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CASE REPORT

Mandibular fractures associated with endosteal implants

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Abstract
Purpose The purpose of this study is to report four cases of mandibular fractures associated with endosteal implants and to discuss prevention and treatment of these types of fractures.
Discussion To evaluate whether the patient's anatomy allows insertion of implants, radiological exams that demonstrate the height and the labial–lingual width are needed. To reduce the potential fracture problem, the mandible can be restrengthened with bone grafting techniques. The treatment of a fracture in an atrophic mandible is always a challenge because of the diminished central blood supply, the depressed vitality of the bone, and the dependence on the periosteal blood supply. The basic principles in fracture treatment are reduction and immobilization of the fractured site for restoration of form and function.
Conclusions If implants are placed in severe atrophic mandible, iatrogenic fracture of the mandible may occur during or after implant surgery because implant placement weakens the already-compromised mandible. A few millimeters of cortical bone should remain on both the labial and the lingual sites after the hole for insertion of an implant has been drilled. A 3-D surgical planning should be recommended at least in severe atrophic mandibles in order to prevent a severe reduction of bone tissue.

Keywords Edentulous patient · Dental implant · Mandibular fracture

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Introduction

Endosseous cylinder implant rehabilitation of edentulous and partially edentulous jaws is currently an accepted and widespread treatment modality. The high success rate experienced in current clinical practice with endosseous cylinder implants is largely the result of the work of Brånemark [1], whose research led to the concept of osseointegration.

One of the most severe complications related to endosteal implants is fracture of the edentulous mandible. Such fractures have been sparsely reported in the medical literature [2–12]. This complication is most likely to occur in the very atrophic mandible and may represent 0.2% of the patients with inserted implants in an edentulous mandible [2, 9, 13]. The objective of this report is to describe four cases and to discuss treatment philosophy.

Cases report

Case 1

A 75–year-old woman was having persistent problems with her lower conventional denture. She wanted a better stabilization of the prosthesis. An overdenture with the use of dental implants was proposed by the dentist. Figure 1a shows her radiological condition before treatment. Three IMZ© cylindrical endosteal implants (3.75× 13.0 mm) of external hexagon were inserted in the interforaminal region of the edentulous mandible (Fig. 1b). After an osseointegration period of 4 months, second stage surgery was performed. Then, a new prosthesis with O-ring attachments was fabricated. The patient was satisfied and functioned well with her prosthesis. But 6 months later, she lost one implant and was having symptomatic problems with the other two, with some pus after removal of a periodontal probe. During these 6 months, she did not show up at her regular follow-up appointments. The two remaining implants were removed. Initially, wound healing was uneventful. After more 6 months, the patient experienced pain in the chin. She had no history of traumatic accident. She was referred by her implantodontist to the Department of Oral and Maxillofacial Surgery at the Pontifícia Universidade Católica de Minas Gerais. Clinical examination showed a granulomatous tissue at the submental region (Fig. 2a). Intraoral examination revealed a purulent exudate evident exuding from the inferior alveolar ridge (Fig. 2b). A mandibular mobility was present. A panoramic radiography and a computed tomography (CT) (Fig. 3) revealed a discontinuity in the symphysis area, a sign of pathological fracture of the mandible, caused by an

