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Clinical aspects of a 2.0-mm locking plate system for mandibular fracture surgery

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SUMMARY. Purpose: **The use of a 2.0-mm locking plate system was evaluated in mandibular surgery.** Patients and methods: **53 patients (42 male, 11 female) with a total of 56 mandibular fractures were treated with a 2.0-mm mini-locking-plate system and retrospectively examined. Gender, age, cause of fracture, surgical access, classification of fractures, osteosynthesis, postsurgical findings and complications were evaluated.** Results: **Assault in male patients (mean age 31) was the most common aetiological factor. Fractures in women (mean age 43 years) mostly occurred due to falls. Mandibular angle fractures were the most common and this anatomical site also presented the highest complication rate. Only 6% of patients had minor occlusal disturbance postoperatively, and minor complications (infections and dehiscence) occurred in 14% of patients in this study. Major complications only occurred in one patient included in the study (1.9%). Risk factors for the development of complications in this series were a history of alcohol or tobacco use, mandibular angle fractures, associated facial fractures, presurgical occlusal disturbance and concomitant dental infections. Surgical access to the fracture and the interval from injury to surgery was not associated with the development of complications.** Conclusions: **The use of a 2.0-mm locking plate system with its advantages of improved handling characteristics, increased stability, shorter surgical time and the preservation of bony perfusion is a viable alternative to conventional miniplates in the management of mandibular fractures.** © **2010 European Association for Cranio-Maxillo-facial Surgery**

Keywords: **clinical study, locking plate system, mandibular fracture, plate osteosynthesis**

INTRODUCTION

Since the development of osteosynthesis in maxillofacial surgery various reconstruction plate designs have improved intraoperative handling as well as postsurgical results in the management of mandibular fractures (*Ellis* and *Graham*, 2002; *Gutwald* et al., 2003). While the introduction of miniplates in the treatment of mandibular fractures led to a notable decrease in surgical soft tissue trauma and improved ease of handling, with sufficient stability and fixation of mandibular fractures, loosening of screws due to transmission of pressure to the underlying bone leads to loss of fracture stability and fixation failure (*Gutwald* et al., 2003; *Sauerbier* et al., 2008). Advantages of the locking system are the ease of plate adaptation, enhanced stability without transmitting excessive pressure to the underlying bone, leading to less impairment of blood supply (*Ellis* and *Graham*, 2002; *Gutwald* et al., 2003). The mini-locking-system (UniLock 2.0, Synthes, Oberndorf, Switzerland) developed by the Albert-Ludwigs-University of Freiburg in cooperation with the AO/ASIF-Institute (Davos, Switzerland) was evaluated in an in-vitro study by Gutwald and co-workers and was shown to provide superior accuracy in bone reduction and stability when compared to conventional miniplates (*Gutwald* et al., 2003). The system was also evaluated in an animal study indicating good handling characteristics as well as favourable histological results (*Gutwald* et al., submitted for publication). This retrospective study evaluated the use of the 2.0-mm Unilock system in the management of mandibular fractures.

PATIENTS AND METHODS

This retrospective study included 53 patients with mandibular fractures, treated at the Department of Oral- and Maxillofacial Surgery at the University Hospital of Freiburg, utilising the UniLock 2.0 system from January 2001 to May 2004. All patients included in the study were diagnosed with mandibular fractures and were treated with the UniLock 2.0 system, some of the fractures were, however, treated with additional conventional miniplates. Relevant data was obtained from patient records as well as pre- and postsurgical imaging and entered into a database for analysis. Data collected included age, gender and medical history of the patients, history of aetiological factors and use of alcohol and tobacco, presence of associated fractures, localisation of

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the fracture, time from injury to surgery, management of teeth within the fracture line, surgical access, osteosynthesis, postoperative occlusion and complications.

RESULTS

56 mandibular fractures in 53 patients (42 male, 11 female) with a mean age of 34 years (male 31 years and female 43 years) were treated with the Unilock 2.0 system. Co-morbid disease consisted of hypertension (18%), hepatitis (12%), asthma (6%), epilepsy (6%), hypotension (6%) and syncopy (6%). Use of alcohol was reported by 34% of patients and tobacco by 56% of patients. Aetiological factors included assault in 39% with a high incidence of concurrent alcohol history, falls and accidents at home (24%), motor vehicle accidents (18%), sport injuries (8%) and other causes (10%). Associated facial fractures were present in 6% of patients included in the study with 2% of patients having skull base fractures and 17% of patients presenting with concurrent head injury. Dental fractures occurred in 81% and luxations in 6% of the study group. Teeth were present in the fracture line in 79% of patients, of which 26% were removed during osteosynthesis. Seven percent of these teeth were extracted during plate removal. The complexity and the anatomical distribution of the fractures are displayed in Table 1.

