



CASE REPORT

An unusual case of atrophic mandible fracture in a patient with osteogenesis imperfecta and on oral bisphosphonate therapy: Case report



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Abstract Fractures of severely atrophic (height < 10 mm) edentulous mandibles are infrequent and challenging to manage. Factors such as sclerotic bone and decreased vascularity combined with systemic diseases complicate the management of such fractures. Osteogenesis imperfecta (OI) is a heterogeneous group of inherited disorders of type I collagen metabolism. Patients with OI characteristically present with histories of long bone fractures, deformities, blue sclerae, and opalescent dentin. However, fractures of the facial skeleton are rare. Bisphosphonate therapy has been proven to effectively reduce the fracture risk in patients with OI. The purpose of this clinical report is to present an unusual case of spontaneous fracture of the atrophic mandible in a patient with OI. Despite open reduction and internal fixation (ORIF) with miniplate osteosynthesis, the patient developed a second fracture at a screw placement site distal to the first fracture. The patient was successfully treated with ORIF using locking reconstruction plates fixed in the symphyseal and angle regions. Bone healing following ORIF was normal, and no clinical sign of osteonecrosis as a result of bisphosphonate therapy was observed. Patients with OI can present with spontaneous fractures of already weakened mandibles. Although such fractures can be managed with care using established protocols, further research is required to examine the effects of concomitant medication, such as bisphosphonates.

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1. Introduction

Mandibular atrophy due to edentulism leads to decreased bone mass and increased vulnerability to fracture (Ellis and Price, 2008). Fractures of the atrophic edentulous mandible are not common and present challenges to the clinician in terms of reduction and immobilization of the fracture site (Ellis and Price, 2008; Melo et al., 2011). Such fractures occur more

frequently in elderly patients, in whom anatomic and physiologic changes affect bone repair negatively. Local factors, such as dense cortical bone and inadequate blood supply, combined with an increased risk of systemic disease in this population, further complicate the outcomes of treatment (Ellis and Price, 2008; Eyrich et al., 1997; Wittwer et al., 2006). Although falls are the main etiologic events leading to fracture of the atrophic mandible, the placement of implants and interpersonal assault have also been reported (Ellis and Price, 2008; Melo et al., 2011; Mugino et al., 2005; Raghoebar et al., 2000). The basic principle of treatment for these fractures is to restore the anatomic form and function by reduction and immobilization of the fracture segments. Treatment options reported in the literature are controversial (Barber, 2001; Eyrich et al., 1997; Marciani, 2001; Wittwer et al., 2006). Unfavorable results associated with conservative management have shifted the focus toward open surgical treatment of atrophic mandibular fractures. Open reduction and internal fixation (ORIF) enables free movement of the mandible during speech and mastication. Nevertheless, treatment depends on the systemic status of the patient and the degree of fracture displacement (Eyrich et al., 1997; Luhr et al., 1996; Melo et al., 2011).

Osteogenesis imperfecta (OI), also referred to as “brittle bone” disease, is an inherited connective tissue disorder characterized by bone fragility. The overall incidence of OI is approximately one in 10,000 births (Huber, 2007). It is known to be inherited both dominantly and recessively, and is due to a mutation in the genes responsible for procollagen synthesis (Table 1). The disease is caused by the production of abnormal matrix by osteoblasts, which fails to withstand mechanical loads adequately (Gallego et al., 2010; Huber, 2007). Patients with OI are susceptible to fractures in response to mild trauma or even occurring spontaneously. Fractures of the extremities are encountered frequently, but facial bone fractures are relatively rare (Feifel, 1996; Gallego et al., 2010). Treatment of OI is essentially palliative and is aimed at reducing fractures and improving the quality of life. In the past decade, however, bisphosphonates have been used to alleviate bone pain and reduce fracture risk in patients with OI (Landesberg et al.,

2009; Rauch and Glorieux, 2005). Bisphosphonates are a potent group of drugs that target osteoclasts, resulting in reduced bone resorption. Their use to manage osteoblast disorders, such as OI, is based on the hypothesis that a reduction in bone resorption might compensate for the weakness in bone formation and reduce the development of osteoporosis due to disuse (Gallego et al., 2010; Rauch and Glorieux, 2005). Moreover, their effects on bone turnover may lead to bisphosphonate related osteonecrosis of the jaws (BRONJ) following oral surgical procedures (Heufelder et al., 2012; Ruggiero et al., 2009).