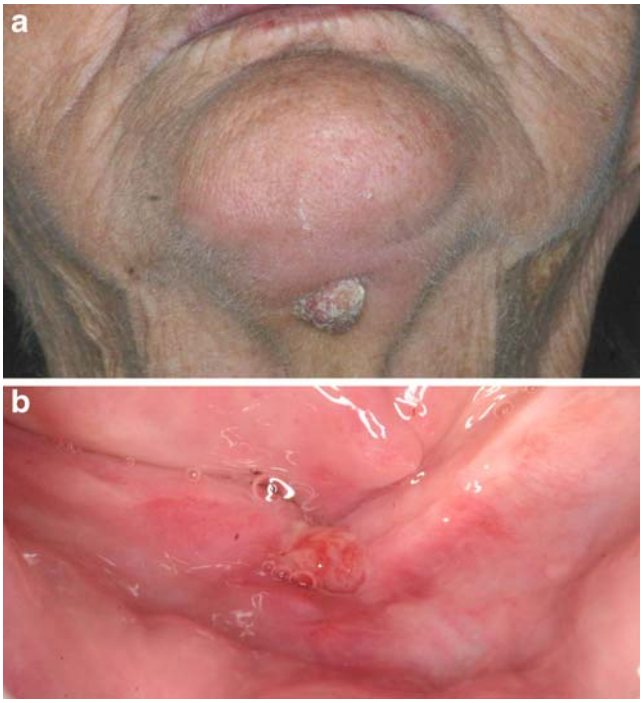

Fig. 2 **a** Granulomatous tissue at the submental region. **b** Purulent exudate evident exuding from the inferior alveolar ridge

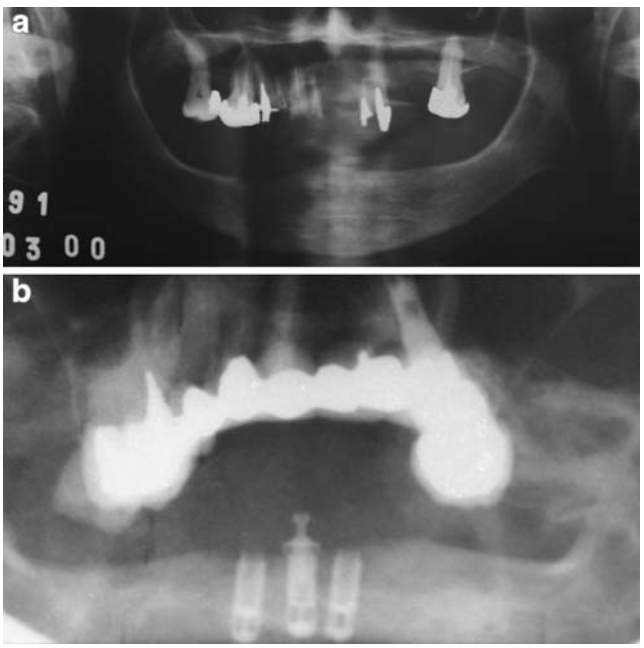

Fig. 1 **a** Radiological condition before any treatment with dental implants. **b** Three implants inserted in the interforaminal region of the mandible

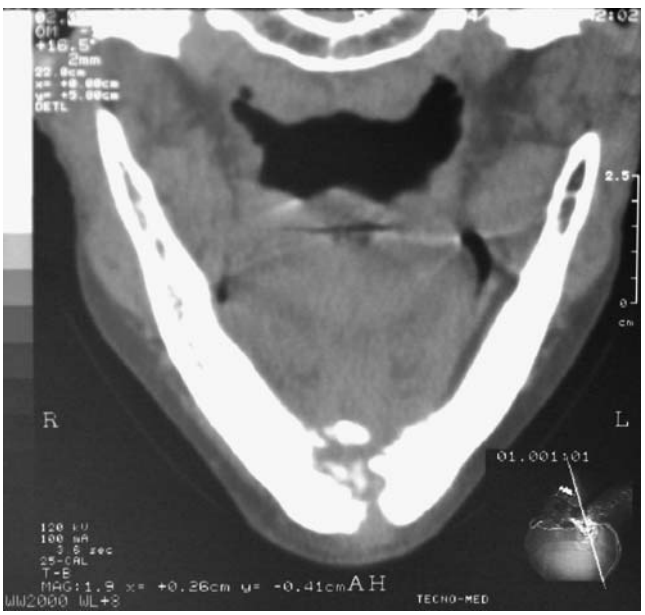

Fig. 3 Computer tomography showed an osseous discontinuity in the mandibular symphysis

