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ORIGINAL ARTICLE

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# Miniplate osteosynthesis of fractures of the edentulous mandible

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**Abstract** This study was performed to analyze treatment of fractures of the edentulous mandible and to discuss this method in relation to the mandibular height at the fracture site. Fifteen fracture sites in 11 patients with an edentulous mandible were retrospectively examined. These fractures were located: nine fractures in the mandibular body, three in the paramedian region, and three in the mandibular angle. Fractures in a mandible measuring more than 10 mm in the vertical height were treated with one miniplate. Fractures in an extremely atrophic mandible with 10 mm or less were treated using one or two miniplates, also using a modified Champy plate with 1.3 mm in thickness. A mandibular fracture with a height of 5 mm was treated with a combination of a microplate on the buccal side and a miniplate on the inferior border of the mandible with additional direct circumferential wiring. Oblique or splitting fractures were treated with direct circumferential wiring or a Herbert screw, at one fracture site each, respectively. Complications, including infection, fibrous union, nonunion and trismus, were not seen. In one patient, hypesthesia of the lower lip was, however, persistent 1 month after surgery. Miniplate osteosynthesis is the less invasive treatment, and it is suitable for fractures of the atrophic edentulous mandible, except for comminuted or defect fractures. To obtain stable fixation in severely atrophic mandibles, we need to consider the use of two miniplates or a combination with microplates.

**Keywords** Edentulous mandibular fracture · Miniplate · Atrophy

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## Introduction

In the treatment of fractures of the edentulous mandible, the problems differ from those of dentate patients. The major problem in edentulous patients is associated with the healing of fractured bone. Usually, fractures of the edentulous mandible occur in elderly people in whom bone regeneration is delayed, and the contact area between the fractured ends is reduced due to bony atrophy. A decreased blood supply in the atrophic mandible showing usually dense and sclerotic bone also contributes to problems [1].

It is known that there is an obvious relation between the height of the mandible and the incidence of complications in fracture healing [2, 3]. Luhr et al. [3] reported that the term "edentulous" made it difficult to compare results of different treatment modalities. They defined a mandible with a height at the fracture site of 20 mm or less as an atrophic mandible and proposed a comprehensive classification of the atrophic edentulous mandible (Table 1).

Since the advent of plate osteosynthesis or internal fixation, several treatment strategies for edentulous mandibular fractures have been reported. However, the treatment of these fractures remains controversial. We retrospectively analyzed treatment results of miniplate osteosynthesis and discussed this in relation to the mandibular height at the fracture site.

## Materials and methods

We treated 335 patients with mandibular fractures at our department between January 1, 1980 and January 31, 2004. Eleven (3%) of these patients showed fractures of the edentulous mandible. In 11 patients, fractures were located in the following regions: nine fractures in the mandibular body, three in the paramedian region, and three in the mandibular angle. There were six males and five females. The age of the patients ranged from 46 to 83 years, with a mean age of 69.5 years. Eight of the 11 patients were 70 or more years old. In eight patients, the cause of the injury was a fall. Other causes were assault, traffic accident, and

**Table 1** Classification for the fractures of edentulous mandibles

| Class | Height (mm) | Fracture lines |
|---|---|---|
| I | 16–20 | 3 |
| II | 11–15 | 3 |
| III | <10 | 5 |
| Others | >20 | 4 |
| Total | | 15 |

spontaneous fracture, in one patient each. The period from injury to treatment was from 3 to 20 days, with a mean of 10.7 days.

The height of the mandible at the fracture site was measured, and an approximate value was obtained in 11 fractures treated with plate fixation, on the basis of the actual width of the plate on the postoperative panoramic radiograph, and in 4 fractures by calculating the average magnification ratio of 1.2 of the panoramic film. They were classified into four Classes, adding "Others" to the classification of Luhr et al. [3] (Tables 1 and 2). The types of fractures were classified into two categories; one was an approximately perpendicular fracture to the mandibular border, and another was an oblique or a splitting fracture. Neither a comminuted nor on defect fracture was recognized in this series.

One patient (case 11) with no displacement in either the mandibular body or the ramus and with a vertical height of 34 mm at the mandibular body was treated with a closed method, i.e., restriction of mouth opening for 1 month using a chin cap and the patient's full dentures.