Here, we report a case of spontaneous atrophic mandibular fracture in an adult patient with type I OI receiving oral bisphosphonate treatment. To our knowledge, this presentation of atrophic mandibular fracture concomitant with systemic bone disorder is unusual. We describe the failed treatment of the fracture with miniplate osteosynthesis and successful retreatment with locking mandibular reconstruction plate osteosynthesis. In spite of the potential risk of developing BRONJ, the bone healing following fracture retreatment was unremarkable and no clinical sign of osteonecrosis was observed.

2. Case report

In June 2011, a 48-year-old male Saudi patient was referred to the Oral and Maxillofacial Surgery Clinic at King Saud Medical Complex, Riyadh, Kingdom of Saudi Arabia. On presentation, the patient complained of numbness in his lower lip associated with discomfort in the right mandible for 3 weeks. He had no history of trauma or injury. His medical history revealed a diagnosis of type I OI based on the Sillence et al. classification (Sillence et al., 1979). The patient had undergone multiple orthopedic surgical interventions for spontaneous lower extremity fractures, including retreatment of a non-united tibial fracture, which necessitated bone graft placement. The last surgical intervention had been performed 18 months previously. The patient had also been diagnosed with osteoporosis 8 years previously, and since that time had received treatment with oral alendronic acid (Fosamax, 70 mg once/week; Merck, Whitehouse Station, NJ, USA), alfacalcidol

Table 1 Types of osteogenesis imperfecta (Huber, 2007).

Types	Clinical features	Prevalence	Mode of inheritance
I*	Normal stature with bone fragility and blue sclera First fractures when learning to walk or stand. Ambulatory with no bowing of legs Associated with sensorineural deafness > 50%	1: 15,000–20,000	AD
II*	Severe bone fragility and lethal either in utero or in the perinatal period Associated with cardio-pulmonary insufficiency New borns exhibit blue sclera, soft calvarial bones, triangular face and beaked nose	1: 20,000–60,000	AD; AR (rare)
III*	Short stature due to progressive deformity and a high fracture rate Enlarged head with deformation of bone at the base of the skull and triangular facies Early hearing loss and variable sclera	1: 50,000–100,000	AD; AR (rare)
IV*	Short stature with bowing of legs Progressive impairment of mobility Normal sclera with variable hearing loss	Unknown	AD
V#	Mild to moderate stature with dislocation of the head of the radius Associated with hyperplastic callus formation and white sclera	Unknown	AR
VI#	Scoliosis with moderate stature and white sclera	Unknown	AR
VII#	Bone fragility at birth with rhizomelia, coxa vara, osteopenia and blue sclera	Unknown	AR

* Originally classified by Sillence et al. (1979).

Recently added uncommon types by Glorieux et al. (2000); Glorieux et al. (2002) and Ward et al. (2002).

(One-Alpha, 1 µg/day; Leo Pharmaceutical Products, Ballerup, Denmark), and calcium carbonate (Osteocare, 600 mg twice/day; Vitabiotics, London, UK). The patient's dental records showed a history of multiple uncomplicated dental extractions, a completely edentulous mandibular arch, and a normal C-terminal telopeptide (CTX) reading. CTX testing had been performed before 1 month, as the patient sought dental implant rehabilitation due to an ill-fitting lower denture.

Clinical examination revealed reduced mobility of the mandible associated with pain in the right mandibular body region and anesthesia of tissues along the distribution of the right mental nerve. Radiographic examination showed fracture of the right mandibular body with gross displacement (Fig. 1). The patient consented to and was prepared for ORIF of the fracture under general anesthesia. Surgical exposure of the fracture site was achieved using an extraoral submandibular approach. Upon exposure, the mandible was found to be severely atrophic (class III; height, 9 mm) and the right inferior neurovascular bundle was found to be completely transected. Anatomic ORIF of the mandibular body fracture was performed with a 2.0-mm miniplate (Mini-System; KLS Martin, Tuttlingen, Germany) and four self-drilling screws (9-mm maxDrive drill-free screws; KLS Martin), which were placed on either side of the fracture line at the inferior border of the mandible (Fig. 2). The postoperative period was uneventful and after completion of a short-term intravenous (IV) antibiotic course (cephradine, 500 mg every 6 h, and metronidazole, 500 mg every 8 h, for 5 days), the patient was discharged with a prescription for oral antibiotics (clindamycin, 300 mg every 8 h for 5 days) and strict advice to maintain a liquid diet for 4 weeks and to discontinue the use of any denture or prosthesis.

