Treatment of Atrophic Mandibular Fractures Based on the Degree of Atrophy—Experience With Different Plating Systems: A Retrospective Study

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Purpose: The aim of this retrospective study was to evaluate the clinical outcome of fractures of the atrophic mandible based on the degree of atrophy and treatment by different plating systems.

Patients and Methods: Thirty patients with 40 fractures of atrophic mandibles were treated by open reduction and internal fixation at our department between 1994 and 2001. Twelve fractures occurred in Class I (between 15- and 20-mm bone height), 10 fractures in Class II (between 10 and 15 mm), and 18 fractures in Class III atrophy (<10 mm). The profile heights of plating systems used for stabilization varied from 0.5 to 2.2 mm and were applied with an intraoral (n = 37) and extraoral (n = 3) approach.

Results: In 36 fractures, bone healing was uneventful. Major complications (loose hardware or nonunion) occurred in 4 fractures: 2 in Class II and 2 in Class III atrophy. Major complications were observed with 1.4-mm (n = 3) and 2.2-mm (n = 1) plates. Minor complications (infections or dehiscence) were observed in 6 fractures: 3 in Class II and 3 in Class III atrophy. Hypesthesia of the inferior alveolar nerve was present 1 week and 1 year postoperatively in 39 and 16 fractures, respectively.

Conclusions: Treatment of atrophic mandible fractures should be based on the degree of atrophy. More rigid fixation may be necessary in mandibles with less than 15 mm bone height.

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Fractures of the atrophic mandible represent a subset of facial injuries that are more commonly sustained by older victims.[1] Treatment of these fractures is still a challenge due to the patient's age, poor bone quality, and vascularity, as well as reduced contact area between the fracture ends.[2,3] Enthusiasm for various methods of closed reduction has waned in recent years with the development of modern fixation materials and techniques.[1,4] Open reduction and internal fixation is currently the most predictable method of managing fractures of the atrophic mandible.[5,6] However, the choice between intraoral or extraoral approach, as well as the dimension of the plating system used, remains controversial.[1,5-9] Some authors recommend the use of plates with small dimensions,[10,11] whereas others prefer rigid fixation with plates of larger dimensions.[5,12]

The incidence of atrophic mandible fractures has been reported to be low compared with dentate mandibles[4,13]; however, the complication rate has been found to be higher and ranges up to 20%,[4,14] including malunion and nonunion.[5,11]

Although an objective classification scheme of atrophic edentulous mandibles has been described,[5] most studies evaluating the postoperative outcome of these fractures have not related the degree of atrophy of the mandible to the clinical outcome.

The aims of this study were to evaluate the treatment of atrophic mandibles based on degree of atrophy and to compare the outcome of different plating systems used for stabilization.

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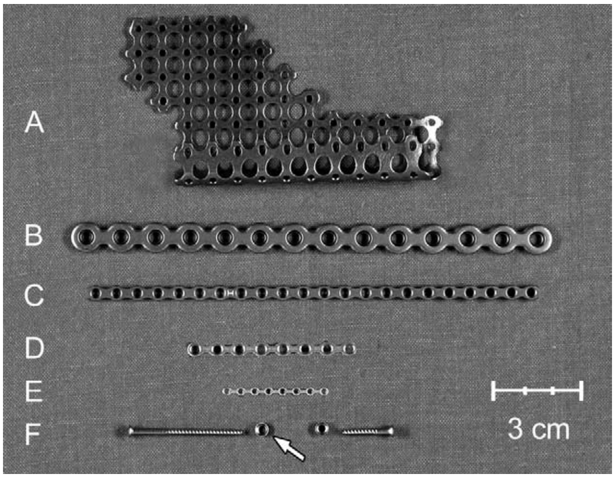

FIGURE 1. Osteosynthetic materials used for fixation of fractures of the atrophic mandible. A, A 0.5-mm mesh system (Stryker Leibinger Corp, Freiburg, Germany). B, A 2.2-mm plating system (Stryker Leibinger Corp). C, A 1.4-mm plating system (Martin Corp, Tuttlingen, Germany). D, A 1.0-mm plating system (Stryker Leibinger Corp). E, A 0.6-mm plating system (Stryker Leibinger Corp). F, A 2.0-mm lag screw system (Stryker Leibinger Corp).