In 12 fracture sites of nine patients with approximately perpendicular and displaced fractures, open reduction and fixation were performed with a stainless steel Champy miniplate (Table 2; Figs. 1, 3, and 4) or its modified type with increased thickness (Fig. 2). Champy miniplates were made of stainless steel when the plates were removed. When the miniplate was placed on the alveolar process, prosthetics could not be used until the plate was removed. When bone fusion of fracture site was recognized, the plates were removed.

In the case that mandibular canal lies very close to the surface, two miniplates cannot be used because of the limited space to fix with retainer. In such a case, a microplate was used. In one patient (case 8) with a vertical height of 4.6 mm at the fracture site, a titanium microplate was employed on the buccal side of the mandible because of limited room for placing a miniplate. The operation performed by the intraoral approach at first, but fixation of bone fragment was not enough, resulting in a bone gap. In addition, an exposure to surface layer of mandibular canal was found. Therefore, we decided that plating must be done on the lower border of the mandible. This plating cannot be performed via intraoral incision. Direct circumferential wiring was added to reinforce the fixation (Fig. 3). In this case, bone transplantation was impossible because serious osteoporosis was recognized caused by steroid dosage administered for a long period, and ability for bone regeneration was deteriorating.

The number of miniplates used for immobilization is described in Table 2. Oblique fractures were treated with

**Table 2** Characteristics of patients

| No. | Age (years) | Gender | Cause | Location of fracture | Height (mm) (class) | Period until treatment (days) | Treatment (no. of plates) | Follow-up (months) |
|---|---|---|---|---|---|---|---|---|
| 1 | 56 | M | Traffic Accident | Paramedian<br>Condyle (Bilateral) | 20 (I) | 6 | Miniplate (2)<br>Closed reduction | 6 |
| 2 | 78 | M | Assault | Body (Oblique)<br>Angle | 19 (I)<br>23 (Others) | 20 | Herbert screw<br>Miniplate (1) | 25 |
| 3 | 83 | F | Fall | Paramedian (Oblique) | 18 (I) | 8 | Direct circumferential wiring | 19 |
| 4 | 77 | F | Fall | Body | 13 (II) | 9 | Miniplate (1) | 4 |
| 5 | 72 | F | Fall | Body<br>Body | 12 (II)<br>9 (III) | 11 | Miniplate (1)+Microplate (1)<br>Miniplate (1) | 13 |
| 6 | 82 | F | Fall | Paramedian<br>Body | 13 (II)<br>9 (III) | 7 | Miniplate (1)<br>Miniplate (1) | 11 |
| 7 | 71 | M | Fall | Body<br>Body | 9 (III)<br>8 (III) | 15 | Miniplate (2)<br>Miniplate (1) | 28 |
| 8 | 70 | F | Spontaneous | Body | 5 (III) | 10 | Miniplate (1)+Microplate (1)+Direct circumferential wiring | 27 |
| 9 | 46 | M | Fall | Angle | 33 (Others) | 16 | Miniplate (1) | 16 |
| 10 | 53 | M | Fall | Angle<br>Condyle | 33 (Others) | 13 | Miniplate (1)<br>Close reduction | 7 |
| 11 | 77 | M | Fall | Body<br>Ramus | 34 (Others) | 3 | Close reduction<br>Close reduction | 5 |

