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An unusual case of dental root injury after miniplate osteosynthesis of the mandible

CASE REPORT

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Abstract – Based on the case history of a 44-year-old female patient with a mandibular fracture, dental root injury from cutting off the apical blood supply after miniplate osteosynthesis is reported. The different types of dental injuries and complications are emphasized as well as the resulting therapeutic strategies.

Miniplate osteosynthesis is presently regarded as the standard therapy for common mandibular fractures. Through the concept of monocortical fixation the possibility of a dental root injury is clearly reduced (1–6). However, a small risk still remains of causing damage to the inferior alveolar nerve (7–9, 23) as well as provoking a direct or an indirect dental root injury or pulp injury (10–12).

The intention of this case report is to draw attention to the possibility of an indirect dental root injury, in a case where no contact between the miniplate or screws and the respective teeth is observed in the X-rays. Furthermore, the resulting therapeutic strategies shall be described, and a therapeutic regime depending on the type of injury shall be suggested.

Case report

A 44-year-old woman was admitted after a bicycle accident with a fracture of the condylar process on both sides, as well as a non-dislocated paramedian fracture of the mandible region 41/42. On the following day after adjustment of the habitual occlusion and mandibulo-maxillary fixation with IMF-Screws (Synthes GmbH, Umkirch, Germany), osteosynthesis was performed by positioning one four-hole-miniplate close to the alveolar ridge and one compression screw basal (Synthes GmbH). The postoperative X-ray control, including an ortho-panthography and a skull radiograph according to Clementschitsch, showed a subapical positioned miniplate fixed by four 6 mm screws. A direct contact to dental roots could not be detected (Fig. 1, upper left).

Three months postoperatively the patient went to her dentist with spontaneous pain in the anterior mandibular teeth lasting several minutes. Teeth 41, 42 and 43 responded negatively to the pulp vitality test with CO_2 and were sensitive to percussion. Radiology (dental film) revealed no pathological findings, neither apically nor at the periodontal space, so an irreversible pulpitis of the teeth 41–43 was diagnosed. The dentist extirpated the pulp and applied a temporary root canal dressing [$Ca(OH)_2$-preparation] (Fig. 1, upper right). The root canal was filled 3 months later with gutta-percha and a sealer (AH-Plus®, Dentsply DeTrey GmbH, Konstanz, Germany).

Nevertheless, the teeth developed an abnormal tooth mobility (grade I) 1 month later and for a total of 7 months postoperatively. Under palpation in the mucolabial fold the dental roots hurt. The X-ray (dental film) now showed a periapical translucency as well as enlarged periodontal spaces of teeth 41, 42 and 43. Hereupon the osteosynthesis material was removed. There was neither granulation tissue around the implanted material nor signs of an osteomyelitis which could be observed. Simultaneously, a resection of the root apices of the teeth 41–43 was performed together with an orthograde root filling (Fig. 1, lower left). One month later the patient developed an irreversible pulpitis in tooth 31, which again required a root-canal treatment by the dentist.

Three months later, the patient reported sensitivity to percussion in teeth 31 and 41. Resection of the root apex and postresection retrograde root-end filling, using a self hardening root-canal filling material based on