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Patients and Methods

In this retrospective study, the charts of 30 patients (20 women and 10 men) who were treated by open reduction and internal fixation of fractures (n = 40) of atrophic (<20-mm bone height) mandibles between 1994 and 2001 at our department were included. The following parameters were retrieved from the patients' records: patient's age and gender, cause and site of fracture, period between injury and treatment, type and number of plating system used, and type of anesthesia and surgical approach used. Fracture sites included the parasymphyseal (n = 12) and body (n = 28) region of the mandible. In 10 patients, fractures were additionally located on the contralateral side of the mandible.

Panoramic radiographs were made preoperatively and postoperatively at 1, 4, and 12 weeks and 1 year. Radiographic appearance of fracture healing and loosening of screws and plates were documented. One of the authors who was blinded to the patients' charts performed measurements (in mm) of bone height in the first postoperative panoramic radiograph. Using the ratio of actual plate height to radiologically displayed plate height, the actual height of the mandible at the fracture site was calculated. The degree of atrophy of the mandibles was categorized according to Luhr et al[5]: bone height from 16 to 20 mm was classified as Class I, from 11 to 15 mm as Class II, and less than 10 mm as Class III atrophy.

A senior surgeon dictated the indication for surgery and the technique used. Twenty-nine patients (38 fractures) were treated by open reduction and fixation under general anesthesia without mandibulomaxillar fixation and 1 patient (2 fractures) under local anesthesia received mandibulomaxillar fixation for 3 weeks. The plating systems used for fixation are displayed in Figure 1. The 2.2-mm plating system was fixed with 2.7-mm-diameter screws, the 0.6-mm plating system with 1.0-mm-diameter screws. The other plates and the mesh were fixed with 2.0-mm-diameter screws. In 6 fractures, 2.0-mm lag screws were used for additional fixation.

Antibiotic prophylaxis (clindamycin 1,800 mg/day in divided doses) was used for all patients perioperatively until day 7 after surgical intervention. In the follow-up period, ranging from 9 to 22 months (mean, 1.4 years), clinical and radiologic outcome was evaluated by 2 observers. The following complications were considered: neurosensory changes in the distribution of the inferior alveolar nerve, wound dehiscence, infection, malunion or nonunion, and loosening of osteosynthetic hardware.

STATISTICAL ANALYSIS

Data were analyzed using SPSS 11.5 for Windows statistical software package (SPSS Inc, Chicago, IL). Descriptive statistics and test of significance were used as appropriate.

Results

The age of the patients (mean ± SD) was 72.3 ± 13.8 years, with a range from 42 to 91 years. Causes of fracture were fall (n = 23), assault (n = 2), motor vehicle accident (n = 2), post tooth removal (n = 2), and post cyst removal (n = 1). Thirteen of 17 were partially edentulous.

Surgical treatment was performed after a time interval (mean ± SD) of 2.3 ± 1.1 days. An intraoral approach was used in 27 patients (37 fractures) and an extraoral approach was used in 3 patients (3 fractures). Table 1 shows the fracture distribution in relation to degree of atrophy.

Autogenous corticocancellous bone grafts from the iliac crest were used due to bone defect (n = 1) and

Table 1. FRACTURE DISTRIBUTION (N = 40) BY ATROPHY DEGREE

Atrophy	No. of Fractures	%
Class I (bone height: 16-20 mm)	12	30
Class II (bone height: 11-15 mm)	10	25
Class III (bone height: ≤10 mm)	18	45

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Table 2. PRESENCE OF HYPESTHESIA

Atrophy Class	Preoperative	Postoperative 1 Week	Postoperative 1 Year
I	8	11	2
II	8	10	4
III	18	18	10
Total	34	39	16

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comminution (n = 2) in Class III atrophy from an extraoral approach with application of a 0.5-mm mesh system.

Hypesthesia along the distribution of the inferior alveolar nerve was present preoperatively for the intraoral and extraoral approach in 31 and 3 fracture sites, respectively; 1 week postoperatively, hypesthesia was present in 36 and 3 fracture sites, and 1 year postoperatively, in 14 and 2 fracture sites, respectively. According to the level of atrophy I to III, hypesthesia was present preoperatively in 8, 8, and 18 fracture sites, 1 week postoperatively in 11, 10, and 18 fracture sites, and 1 year postoperatively, hypesthesia was present in 2, 4, and 10 fracture sites, respectively (Table 2). The difference between groups I and III preoperatively was statistically significant ($P = .04$). No statistical difference was found between hypesthesia and the type of plating system used.