Three weeks after the first surgery, the patient presented to the emergency department of King Saud Medical Complex immediately after hearing a cracking sound at the surgical site. Clinical examination revealed moderate tenderness at the surgical site with diffuse extraoral edema. Radiographic examination showed a displaced screw and a new fracture in the distal segment of the old fracture (Fig. 3). The patient consented to and was prepared for a second surgical procedure under general anesthesia. The previous ORIF site was exposed using the same approach. Comminution at the new fracture site and callus formation at the old fracture site were observed upon exposure. Fixation was performed using a 2.4-mm locking mandibular reconstruction plate (Compact 2.4 UniLOCK; Synthes, Oberdorf, Germany) and bicortical self-drilling screws (14-mm UniLOCK screws; Synthes), which were placed in the more stable mandibular ramus and symphyseal regions (Fig. 4). The postoperative period was uneventful and the patient was given an IV antibiotic regimen (cephradine, 500 mg every 6 h, and metronidazole, 500 mg every 8 h) for 7 days. The patient was then discharged with a prescription for oral antibiotics (clindamycin, 300 mg every 8 h for 2 weeks) and advised to follow a strict liquid diet for 4 weeks and return monthly for follow-up clinical visits. A follow-up radiograph taken 6 months postoperatively showed no appreciable frac-

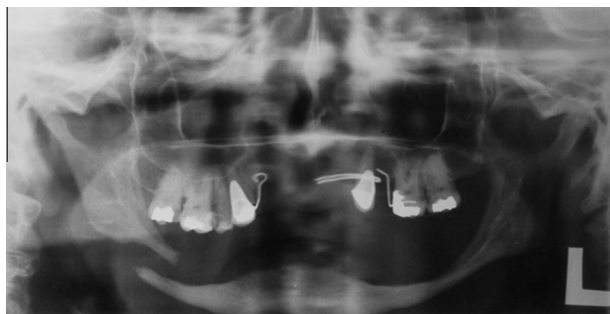


Figure 1 Pre-operative panoramic radiograph showing fracture of the atrophic mandible with displacement in the right mandibular body region.



Figure 2 Post-operative panoramic radiograph (immediately after first surgery) showing miniplate fixation of the right mandibular body fracture with four screws placed on either side of the fracture line.



Figure 3 Post-operative panoramic radiograph (3 weeks after first surgery) showing displacement of a screw and evidence of undisplaced fracture distal to the site of primary fracture.

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Figure 4 Post-operative panoramic radiograph (immediately after second surgery) showing stable reduction and fixation of the right mandibular body fracture using a mandibular reconstruction plate fixed to the mandibular angle and symphysis regions.



Figure 5 Post-operative postero-anterior view of the skull (3 months after second surgery) showing stable fixation of the mandible and no evidence of osteonecrosis.

ture line (Fig. 5). The patient has shown no clinical sign of fracture non-healing or osteonecrosis during the past 2 years.

The patient provided informed consent to the publication of this report and his radiographs. Ethical approval for the publication of this case report was also obtained from the institutional ethics board.

3. Discussion

Following dental extraction, biological processes lead to the loss of the alveolar ridge. The combined effects of tooth loss and bone resorption result in an atrophic mandible that is vulnerable to fracture with increasing age (Madsen et al., 2009). Ellis and Price (2008) defined an atrophic mandible as any mandible with a height < 15 mm. Luhr et al. provided a more comprehensive classification of atrophic mandibles based on height, consisting of classes I (height 16–20 mm), II (height 11–15 mm), and III (height ≤ 10 mm) (Luhr et al., 1996). Class III atrophic mandibles are most susceptible to fracture, as the region of least height is associated with the greatest fracture frequency (Melo et al., 2011). In the present clinical case, the patient had a class III atrophic mandible according to the Luhr et al. classification.

Despite the lack of conclusive evidence in the literature supporting a conservative or surgical approach for the management of fracture of an edentulous atrophic mandible (Holland, 2007; Nasser et al., 2007), several studies have provided better support for the latter approach (Ellis and Price,

2008; Eyrich et al., 1997; Madsen et al., 2009; Marciani, 2001). The recommended fixation methods have been miniplate osteosynthesis (Clayman and Rossi, 2012; Melo et al., 2011; Mugino et al., 2005) or the use of locking mandibular reconstruction plates (Madsen et al., 2011; Santos et al., 2013; Tiwana et al., 2009; Van Sickels and Cunningham, 2010). In a large series (335 patients) of mandibular fractures reported by Mugino et al. (2005), 15 fracture sites in the edentulous mandibles of 11 patients were all treated with miniplate osteosynthesis. The authors recommended the placement of two miniplates – one buccally and the other at the inferior border – in cases of extremely thin (height < 10 mm) mandibles. Based on a series of 16 patients with edentulous mandibular fractures, Clayman and Rossi (2012) affirmed the safety and effectiveness of ORIF with miniplates placed at the inferior mandibular border. In the present case, the mandibular fracture was treated in the first instance using miniplate fixation; a 2.0-mm miniplate was selected based on the observations of Wittwer et al. (2006), who recommended the most rigid fixation possible for mandibles with heights < 15 mm.