osteomyelitis. The CT also showed that there was only 2.5 mm of mandibular bone at the vestibular and at the lingual aspect of this implant. Two weeks after detection of the fracture, the patient underwent surgery under general anesthesia to reposition the mandible. Via submental approach, the fibrous tissue was curetted and the mandible was fixed with a 2.4-mm titanium osteosynthesis compressive plate (Fig. 4a). She received clindamicin (600 mg) + gentamicin (80 mg) IV every 8 h at the hospital and oral administration of clindamicin 300 mg every 8 h for 21 days, after which the complaints faded out. A postoperative panoramic radiography was made (Fig. 4b). Postoperative wound healing was uneventful, with normal sensibility of the lower lip. The patient have decided not to do new dental implants and remained with conventional denture.

Case 2

A 43-year-old woman decided to undergo an inferior alveolar nerve lateral transposition in order to place dental implants (three Brånemark© cylindrical endosteal implants 3.75×13.0 mm of external hexagon), after many years of using a partial removable prosthesis. The nerve transposition and the implants surgery were made in one stage. Postoperative wound healing was uneventful. But after waking up about 30 days after the surgery, the patient experienced pain in the operated region. Her mandible fractured at the left mandibular body. The patient underwent surgery under general anesthesia to reposition the mandible via submandibular approach (Fig. 5a), with a 2.0 mm titanium miniplate. The miniplate fractured 2 weeks later because of her bruxism. Then an intermaxillar fixation with Erich bars was made, and the mandibular fracture consolidated without any further complications. No problems were observed with regard to the osseointegration of the implants. Figure 5b shows the postoperative radiography. No CT was made. Note the fractured miniplate (arrow).

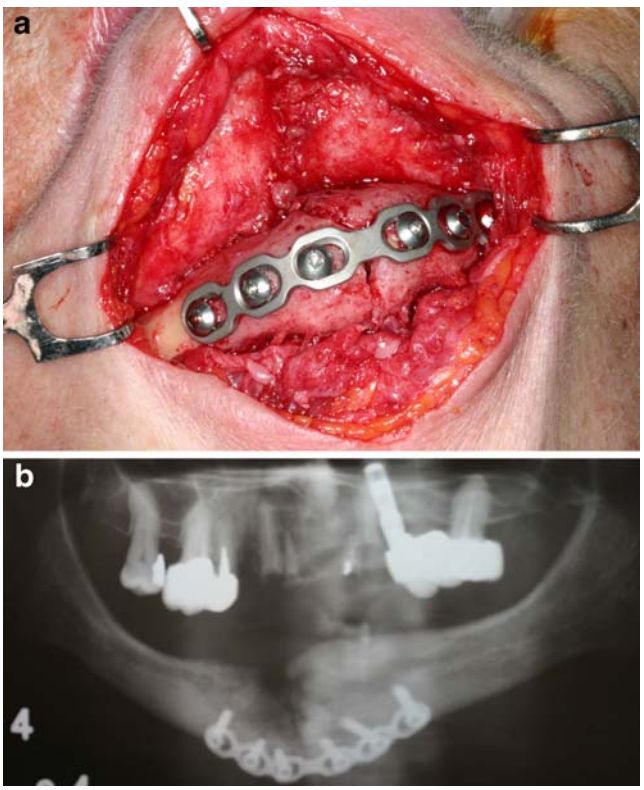

Fig. 4 **a** Fracture fixed with a 2.4-mm titanium osteosynthesis compressive plate. **b** Postoperative panoramic radiography