Minor complications (6 of 40) that did not require reoperation were infection (n = 2; both Class II atrophy), wound dehiscence (n = 4; 1 in Class II and 3 in Class III atrophy) and were adequately managed with incision, drainage, and medication. These complications were seen in fractures treated with 1.0-mm (n = 3) and 1.4-mm (n = 3) plating systems.

Major complications (4 of 40) requiring further hospitalization and reoperation were present in 4 fractures (3 patients) and included nonunion with fracture of hardware (n = 2, Class III atrophy), and loosening of screws (n = 2, Class II atrophy) (Figs 2-4). These complications were seen in fractures treated with 1.4-mm (n = 3; 1 in Class II and 2 in Class III atrophy) and 2.2-mm (n = 1; Class II atrophy) plating systems. Table 3 shows the degree of atrophy, the plating system used, and the major complications.

All minor and major complications were associated with an intraoral approach. There was a statistically significant difference between the degree of atrophy and the presence of major complications ($P = .03$).

Discussion

Treatment of fractures of the atrophic mandible offers a challenge for the surgeon due to the limited bone quality and quantity as well as reduced bone-to-bone contact at the fracture site. In our study, the cause of injury and location of fracture were similar to previous reports in the literature.[5,6,13,15,16] In prior studies, the approach, dimension of hardware used for fixation, as well as the utilization of primary bone grafting varies when treating these fractures.[5-18] While some authors[5,11] have advocated an intraoral approach in the management of atrophic mandibular fractures, other authors preferred an extraoral approach avoiding complete periosteal stripping of the mandible.[8,18] In our study, an intraoral approach was predominantly used, except in cases of avulsion and comminution. Although all complications were associated with an intraoral approach, this approach is still preferred in our institution because it avoids the creation of extraoral scars and reduces the risk of injury of the facial nerve. Furthermore, this approach offers in high-risk patients the possibility of treatment of these fractures under local anesthesia.

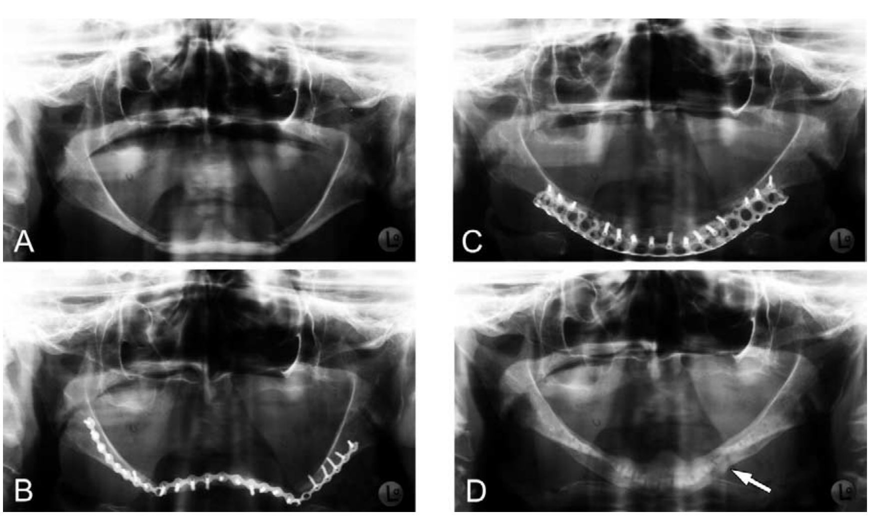

FIGURE 2. *A*, An 80-year-old woman with a bilateral parasymphyseal mandible fracture (Class III). *B*, The fracture was stabilized with a single 2.0-mm plate through an intraoral approach. Six weeks after treatment, the radiograph displayed nonunion of the fracture and a broken hardware. *C*, The 2.0-mm plate was subsequently replaced by a 0.5-mm mesh system through an extraoral approach using iliac bone graft. *D*, Six months postoperatively, the radiograph displayed an increase of bone height (*arrow*) after removal of the plate.