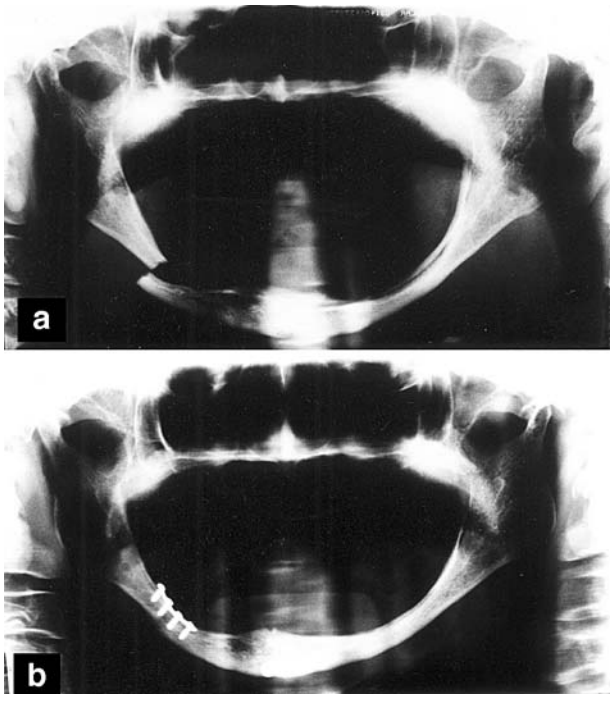


**Fig. 1** **a** Class II fracture of the paramedian, and Class III fracture of the mandibular body (on the right side) of case 6. **b** The fractures were stabilized using one miniplate by intraoral approach

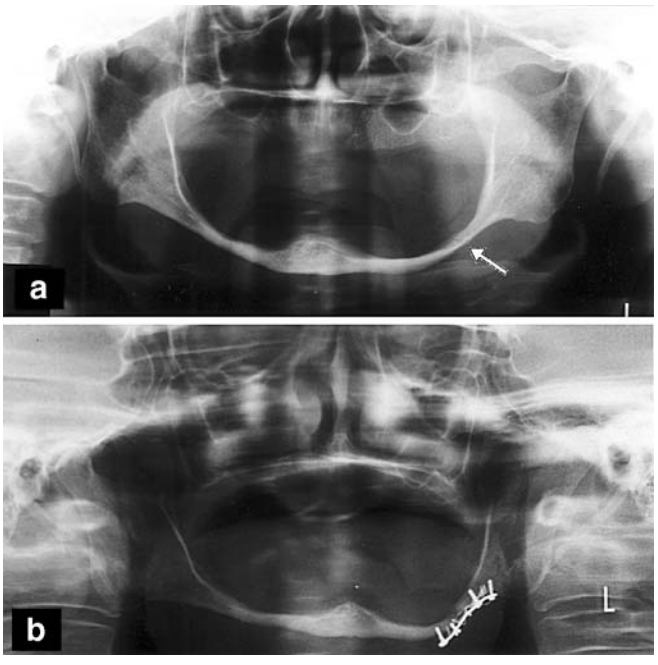


**Fig. 3** **a** Class III fracture (arrow) with a height of 4.6 mm (case 8). **b** 24 months after stabilizing with a microplate on the buccal side and a miniplate on the lower surface of the mandible. Direct circumferential wiring was added to reinforce the fixation

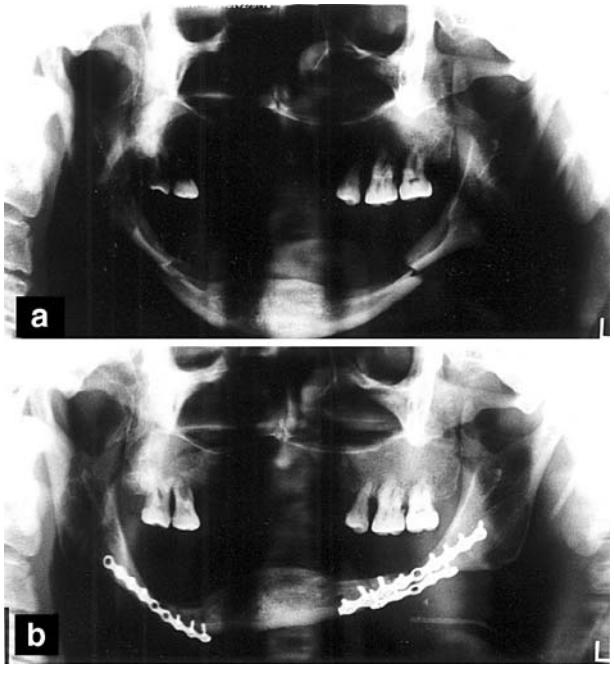


**Fig. 2** **a** Class III fracture (case 7). **b** The fracture on the left side was stabilized using two miniplates (1.3 mm in thickness) by an intraoral approach