Case 3

Four implants (four Brånemark© cylindrical endosteal implants 4.00×11.0 mm of external hexagon) were planted for a fixed mandibular prosthesis in a totally edentulous 64-year-old woman who was having persistent problems with her lower conventional denture (Fig. 6a). The implantodontist told us that during the implantation procedure, no problems were noted, and the cortical bone was considered to be very dense at time of surgery. One implant was subsequently placed by slightly penetrating the inferior border of the mandible. This implant was extremely painful after few days and was removed (Fig. 6b). Four weeks later, the patient complained about mobility of the mandible, and the results of clinical and radiographic examinations showed a fracture in the region of this removed implant. The mandible was fractured (Fig. 7a and b). The CT showed that there was only 2 mm of mandibular bone vestibular to this implant; about 3 mm was present in the lingual aspect of the same implant. The patient underwent surgery under general anesthesia to reposition and fixate (titanium miniplate 2.0 mm) the mandible via submandibular approach. Postoperative wound healing was uneventful. No problems were observed with regard to the osseointegration of the remaining implants. Her treatment had changed to an inferior overdenture with a bar superstructure.

Case 4

Five implants were planted for an immediate fixed mandibular prosthesis in a totally edentulous 62-year-old man (five Neodent© cylindrical endosteal implants 4.30×10.0 mm of internal hexagon). At the surgery, the fifth implant was not stable, and it was decided not to maintain it (Fig. 8a). No CT was made. The prosthesis was made, and after 30 days, the patient complained about mobility of the mandible. The mandible fractured (Fig. 8b). The patient underwent surgery under general anesthesia to rigidly fix

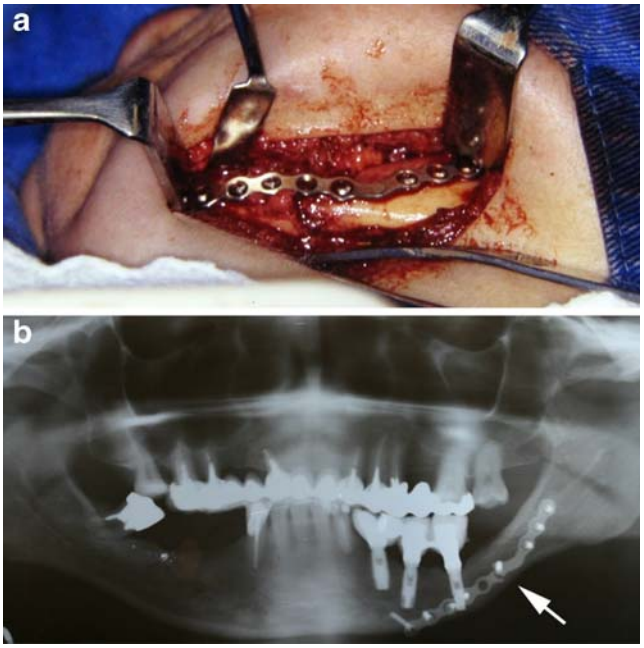

Fig. 5 **a** Submandibular approach and fixation with 2.0-mm titanium miniplate. **b** Postoperative radiography. Note the fractured miniplate (*arrow*)

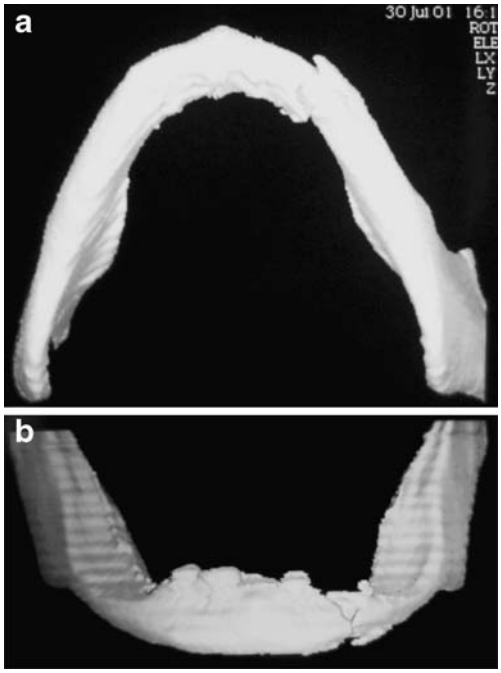

Fig. 7 **a** 3-D computer tomography inferior view. Oblique fracture of mandibular parasymphysis. **b** 3-D computer tomography anterior view. Oblique fracture of mandibular parasymphysis

the mandible with a 2.0-mm titanium miniplate via submandibular approach (Fig. 9a and b). Postoperative wound healing was uneventful. Her mastication was restrained for 60 days, and she remained with the fixed mandibular prosthesis with no further problems. No problems were observed with regard to the osseointegration of the remaining implants.