OI is an inherited disease that affects bone formation, resulting in low bone mass and fragility. It can be divided into four main types based on disease progression and severity (Huber, 2007) (Table 1). Type 1 OI, the most common form of the disease, is characterized by vertebral and long bone fractures, which begin with ambulation in childhood and are associated with falls later in life. It is rarely deforming, and affected patients attain near-normal height. Commonly observed dental anomalies associated with OI include dentinogenesis imperfecta and malocclusion (Huber, 2007), and rare instances of mandibular fracture during dental extraction have also been reported (Feifel, 1996; Gallego et al., 2010). Patients with OI have reduced quantities of cortical and trabecular bone compared with normal patients (Huber, 2007). Prolonged edentulism leads to the reduction of the mandibular cross-sectional area, ultimately decreasing the amount of internal buttressing (Santos et al., 2013). All of these factors prompt the hypothesis that the primary mandibular fracture in the present case, which occurred in the absence of any fall, was due to the combined effects of OI and the reduced load-bearing ability of the atrophic mandible.

Within 3 weeks of ORIF using the 2.0-mm miniplate, the patient presented with a secondary fracture distal to the primary fracture. This fracture occurred despite the patient's maintenance of a strict liquid diet in the postoperative period. While the observation of callus formation at the primary fracture site indicates the effectiveness of ORIF, comminution and screw displacement at the secondary fracture site demonstrate the weakening effect of OI on the already atrophic mandible. The second ORIF was performed using 2.4-mm locking mandibular reconstruction plates, following the findings of Tiwana et al. (2009) and Van Sickels and Cunningham (2010) that the use of a large reconstruction plate and the thick bone in the symphyseal and angle regions provides for ideal healing of fractures in severely atrophic (height < 10 mm) mandibles. Although load-bearing reconstruction plates enable better fracture healing and early restoration of function, concomitant placement of autologous corticocancellous bone grafts is presumed to increase the osteogenic potential of the native bone and accelerate healing at the fracture site (Ellis and Price, 2008; Eyrich et al., 1997; Santos et al., 2013; Tiwana et al.,

2009). In the present case, the patient's systematic status prevented the use of autologous bone.

Surgery combined with physiotherapy and rehabilitation has been the mainstay of OI treatment (Gallego et al., 2010). Medical therapies that have been used without proven success include sodium fluoride, calcitonin, cortisone, growth hormone, and vitamins C and D (Huber, 2007). Bisphosphonate treatment has had significant clinical benefits, such as reduced pain and fracture incidence and increased mobility, in children and adolescents with OI (Rauch and Glorieux, 2005). The therapeutic benefits of bisphosphonates are attributed to their inhibitory effects on osteoclast formation and activity, and promotion of early osteoclast apoptosis (Huber, 2007; Landesberg et al., 2009). IV pamidronate (Rauch and Glorieux, 2005) and oral alendronate (Gallego et al., 2010) treatments have been reported to increase the long-bone bone mineral density and decrease the number of fractures in patients with OI. No significant difference has been observed between oral and IV bisphosphonate therapies in patients with OI (Gallego et al., 2010). BRONJ has been reported in many patients who have received bisphosphonate treatment and undergone oral surgical procedures (Ruggiero et al., 2009). However, there are no reported cases of BRONJ in patients with OI treated with bisphosphonates, even after dental extraction (Schwartz et al., 2008). Elevated fasting CTX levels have also been associated with predictable outcomes following fracture fixation and osseointegration (Marx et al., 2007). Marx et al. (2007) proposed stratification of the risk of BRONJ following oral surgical procedures, with a fasting CTX level > 150 pg/ml indicating little or no risk, a level of 100–150 pg/ml indicating moderate risk, and a level < 100 pg/ml indicating high risk. Oral alendronate therapy did not affect the final outcome in the present case.

4. Conclusion

No previous report has described spontaneous fracture of an atrophic edentulous mandible in a patient with OI. The patient's receipt of simultaneous oral bisphosphonate therapy makes the present case a unique example wherein the clinician was confronted with difficulties in treatment planning and delivery. The presence of comorbid systemic conditions dictates the use of techniques proven to be successful, and not those that are only expected to be successful (Madsen et al., 2011). This case report highlights the susceptibility of patients with OI to a fracture of the mandible when it is weakened by physiological or pathological processes. Nevertheless, the risk of BRONJ in such patients receiving bisphosphonate therapy cannot be neglected and should be evaluated in long-term clinical studies.

Conflict of interest

The authors declare no conflict of interest.

Source of support

Nil.

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