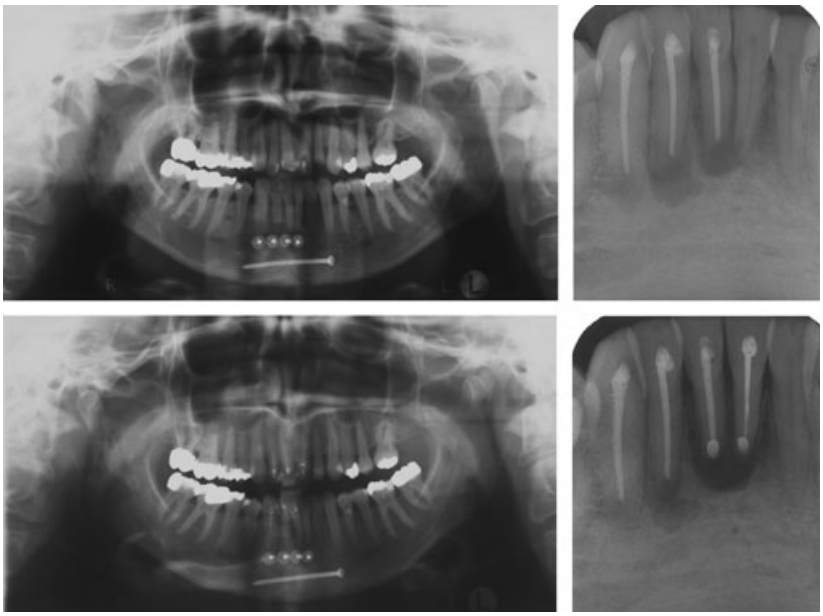

Fig. 1. X-ray pictures of an indirect dental root injury after miniplate osteosynthesis of a paramedian mandibular fracture. Upper left (a): orthopanthography: X-ray control after reduction osteosynthesis with one miniplate and one compression screw, 3 days postoperatively. Lower left (b): orthopanthography: $Ca(OH)_2$-insole of the teeth 41–43, 3 months postoperatively. Upper right (c): dental film: root apices resection and orthograde root-canal filling of the teeth 41–43, 7 months postoperatively. Lower right (d): dental film: root apex resection and retrograde root-canal filling of the teeth 31 und 41, 11 months postoperatively.

polyketone (Diaket®, Firma ESPE, Seefeld, Germany) was performed on tooth 31 and, for the second time, on tooth 41 (Fig. 1, lower right).

Again 1 month later, the patient developed a submucosal abscess in regio 31–42. The inflammation declined after incision and drainage, as well as daily change of the inserted strip and oral antibiotic therapy with clindamycin 300 mg three times daily. Teeth 31, 41 and 42 were extracted. An inapparent fracture of the teeth was excluded macroscopically. For further treatment, it was planned that dental implants would be inserted.

Discussion

Diagnosis

As the reason for the loss of tooth vitality and on the long view of the teeth themselves in the present case, we diagnosed an indirect injury by the drilling procedure or by the placement of the screws. Other reasons could be a tooth fracture as well as a fracture site infection, but these reasons were excluded as mentioned.

Interestingly, the X-rays did not provide any evidence of tooth injury. However, X-rays only show the screws and miniplates already *in situ*, and they do not show a possible injury from the drilling procedure. Furthermore, X-rays present a three-dimensional situation on a two-dimensional plan, thus limiting its validity (13).

Driemel et al. (14) described four types of dental root injuries resulting in two different clinical courses:

First, a screw contacts the dental root without affecting the pulp (type II or type III; positive reaction in pulp vitality test, no sensitivity to percussion, unchanged tooth mobility, unchanged pocket probing depth).

Secondly, a direct pulp injury (type Ia) or an injury to the supplying apical blood vessels (type Ib) by the screw or the drilling procedure occurred (negative reaction in pulp vitality test, positive sensitivity to percussion, abnormal tooth mobility, increased pocket probing depth) (Fig. 2).

According to this classification the presented case history demonstrates a type Ib injury.

Complications

Compared with the maxilla, the mandible has a much thicker corticalis, especially in the lateral part of the alveolar ridge. Therefore, the root contours are more difficult to locate intraoperatively in the mandible (15). This means that, in general, the risk of misdrilling or of misplacing a screw with a resulting dental root injury is higher in the mandible than in the maxilla.

After an isolated direct root injury by osteosynthesis screws without a concomitant fracture, Ewers and Düker (16) observed no pulpal necrosis in experimental animals

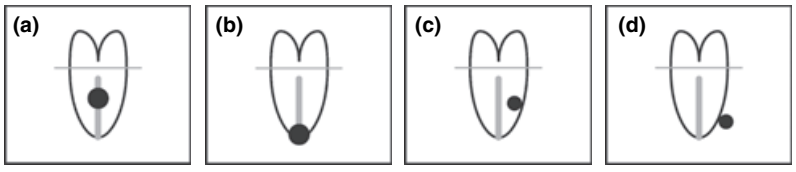

Fig. 2. Classification of tooth injuries resulting from miniplate osteosynthesis according to Driemel et al. (14) (a) Type Ia: injury of the pulp above the apical radicular dentin. (b) Type Ib: injury of the pulp in the apical third or extradental injury of the supplying apical blood vessels. (c) Type II: injury of the central radicular dentin without pulp involvement. (d) Type III: injury of the peripheral radicular dentin and root cementum.

within a 6-week follow-up period. The authors argued that despite an extensive trauma to the dental pulp, either a part of the blood support remained, or a complete revascularization took place.