Discussion

Edentulous patients with severely resorbed mandibles often experience serious functional and psychosocial problems related to their dentures [13]. Severe atrophy of the inferior alveolar process and underlying basal bone often results in problems with a lower denture. These problems include

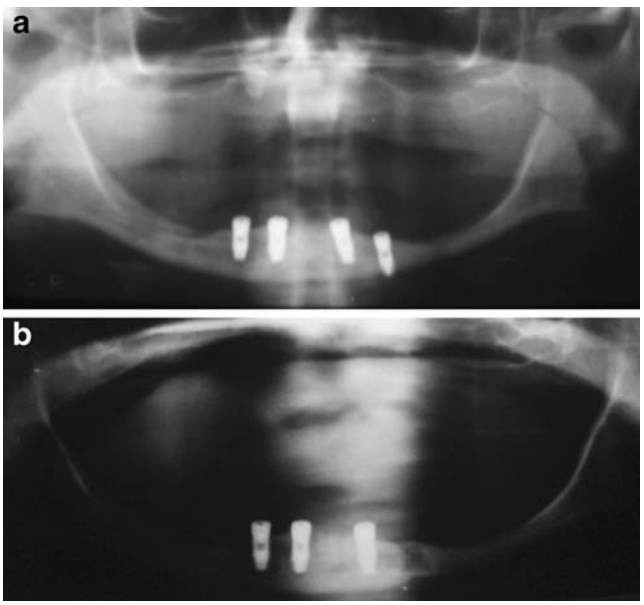

Fig. 6 **a** Four implants inserted in edentulous mandible. **b** One implant was removed because of extreme pain after surgery

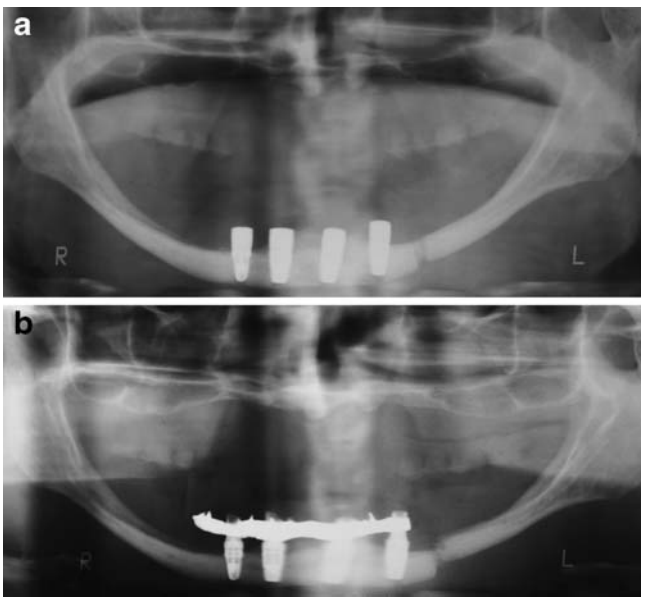

Fig. 8 **a** One implant was not maintained at the surgery because of its lack of stability. **b** The mandible fractured 30 days after the surgery

