO-group, 30.5% of all patients’ complications could be managed without surgical measures. In 8.9%, surgical intervention was required, and in 4.9%, the complication was permanent. Complications, such as soft tissue complications (8.0%), insufficient vector control (7.6%), temporary IAN neurosensory disturbances (6.5%), device-related problems (3.5%), mandible fractures (2.8%), insufficient bone formation (2.5%), and fracture of the transport disc (1.3%) were seen.

The residual group consisted of those who underwent reconstructive surgery for mandibular defects, TMJ ankylosis, post-traumatic surgery, OSAS, and complications of prior treatments. This makes comparison difficult, and such a comparison may not even be possible. However, to provide a full spectrum of all the types of MDO, these patients have also been included. In the residual group, 33.3% of all patients’ complications could be managed without surgical measures. In 7.3%, surgical intervention was required, and in 6.3%, the complications were permanent. Complications such as temporary IAN neurosensory disturbances (13.4%), minor infection (5.3%), DO failure (4.0%), and device-related problems (3.8%) were reported.

The distribution of the type or severity of the complications was similar in all categories. The highest incidence of permanent complications (9.6%) was seen in the developmental group.
Neurosensory disturbances

It has been suggested that the risk of neurosensory disturbance (NSD) of the IAN is lower in patients treated with mandibular DO than in those who underwent conventional surgery for mandibular advancement (bilateral sagittal split osteotomy). Gradual lengthening and stretch of the soft tissue may lead to less NSD. Chapter 5 describes a retrospective study, including 91 patients, in which these techniques were compared in terms of long-lasting NSD and overall patient satisfaction.

In the BSSO-group (90 nerves), long-lasting NSD was reported in 27 cases (30%), as compared to 21 cases (23%) in the DO group (92 nerves). In 39 cases (24 BSSO, 15 DO) the long-lasting NSD was reported to affect the lower lip, the chin, or both. Of these cases, 9 (5 BSSO, 4 DO) were objectively tested as positive for NSD.

The overall prevalence of NSD was 8% in the BSSO group and 10% in the DO group. There was no significant difference in subjectively reported and objectively measured NSD between the groups. In both groups, the subjective outcomes of NSD were higher than the objective outcomes.

For both procedures, overall patient satisfaction was high. This indicates that the discomfort of the nerve damage seems to be outweighed by the positive functional and aesthetic results.

Based on the results of this study, it can be concluded that both BSSO and DO are appropriate techniques for the treatment of mandibular retrognathia, with no significant difference in prevalence of long-lasting NSD of the IAN. There seems to be slightly more patient distress inherent to the DO technique than with the advancement of the mandible by BSSO, although the degree of satisfaction was high in both groups.

Other factors can also influence the perceived outcome of BSSO and DO, such as stability and relapse, and patient-related factors, such as discomfort and cooperation (DO procedure).
Symptomatic venous thromboembolism in orthognathic surgery and DO

Venous thromboembolism is a common postoperative complication, and orthopaedic procedures are particularly at risk. Chapter 6 describes a retrospective, single centre, observational, cohort study of 4127 patients (mean (SD) age: 27 (11) years), who had elective orthognathic operations or distraction osteogenesis between January 1970 and February 2012 at the VU University Medical Centre, Amsterdam, to investigate the incidence of this complication. In this group, over the 42-year period, only 2 patients developed symptomatic venous thromboembolism (1 woman had a deep vein thrombosis (DVT) and 1 man had a DVT and pulmonary embolus) postoperatively. In relatively young patients with low to moderate risk factors and a short hospital stay, this type of operation is associated with a particularly low risk of developing thrombosis. It could be advisable to limit the use of thromboprophylaxis in patients at high risk, or according to hospital guidelines.

Infections in intraoral DO for mandibular lengthening

In chapter 7 we report on clinical infections in MDO that can lead to more severe complications, such as loosening of hardware, which can lead to removal of the distraction device in some patients, osteomyelitis, and fracture of the newly generated bone. The incidences of such complications for intraoral devices vary from 2.3 to 8.0%. Our systematic review reports an incidence of 8.6%. A retrospective study was performed to analyze the incidence of local infections in 60 patients treated with MDO for a Class II mandibular hypoplasia. Seven patients (11.7%) presented with a form of infection. In one patient, one of the distractors had to be refixed under general anesthesia. In all studies, the majority of the infections occurred relatively late in the consolidation phase. Persistent infection around the distraction rod is common. The activation rod of the distractor forms a niche or porte d’entree, which results in a continuous bacterial contamination around the distractor. The distractor can behave as a corpus alienum and remains subject to a limited amount of movement during the entire distraction phase. However, this seems inevitable in this treatment modality. A recommendation could be to shorten the activation rod after active distraction to prevent continuous contact with commensal and pathogenic oral flora.
Transpalatal DO

Transpalatal DO is an established technique for surgical expansion of the transverse hypoplastic maxilla. The purpose of this study was to investigate and categorize the short- and medium-term incidence of peri- and postoperative difficulties (classified in problems, obstacles, and complications; chapter 8). The surgical procedure requires bone cuts between the central incisors, in the proximity of the periodontal ligament and the lateral wall of the maxillary sinus. Our clinical and radiological investigation shows a low incidence of dental and periodontal damage (gingival recession at 15 sites, 4.0% and pocket depths, 4-5 mm at 11 sites, 2.9%). In 28.6% of the incisors, we found radiographic signs of external apical root resorption (EARR). This phenomenon is also seen after orthodontic treatment and incisors are generally more susceptible to EARR. A low incidence of iatrogenic damage to the roots was seen, and endodontic and peri-apical treatment was required. No premature loss of teeth was reported.

Mainly appliance-related problems occurred, such as loosening of the fixation screws. This is a common problem encountered during the active distraction and neutrofixation phase, which leads to further treatment, such as re-fixation or placement a new module. The local bone conditions may be unfavorable for re-fixation, and are limited on the palate. In some cases, a tooth-borne appliance is required, which might lead to more expansion on the dental level.

More challenging problems were seen in patients with dislocation of the TPD-module and asymmetric maxillary expansion, requiring replacement of the module, re-corticotomy or Le Fort I-osteotomy/maxillary corrective surgery. In one out 73 patients, a complication of premature loss of the TPD-module, due to lack of space, occurred in a patient with cleft palate. Improvements have been made in the distraction devices since their introduction and placement and use has improved over time. An additional advantage is the possibility of continuing orthodontic treatment during DO8,9.

In our conclusion, transpalatal DO is a reliable technique with predictable outcomes, and is associated with a low incidence of dental and periodontal damage.
REFERENCES