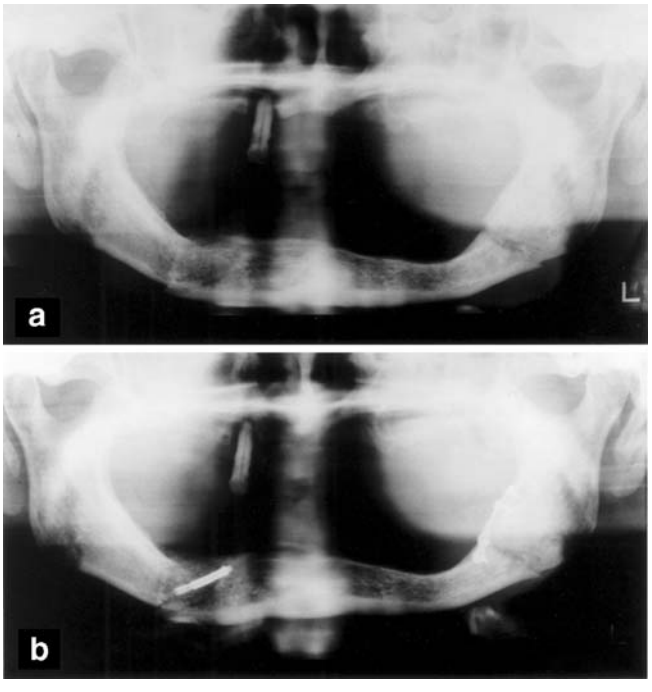


**Fig. 4** **a** An oblique fracture of the mandibular body (on the right side) and a fracture of the angle (on the left side) of case 2. **b** A Herbert screw (on the right side) and a miniplate (on the left side)

direct circumferential wiring in one patient and a titanium Herbert screw [4] in another one (Fig. 4).

Concomitant fractures of the condyle were recognized in two patients. After stabilizing the mandibular fractures using miniplates, fractures of the condylar process were treated by early functional treatment without maxillomandibular fixation [5]. In case 1 with bilateral luxation fractures of the condyles, extraoral traction [6] and denture adjustment were conducted, resulting in good occlusion.

## Results

Three fractures belonged to Class I atrophy, three to Class II, five to Class III, and four to Others (Tables 1 and 2). The mean duration of follow-up was 14.6 months (median 11, range 4–28). A sensory disturbance of the lower lip was persistent in one patient (case 4) 1 month after surgery, although this disturbance was better than on postoperative day 7. In other patients, there were no complications such as the development of infection, plate break, or fibrous union or nonunion.

Two patients (cases 7 and 8) with Class III atrophy could not wear dentures. Except for these two patients, trismus and mastication were examined 3 months after treatment. These nine patients showed good mouth opening with more 4-cm interincisal distance and nondisturbed food intake and mastication.

## Discussion

Atrophy of the alveolar bone due to loss of teeth reduces the mass of bone, which weakens the mandible, making it more susceptible to fractures [2]. Of 11 patients included in the study, 8 patients were 70 or more years old. In 8 of 11 patients, fractures were caused by falls, and the fracture in one patient with osteoporosis arose spontaneously.

In nondisplaced edentulous fractures with a relatively thick mandible, treatment is not problematic. The patients can be treated using a chin cap, which was also reported in the literature [7].

In managing patients with fractures of the edentulous mandible, studies in the USA revealed trends that plating became a common treatment [2, 8, 9]. Luhr et al. [3] employed compression plates for fractures of the atrophic mandible with a height of <20 mm at the fracture site, and in 81 (96.5%) of 84 fractures, an uncomplicated, solid, bony union was achieved. This is an excellent result, but it appears that rigidity of fixation depends on the rigidity of the plate itself rather than compression force [10]. A reconstruction plate may provide more rigid stabilization, but the adaptation of this plate to the repositioned bony surface presents difficulties due to its thickness, and it is also difficult to apply the large plate to the thin mandible. Large bicortical screws may violate the inferior alveolar nerve or may even lead to further jaw fractures [11, 12].