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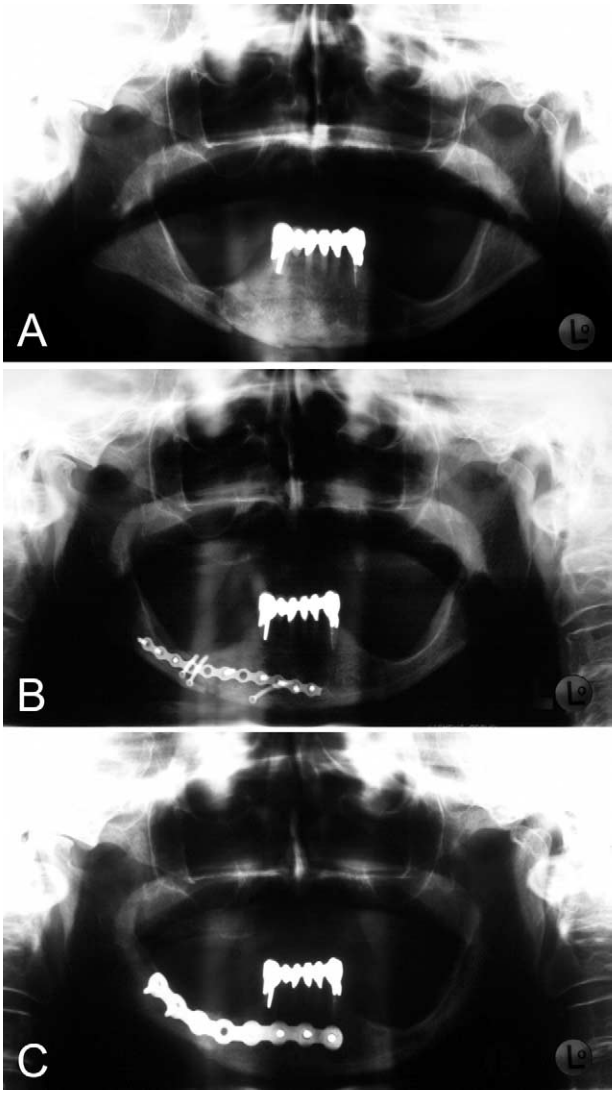

FIGURE 3. *A*, An 84-year-old woman with a left body mandibular fracture (Class II atrophy). *B*, One week postoperatively, loosening of screws of the 1.4-mm plating system is visible. *C*, At 12 weeks postoperatively after replacement with a 2.2-mm plating system, the radiograph displayed consolidation of the fracture.

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Injury of the inferior alveolar nerve in mandibular fractures can be caused by trauma or the surgical repair.[18] The high incidence of sensory disturbances preoperatively in our study was dependent on the level of atrophy and is consistent with findings of other authors.[11,18] One year postoperatively, 40% of the patients demonstrated persistent hypesthesia. This finding is similar to that of Iatrous et al.[11] Furthermore, our result demonstrated no difference in residual hypesthesia following treatment related to the degree of atrophy and type of plating system used.

The overall incidence of postoperative minor complications (15%) is comparable to others who have reported a complication rate between 6% and 26%.[16,17,19] In our study, these complications were only observed in Class II and III atrophy.

A high rate of serious complications requiring reoperation such as nonunion or fracture of hardware has been widely reported in the management of fractures of atrophic mandibles and ranges from 4% to 20%.[4-6,11,12,14,17] This has been attributed to a combination of unfavorable conditions produced by the reduced cross section and smaller contact area of fractured ends and sclerotic and poorly vascularized bone.[1,5] In our study, major complications (10%) were observed in Class II and III atrophy. This is similar to the findings of Luhr et al[5] and Kunz et al.[6]