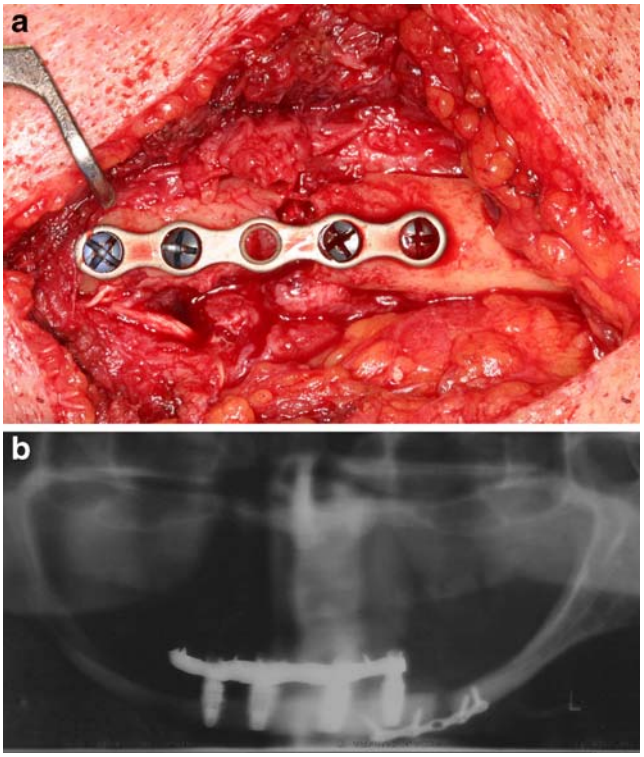

Fig. 9 **a** 2.0-mm titanium osteosynthesis miniplate. **b** Postoperative panoramic radiography

insufficient retention of the lower denture, intolerance to loading by the mucosa, pain, difficulties with eating and speech, loss of soft-tissue support, and altered facial appearance. These problems are a challenge for the prosthodontist and surgeon.

Since dental implants have been shown to provide a reliable basis for fixed and removable prostheses, reconstructive preprosthetic surgery has changed from surgery aimed to provide a sufficient osseous and mucosal support for a conventional denture into surgery aimed to provide a sufficient bone volume to enable implants to be placed at the most optimal positions from a prosthetic point of view [14]. This treatment is generally accepted for the moderate to severely resorbed edentulous mandible. However, the use of implants in the extremely resorbed mandible may become a future problem.

A mandibular fracture after implant placement is a rare complication and has been reported in conjunction with severely resorbed mandibles [4]. Patients are warned of the latter complications, but patients with an extremely resorbed mandible should also be warned routinely about the risk of a mandibular fracture [13].

The majority of the patients included in the studies of severely resorbed edentulous mandible had an anterior mandibular bone height of less than 12 mm [14–17]. According to Raghoebar et al. [13], a severely resorbed mandible has a maximum bone height in the mandibular symphysis region of 15 mm. Our cases number 3 and 4 fitted these features.

In the case of severe ridge atrophy and short implants (<12 mm), the ratio between implant length and the distance to the occlusal plane is compromised, resulting in unfavorable biomechanics. Since the latter could jeopardize long-term osseointegration, this mode of treatment is not widely used [18, 19]. Nevertheless, it is an attractive treatment option because of the relatively simple surgical procedure and limited morbidity [6, 20–26].

In the moderately resorbed edentulous mandible, fabrication of an overdenture for two or four implants inserted in the interforaminal region is currently an accepted, widespread treatment modality for improving the function of a mandibular prosthesis [27, 28], as our case number 1. If the mandibular bone is severely resorbed (bone height< 12 mm), some clinicians recommend placing four endosseous implants [28]. However, as more implants are inserted, the risk rises that the structure of the atrophic mandible will be compromised. This may make the atrophic mandible more susceptible to fracture or other complications. The cases number 3 and 4 fitted these features too.