Nevertheless, as a result of direct dental root injury with an involvement of the pulp, patients may develop a pulpitis as well as relevant external root resorptions (5). Freitag and Gaebel (11) described the devitalization of two teeth after miniplate osteosynthesis of 59 mandibular fractures in 46 patients, but documented neither the radiological findings nor the further clinical and radiological outcome or the therapeutic interventions.

Also, indirect dental root injuries by interrupting the apical blood supply as observed in the presented case seem to increase the risk of a pulpitis with consecutive apical peridontitis up to the loss of the affected tooth (14). In a prospective study on the morbidity of harvesting chin grafts, Nkenke et al. (17) also reported a remaining negative sensitivity of the lower anterior incisor teeth in 20 of 176 patients (11.4%) without damage to the apices being evident in X-rays. In an investigation of postoperative morbidity following chin graft surgery in 27 patients, Joshi (18) reported a continuing negative sensitivity of the lower anterior incisor teeth in two patients. To preserve blood supply and avoid loss of sensitivity of the front teeth, both authors, as well as Neukam et al. (19), assume that the safety margin should be at least 8 mm.

Direct as well as indirect dental root injuries reduce the chance of survival of the affected tooth and require a close clinical follow-up with a symptom dependant therapy, especially in the first 24 months. Two years after drilling failure with an involvement of the pulp, new afflictions become unlikely, but cannot be completely excluded (14).

Therapy

In the present literature only a few and mainly older reports exist about the clinical outcome and the therapy of dental root injuries after miniplate osteosynthesis. The suggested therapeutic procedures extend from no interventive treatment, observing the clinical course up to endodontic treatment as well as to root resection, and lastly to the extraction of the affected tooth.

Borah and Ashmead (20) reported on 13 drilling failures after miniplate osteosynthesis. However, due to a lack of clinical symptoms, none of the drilling failures required a therapeutic intervention.

Simple external root resorptions and localized replacement resorptions may remain without therapeutic consequence as long as clinical symptoms are missing. Because of the expected progression and complications, an external inflammatory resorption, or an internal root resorption always requires an immediate complete pulpectomy, potentially including $Ca(OH)_2$-dressing and consecutive root-canal filling (10, 21, 22).

Gerlach et al. (12) documented 14 drilling failures after a total of 1277 miniplate osteosynthesis. Three of these teeth showed a loss of vitality during follow-up and were treated by root apex resection with orthograde canal filling.

In the present case, as a result of indirect dental root injury or injury to the supplying blood vessels, in the first postoperative year an endodontic treatment and – during further follow-up – even surgical intervention was necessary due to the persistent clinical symptoms and complications (submucosal abscess formation).

According to Driemel et al. in case of dental root injuries after miniplate osteosynthesis, the localization and the extent of the injury determine the survival chance of the tooth. Only an injury of the pulp located in the upper third of the radicular dentin (type Ia), or an injury of the pulp in the apical radicular dentin, as well as an extradental injury of the blood supply (type Ib), have the risk of causing a pulpitis with consecutive apical peridontitis and loss of the tooth. The prognosis of dental root injuries without involvement of the pulp (type II und type III) is good (14).

Conclusions

- Despite the concept of monocortical fixation, miniplate osteosynthesis, especially of the mandible, may result in direct as well as in indirect dental root injuries, probably by ligating the apical blood supply.
- In case of an indirect dental root injury, the X-ray may not provide any evidence of a tooth injury.
- Even an endodontic treatment or a resection of the root apices can fail and lead to the loss of the affected teeth, requiring complex therapeutic procedures.
- The need for therapeutic intervention (close follow-up, pulpectomy, root apex resection up to tooth extraction) results from the synopsis of diagnostic imaging (dental root injury with possible involvement of the pulp) and of clinical symptoms (dental root injury with involvement of the pulp).