Iatrou et al. [13] concluded that a single Champy miniplate [14] used for reconstruction of mandibular fractures in edentulous patients may be considered a reliable method, with a 3.9% reoperation rate of 51 fractures, although there was no information about the degree of atrophy. We have utilized the same plate and its modified version, which is thicker than the original Champy plate, for treatment of most facial fractures since 1980 [10] and also for stabilization in fractures of edentulous patients. In comparison with both a compression plate and an usual reconstruction plate, a Champy miniplate [14] has several advantages because of its small size (4.2 mm in maximal width), malleability (1.0 mm in thickness), and monocortical osteosynthesis without any postoperative maxillomandibular fixation; the small size of the plate allows easy access to a narrow operation field, in most cases via an intraoral approach, and a malleable plate is easily adapted to the curved mandible, although the modified plate with 1.3-mm thickness provides less malleability. In severely atrophic mandibles, the inferior alveolar nerve runs along the superior border of the mandible, sometimes on its upper surface. Miniplates can be placed without injury to this nerve, even in most cases of Class III. It is very important for surgeons to use the smallest possible plate [15]. However, doubt has been expressed about whether miniplate osteosynthesis ensures a stable fixation for atrophic mandibles [12, 16].

The most common site of fractures in edentulous mandibles is the mandibular body, and fibrous union or nonunion arises most frequently at this site when the amount of the residual mandible is below 20 mm, particularly below 10 mm [2, 3]. A full dentition appears to have a stabilizing effect [17]. In the absence of the stabilizing effect of the teeth, the mandibular body acts as a fulcrum for the action of the suprahyoid muscles and the muscles that elevate the mandible [18]. In the atrophic edentulous mandible, biomechanical analysis has not been conducted adequately, but it can be suggested that the body of the mandible is subjected to forces from several directions during function [11]. Therefore, the use of two plates is recommended for Class III atrophy to resist multidirectional stress. In animal experiments for dentate mandibles [10], two miniplates provided a relatively stable fixation effect similar to one AO reconstruction plate under vertical stress. An experiment conducted by Sikes et al. [16] showed that a single miniplate did not offer sufficient fixation for the atrophic mandible. However, different results would be obtained, if they used two miniplates. In addition, when longer plates are desired for fixing the angle and the chin area [19], the modified Champy plate with 1.3-mm thickness should be selected (Fig. 2).

To avoid injury to the neurovascular bundle, we need to select the place for osteosynthesis. The place for one plate is determined depending on the location of the alveolar nerve, either under the nerve or on the superior border of the mandible (Fig. 1) [13, 20, 21]. A microplate is suggested when there is no room for plating on both places. Another miniplate should be placed depending on the space. According to circumstances, the plate is placed on the lower border of the mandible as in Fig. 3. There are, however, other opinions about placement of the plate. It was reported that placing the plate along the inferior border of the mandible was the cause of nonunion due to the strong pull of the suprahyoid musclulature [22], resulting in an “out of plane” placement [3]. However, the cause of failure may be attributed to the use of only one plate.

Eight patients treated by miniplates showed satisfactory results without complications, although there was one patient who had a short follow-up and persistent sensory disturbance of the lower lip. Age was also related to treatment outcome because of the more common comorbidity, malnutrition, and lower immune defense. In older individuals with fractures of edentulous mandibles, therefore, less

invasive surgery is preferable. Although fractures in an atrophic mandible are rare, and a prospective study is difficult, and moreover, our experience is quite limited, it is suggested that miniplate osteosynthesis is a successful method for the atrophic mandible, with minimal impairment of the patient.

Immediate reconstruction with bone grafting is another option for treatment of severely atrophied mandibles, and for fractures with bone loss or comminution, bone grafting is mandatory [3]. However, bone grafting may lead to improved results. In the present series, bone grafting was not needed.

Lag screws also can be used for edentulous oblique fractures [3, 23]. However, we prefer the Herbert screw [4] (Fig. 4) for the elderly.

## Conclusions

Miniplate osteosynthesis is the less invasive treatment, and it is suitable for fractures of the atrophic edentulous mandible, except for comminuted or defect fractures. However, to obtain stable fixation in severely atrophied mandibles, we need to consider the use of two miniplates or a combination with microplates.

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