It seems that the site of an implant that was not yet osseointegrated represents an area of stress concentration and weakness. Thus, routine oral functioning could cause a fracture without any trauma to the mandible [5, 7]. In case number 2, the fracture that occurred about 30 days after insertion of the implants could have been caused by the patient's own bite-force activities, plus her parafunctional activity, the bruxism. The miniplate fractured 2 weeks later, probably again because of her bruxism. It was a mistake not doing an intermaxillar fixation with Erich bars at the first time. In cases number 3 and 4, the fracture that occurred could have been also caused by the patient's own bite-force activities. The implant was already removed, and the mandible was also weakened by its absence. The patient should not have masticated or should be instructed not to do it by the implantodontist, not before the regeneration of local missing bone had happened. A continuous radiological follow-up should have been made by the dentist before the installation of the prosthesis.

Marginal bone loss around a dental implant can also contribute to the fracture of the atrophic mandible. Marginal bone loss of up to 1 mm during the first year of implant function and an annual bone loss of 0.2 mm after this period have been recognized as acceptable [29, 30]. Ongoing bone loss at this rate results in a very long lifetime of the implants. Progressive bone loss can be caused by infection, and total loss of integration can be caused by prolonged infection and by overloading [31]. This resorption can be enhanced by the specific implant design and surface characteristics of an implant system [32]. A major

complication related to excessive bone loss around implants is fracture of the edentulous mandible. This complication is most likely to occur in a very atrophic mandible [4, 13].

To evaluate whether the patient's anatomy allows insertion of implants, radiographs that demonstrate the height and the labial–lingual width are needed. Assessing the width is as important as assessing the height. The panoramic radiographs that are commonly used in implant treatment planning are limited by their characteristics of magnification and distortion as well as lack of sharpness of the image. Also, a panoramic radiograph is a two-dimensional image providing little information about the buccal–lingual width of the jawbones [33]. Computed tomography has been introduced for presurgical implant planning to address the problem mentioned above. Earlier studies concluded that the tridimensional (3-D) planning resulted in implant positioning with improved biomechanics and esthetics [34–36]. The practitioners can simulate ideal implant placement and treatment planning that includes the precise dimensions of the implant, the ideal depth, and angulation made on the CT scans. A 3-D surgical planning should have been made by the implantodontists in at least the cases 3 and 4, where severe atrophic mandibles were present in order to prevent a severe reduction of bone tissue and further complications.

Ideally, a few millimeters of cortical bone should remain on both the labial and the lingual sites after the hole for insertion of an implant has been drilled. A minimum bone height of 7 mm and a minimum bone width of 6 mm should be available for endosseous implant placement. To reduce the potential fracture problem, the mandible can be restrengthened with bone grafting techniques [13]. In cases number 3 and 4, the reason for fracture was the minor bone volume remaining on the labial and lingual site, as well as at the inferior border of the mandible after removal of the implant.

Extreme caution should be exercised in dealing with the surgical handling of the thin mandible, which is particularly vulnerable to thermal injury because of its dense cortical nature. The mechanical strength of the mandible is diminished, at least temporarily, by multiple implant site preparations [8]. Such patients must be cautioned to limit stresses to the jaw during the prolonged healing period. A link with osteoporosis in the female patients has been suggested [7, 12]. Stress fracture of the mandible must be considered when there is persistent jaw pain associated with one or more implants, especially in patients with compromised bone quality [9].

The treatment of a fracture in an atrophic mandible is always a challenge because of the diminished central blood supply, the depressed vitality of the bone, and the dependence on the periosteal blood supply. The basic principles in fracture treatment are reduction and immobilization of the fractured site for restoration of form and function. When a fracture occurs and stabilization and fixation can be achieved without removing the implant, there is no specific indication for its removal [11, 12].

A combination of augmentation and fixation, followed by insertion of the implants in a second stage, appeared to be a good treatment of fractures in the mandible [13, 14]. Onlay techniques as well as interposition of the graft in the interforaminal area are used [14]. The advantage of a one-stage procedure is that the graft and the implant can be placed at the same time, thereby eliminating a second operation. An important disadvantage is that the positioning and angulation of the implants are more complicated, thereby making this one-stage procedure undesirable from a prosthetic point of view [37]. Another drawback of the one-step reconstruction with onlay bone grafts and endosseous implants is the unpredictable resorption of the grafted bone around the implants [38]. Besides grafting techniques, distraction osteogenesis can be performed to improve the starting point for the placement of implants in the interforaminal area of the severely resorbed edentulous mandible [39, 40].