References

1. Austermann KH. Frakturen des Gesichtsschädels. In: Schwenzer N, Ehrenfeld M, editors. Zahn-Mund-Kiefer-Heilkunde Bd 2: Spezielle Chirurgie. Stuttgart, New York: Thieme; 2002. p. 315–6.
2. Champy M, Gerlach KL, Booth PW. Basic guidelines for mandibular osteosynthesis, 2nd edn. S.O.R.G Strasbourg Osteosynthesis Research Group; 2004. p. 1–17.
3. Gerlach KL, Pape HD. Prinzip und Indikation der Miniplattenosteosynthese. Dtsch Zahnarztl Z 1980;35:346–8.
4. Gschoßmann K, Mast G, Ehrenfeld M. Fehler und Komplikationen bei der chirurgischen Versorgung von Unterkieferfrakturen. OP-Journal 2004;2:122–6.
5. Schilli W, Stoll P, Bähr W, Prein J. Mandibular fractures. Mistakes in application and techniques. In: Prein J, editor. Manual of internal fixation in the cranio-facial skeleton. Berlin, Heidelberg, New York: Springer; 1998. p. 58.
6. Schmelzle R. Zur Chirurgie der Gesichtsverletzungen und der Kiefer. In: Kastenbauer ER, Tardy ME, editors. Kopf- und Hals-Chirurgie. Stuttgart, New York: Thieme; 1995. p. 635.
7. von Heydarian F, Ewers R. Die Verletzung des Nervus alveolaris inferior, hervorgerufen durch Osteosyntheseschrauben. Dtsch Zahnarztl Z 1980;35:42–4.
8. Iizuka T, Lindqvist C. Rigid internal fixation of fractures in the angular region of the mandible: an analysis of factors contributing to different complications. Plast Reconstr Surg 1993;91:265–73.

9. Kahnberg KE, Ridell A. Bone plate fixation of mandibular fractures. Int J Oral Surg 1980;9:267–73.
10. Ehrenfeld M, Hickel R. Traumatologie der Zähne und des Zahnhalteapparates. In: Schwenzer N, Ehrenfeld M, editors. Zahn-Mund-Kiefer-Heilkunde Bd 3: Zahnärztliche Chirurgie. Stuttgart, New York: Thieme; 2002. p. 72–3.
11. Freitag V, Gaebel M. Erfahrungsbericht über die Miniaturplattenosteosynthese im Unterkiefer. Dtsch Zahnarztl Z 1983;38:370–2.
12. Gerlach KL, Khouri M, Pape HD, Champy M. Die Ergebnisse der Miniplattenosteosynthese bei 1000 Unterkieferfrakturen an der Kölner und Straßburger Klinik. Dtsch Zahnarztl Z 1983;38:363–8.
13. Chandler NO, Cathro PR. Endodontic sequelae of miniplate bone fixation. Oral Surg Oral Med Oral Pathol 1996;81:467–71.
14. Driemel O, Staudenmaier R, Buch RS, Schüsselbauer U, Wagener H, Reichert TE et al. Zahnverletzungen bei Miniplattenosteosynthese: Einteilung, Therapiemanagement, Komplikationen und Prognose. Mund Kiefer Gesichtschirurgie 2005;9:330–5.
15. Hell B, Bier J. Chirurgische Zahnerhaltung. In: Schwenzer N, Ehrenfeld M, editors. Zahn-Mund-Kiefer-Heilkunde Bd 3: Zahnärztliche Chirurgie. Stuttgart, New York: Thieme; 2002. p. 84.
16. Ewers R, Düker J. Zahnverletzungen durch Osteosyntheseschrauben. Dtsch Zahnarztl Z 1980;35:38–41.
17. Nkenke E, Schultze-Mosgau S, Radespiel-Tröger M, Kloss F, Neukam FW. Morbidity of harvesting of chin grafts: a prospective study. Clin Oral Impl Res 2001;12:495–502.
18. Joshi A. An investigation of postoperative morbidity following chin graft surgery. Br Dent J 2004;196:215–8.
19. Neukam FW, Hausmen JE, Kaufmann K. Animal experimental trials on the blood supply of the alveolar ridge and the teeth after alveolar osteotomy in relation to the distance of the perpendicular osteotomy line to the root apices. Deutsche Zeitschrift für Mund-Kiefer-Gesichts-Chirurgie 1981;5:369–72.
20. Borah GL, Ashmead D. The fate of teeth transfixed by osteosynthesis screws. Plast Reconstr Surg 1996;97:726–9.
21. Flores MT, Andreasen JO, Bakland LK, Feiglin B, Gutman JL, Oikarinen K et al. Guidelines for the management of traumatic dental injuries. Dent Traumatol 2001;17:193–8.
22. Trope M. Clinical management of the avulsed tooth: present strategies and future directions. Dent Traumatol 2002;18:1–11.
23. Mugino H, Takagi S, Oya R, Nakamura S, Ikemura K. Miniplate osteosynthesis of fractures of the edentulous mandible. Clin Oral Investig 1995;9:266–70.