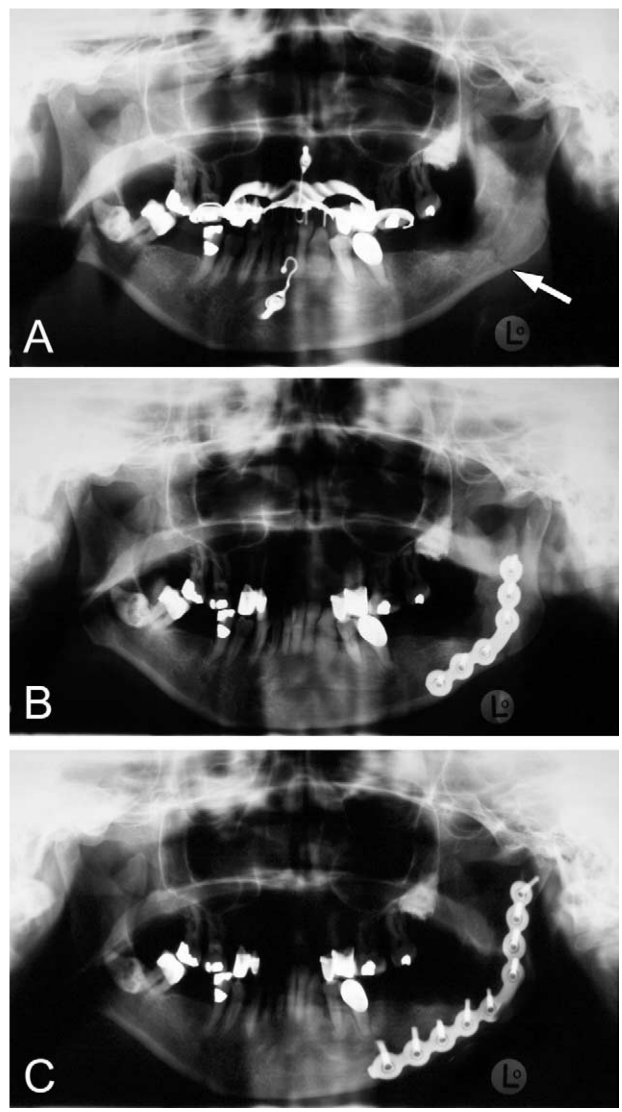

FIGURE 4. *A*, A 64-year-old woman with a left body mandibular fracture (Class II atrophy) (*arrow*). *B*, The fracture was stabilized with a 2.2-mm plate with 6 screws through an intraoral approach. *C*, Due to loosening of the screws caused by aggravated bruxism, the plate was changed to a 2.2-mm plate with 9 screws through an extraoral approach.

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Table 3. NUMBER OF USED OSTEOSYNTHESIS

Class	No. of Fractures	0.5-mm Mesh System	2.2-mm Plating System	1.4-mm Plating System	1.0-mm Plating System	0.6-mm Plating System
I	12	0	2	3	12	1
II	10	1	2 (1)*	6 (1)*	4	0
III	18	2	0	11 (2)*	13	0
Σ	40	3	4 (1)*	20 (3)*	29	1

*Major complications in patients.

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The higher number of complication in our study may be attributable to a greater number of patients with severe atrophy (<10 mm of bone height).

The dimension of osteosynthetic plates for the treatment of fractures of atrophic mandibles remains a controversy in the literature and varies between 0.5 and 3.5 mm.[5,6,8,12,17] Thaller[10] revealed that it would be extremely important to use the smallest available plate, whereas Bruce and Ellis[12] preferred plates of greatest rigidity. Marciani and Hill[1] also advocated the use of a titanium mesh crib with a simultaneous iliac bone graft for treatment of fractures of atrophic mandibles. In our study, the dimension of hardware used was dependent on the category of atrophy and the approach to the fracture sites. In fractures of Class I atrophy, 1.0-mm plates were used, whereas Classes II and III required more rigid fixation.

Major complications associated with the plating systems were due to wrong indication (Fig 2), unstable fixation with a single plate (Fig 3), and aggravated bruxism postoperatively (Fig 4). Although these complications were seen with 1.0- and 1.4-mm plating systems, these dimensions provided adequate rigid fixation with satisfying results.

In conclusion, as there are varieties of osteosynthetic materials for treatment of atrophic mandibular fractures, treatment must be based on the type of fracture, degree of atrophy, and experience of the surgeon. In Class I atrophy, the use of 1.0-mm plates provided adequate stability, due to relatively good bone height of the mandible. In Class II and III atrophy, more rigid fixation was used due to limited bone quantity. The use of 0.5-mm mesh crib with autogenous bone graft yielded good results in complex fractures with avulsion or comminution.

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