According to the AO/ASIF principles, the goal of open reduction and internal fixation in the management of mandibular fractures is to achieve undisturbed healing and restoration of form and function without the adjunctive use of maxillomandibular fixation (MMF) [41, 42]. Complications may occur in miniplate osteosynthesis of mandibular fracture, but miniplate fractures are rare (occurring in 0.8% to 2% of cases, according to Edwards et al. [43] and are generally due to noncompliance with instructions to eat a soft diet for 4 to 6 weeks. This can also occur in patients with bruxism, as had occurred with our case number 2. Bruxism has been described as a complicating factor in mandibular fractures [44]. The absence of MMF makes medical care as well as nutritional support and oral hygiene easier. In edentulous patients, the difficulties of making a MMF become a problem. In these cases, as our case number 1, it may be appropriate to use a thicker titanium plate (2.4 other 2.7 mm) [45].

Pathological fracture of the mandible is relatively rare and occurs in association with chronic osteomyelitis, tumors, cysts, atrophy, or osteolysis [46]. Cope [47] described how pathological fractures of the mandible are often the result of physiological activity of the depressor muscles anteriorly and the elevator muscles posteriorly. Osteomyelitis of the mandible is not rare and may develop if the primary infection is not eliminated by proper treatment [46]. Our case number 1 developed osteomyelitis as a consequence of the initial implants surgical procedure.

It is considered that treatment of pathological fractures of the mandible should differ according to etiology. In a

pathological fracture resulting from chronic osteomyelitis, although bone grafting and rigid internal fixation are obviously also needed in the case of severe bone destruction in the fractured area, Silberman et al. [48] reported that spontaneous bone healing may take place if there is long-term immobilization of the mandible after complete elimination of the infection with or without surgical eradication. Ogasawara et al. [49] reported an interesting case, in which a pathological fracture of the mandible resulting from osteomyelitis was successfully treated with only intermaxillary elastic guiding. Open reduction with a miniplate or compression plates is avoided so as to avoid further ischemic necrosis through periosteal reflection [50]. Raghoebar et al. [13] describe four cases (two of their own and two referred) of mandibular fractures related to the placing of implants in atrophic alveolar processes. Three of the cases required bone grafts to repair the fracture, and the other was treated with osteosynthesis plates.

All of our cases were treated with osteosynthesis plates. In our case number 1, closed reduction with rigid intermaxillary fixation was initially indicated, but the patient refused this treatment for personal reasons. She was strongly reluctant in being treated with MMF. Despite these recommendations, her pathological fractured mandible was treated by open reduction and internal fixation. At least, her mandible was not atrophic. A thicker plate was used (2.4 mm) because the mandible was able to support one.

A combination of augmentation and fixation, followed by insertion of the implants in a second stage, should be a good treatment of fractures in the mandible, as was obvious from case reports 3 and 4. But they did not want to undergo further surgeries. In case number 3, the treatment had changed to an inferior overdenture with a bar superstructure. And in case 4, even with the removal of one implant, the patient remained with four implants, and the dentist insisted in doing a fixed mandibular prosthesis.

Conclusion

Severe atrophy of the inferior alveolar process and underlying basal bone often results in problems with a lower denture. If implants are placed in such a mandible, iatrogenic fracture of the mandible may occur during or after implant surgery because implant placement weakens the already-compromised mandible. A few millimeters of cortical bone should remain on both the labial and the lingual sites after the hole for insertion of an implant has been drilled. A 3-D surgical planning should be recommended at least in severe atrophic mandibles in order to prevent a severe reduction of bone tissue.

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