The interval between trauma and surgical management ranged from 1 day to 2 weeks (mean 2.9 days). Surgical approach to the fracture consisted of an intra-oral approach (57%), a combination of intra- and extra-oral approach (17%), transbuccal and intra-oral approach (17%) and an external approach in 9% of cases. Anatomical distribution of the fractures as well as number of plates utilised in osteosynthesis is illustrated in Graph 1.

Postoperatively only 6% of patients presented with a slight occlusal disturbance and 8% of cases had a radiological gap at the fracture line, although good stability was present. Wound infection and dehiscence each occurred in 7.5% of patients with 87% of these patients having a positive history for either alcohol or tobacco use or for both. Furthermore, 25% of the patients that developed postoperative complications had concomitant dental infections and 75% of these patients had presurgical occlusal abnormalities. Neither the timing of surgery after trauma, nor the surgical access to the fractures appeared to correlate with the occurrence of complications. The majority of complications occurred at the mandibular angle (50%), with 37.5% in the parasymphyseal area and 12.5% in the mandibular body. Additional fractures were present in 62.5% of patients that had complications, of which 60% of these additional fractures were condylar. Only one screw loosened, this was noted during plate removal which was performed in 56% of patients. Two patients needed early surgical removal of hardware due to plate fracture, of which one needed re-plating.

DISCUSSION

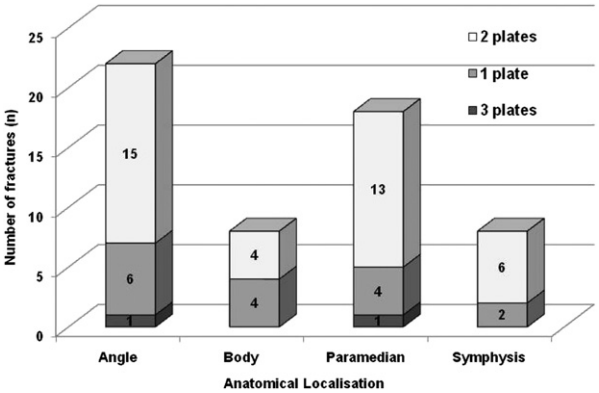
The dimensions of the UniLock 2.0 system correspond to conventional 2.0-mm miniplate systems. The plates are available in three different sizes, 'Mini', 'Intermediate' and 'Large' and in straight or angled forms with or without a bar (for the sizes 'Intermediate' and 'Large'). All plate sizes are fixed with self-tapping 2.0 mm locking screws with a characteristic twin thread on the rim of the screw head (Fig. 1). The screw thread fits exactly into the threaded plate holes and locks the screw into the plate during fixation. These plates were developed in order to improve miniplate osteosynthesis and reduce complications when surgically treating mandibular fractures. The present study evaluated the advantages of the UniLock 2.0 system as an adequate alternative to conventional miniplate systems.

Ellis and Miles state that the primary goal of mandibular osteosynthesis is to achieve the pre-injury occlusion (*Ellis* and *Miles*, 2007). Using the UniLock 2.0 system, the present study showed that only 6% of patients have a slight postoperative malocclusion, and correlates with the study of Ellis and Graham, using the UniLock 2.0 system having two cases with only a slight malocclusion after plate removal (*Ellis* and *Graham*, 2002). Similar studies on conventional miniplates showed postoperative malocclusions in approximately 5% of the cases which were addressed by adjusting the occlusion (*Nakamura* et al., 1994; *Tuovinen* et al., 1994; *Choi* et al., 1995).

Herzberg noticed a higher rate of complications when the interval between trauma and surgical treatment is

Table 1 – Presurgical dislocation of the bony fragments, mobility of the bony fragments and impaired mouth opening

Parameter	*n* out of 53 patients [*n* = patients]	Percentage [%]
Dislocation of fragments		
Yes	47	89
No	6	11
Mobility of fragments		
Slight	21	40
High	24	45
None	8	15
Preop. mouth opening		
Impaired	49	92
Non-impaired	4	8



Graph 1 – Anatomical distribution of fractures and number of plates used for osteosynthesis.

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Fig. 1 – The UniLock 2.0 system consists of a screw with a threaded head which fits exactly into the threads within the hole in the plate [picture published with permission of Synthes, Umkirch, Germany].

delayed for more than 6 days (*Herzberg*, 2001). This study, however, correlates with the findings of Ellis that did not observe a direct relationship between delayed treatment and higher postoperative complication rates (*Koulocheris* et al., 2007). Surgical access to the fracture also did not correlate with the presence of complications. In general, information on complication rates (noted in the literature to be 3.9–30.0%) is not based on standardized definitions. This makes direct comparisons difficult. *Ellis* and *Walker* (1996) subdivided complications into minor and major complications. Minor complications were defined as wound dehiscence and infection, and occurred in 7.5% of cases in this study. Half of the minor complications occurred in mandibular angle fractures, correlating with other published data which mentioned the mandibular angle as the anatomical area with the highest rate of complications. This may be explained by the presence of the pterygo-masseteric sling, transmitting dynamic forces to this anatomical localisation (*Levy* et al., 1991; *Choi* et al., 1995; *Ellis* and *Walker*, 1996). Other risk factors for the occurrence of minor complications in this study are a history of alcohol or tobacco use, concomitant facial fractures (particularly condylar neck fractures), presurgical occlusal disturbances, and the presence of dental infections.

Major complications are considered to be specific disorders of fracture healing which require re-plating (*Ellis* and *Walker*, 1996). Only one patient presented with a major complication that needed re-osteosynthesis. This complication, a plate fracture, occurred in a cerebral palsy patient with epilepsy and a reconstruction plate was placed during the second surgical procedure. The incidence of major complications encountered during this study was therefore 1.9%.

Loosening of screws and plates are considered to be one of the main risk factors for increased rates of infection and complications (*Gutwald* et al., 1999; *Ellis* and *Graham*, 2002; *Gerlach* and *Schwarz*, 2003). The present study showed good results from the UniLock 2.0 system with only 1.9% of major complications and loosening of only one screw, discovered during plate removal. Provided the UniLock 2.0 plates are inserted correctly, risk of screw loosening is minimal. In conventional systems with similar dimensions, fixation is provided by the screw thread inserted into the bone, creating a friction lock between the plate and the bone which is essential to achieve stability after the reduction. Torsional forces between the bony fragments may lead to a loss of this friction lock and result in reduced primary stability. Cordey and co-workers state that the friction between the screw head and plate is the main weak point of the entire fixation (*Cordey* et al., 2000). In the UniLock 2.0 system the thread on the screw head locks into the congruent thread of the plate, transforming the screws and plate into a unit, creating a rigid splint with higher mechanical stability. This corresponds to the principle of an external fixateur (*Gutwald* et al., 1999; *Gutwald* et al., 2003; *Gutwald*, 2004). Haug and co-workers showed superior results of a locking system when compared with conventional plates in a study on polyurethane-mandibles as only the degree of plate adaptation affected the non-locking system (*Haug* et al., 2002). In contrast, Coletti and co-workers observed no statistical difference in terms of fracture displacement in a study with an oak bench model when comparing a threaded with a tapered system (*Coletti* et al., 2007). Locking-plates are often used in reconstructive procedures (*Wongchuensoontorn* et al., 2009). Kirkpatrick and co-workers showed that locking reconstruction plates facilitate the management of complicated fractures, but postoperative infections cannot be entirely eliminated (*Kirkpatrick* et al., 2003). In 45 patients with 74 linear noncomminuted mandibular fractures reduced with a single AO 2.0-mm locking reconstruction plate *Scolozzi* et al. (2009) found sound bone healing with no major complications. Two plates were often used in the presented study because comminuted fractures also were included.

As the human mandible shows an uneven surface, adapting conventional miniplates to the contours of the bone can compensate for such incongruities (*Tillmann* et al., 1983; *Neumayer*, 1991). Repeated bending may cause material fatigue and create predetermined breaking points (*Heinl* and *Neumayer*, 1987). Moreover, inaccurate adaptation of conventional plates causes displacement of the mobile bony fragments when the screws are tightened and can decrease primary stability. In contrast, the fixateur-principle allows the mobile fragments of the bone to stay in the reduced position when

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tightening the screws, even if the plate is not precisely adapted. Therefore, exact plate adaptation is no longer necessary which should shorten operation times (*Gutwald* et al., 1999; *Ellis* and *Graham*, 2002; *Gutwald*, 2004; *Gbara*, 2008a,b). This advantage has already been realized when using reconstruction plates provided with a locking screw like the THORP and UniLock 2.4 system (*Herford* and *Ellis*, 1998; *Klotch* et al., 1999). Gellrich and co-workers compared these two systems in mandibular reconstruction after tumour ablative surgery, in which the UniLock 2.4 system was shown to be slightly superior to the THORP system. This may be explained by the less bulky design of the UniLock 2.4 system (*Gellrich* et al., 2004). Furthermore, the UniLock 2.0 system does not need a friction lock between plate and bone for stability, resulting in decreased pressure transmitted to the underlying bone. Less disturbance of perfusion of underlying bone with decreased bone necrosis is the result, which might lead to increased bony healing and regeneration (*Gutwald*, 2004). These advantages are supported by several other authors (*Gutwald* et al., 1999; *Ellis* and *Graham*, 2002; *Gutwald* et al., 2003; *Gutwald*, 2004).

CONCLUSIONS

The results of the present study are comparable with other published data and support the notion that the mini-locking-system is a valid alternative to conventional miniplates with several advantages. A prospective study comparing this with conventional systems could further highlight these findings and define the specific indications for the use of the mini-locking-system.

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