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A retrospective evaluation of iatrogenic dental root damage with predrilled vs drill-free bone anchor screws for intermaxillary fixation

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Abstract – *Aims*: The aim of this study was to retrospectively evaluate iatrogenic dental root damage, caused by two different techniques that utilized bone anchor screws, for intermaxillary fixation (IMF) in orofacial trauma. *Materials and methods*: The techniques used included either predrilled or drill-free bone anchor screws. A total of 123 patients who required IMF were evaluated (97 men and 26 women). Sixty-four patients were treated in the predrilled group, and 59 patients were treated in the drill-free group. The data were collected over an 8-year period and were analyzed using crosstabs and Fisher's exact test. *Results*: Injuries to dental roots were found only in the predrilled group. Twenty-nine patients (45.3%) were injured at the time of surgery. One year after surgery, 10 patients (15.6%) had permanently injured dental roots. There was a significant difference in injury rates between the predrilled and drill-free groups 1 year after surgery ($P < 0.001$). *Conclusion*: There is an increased potential risk of iatrogenic injury and permanent damage to the dental roots when a technique that involves predrilled holes for bone anchor screws is used.

Intermaxillary fixation (IMF) is a basic and fundamental principle in maxillofacial reconstruction. Stabilization of the patient's dental occlusion provides a solid base from which facial structure and function can be restored with bony union (1). This technique is not always necessary to reduce fractures that are confined to the mandibular bone when a skilled assistant is present (2–4). Nevertheless, there is often a need for temporary IMF intraoperatively when re-establishing the anatomy with rigid internal fixation. Different methods have been used to achieve this purpose. A standard, reliable, inexpensive, and versatile technique has traditionally been the application of arch bars to the maxillary and mandibular teeth using interdental eyelet wires. Owing to the design of the hardware, transmission of blood-borne infectious diseases and risk of penetrating injuries to the operating team are considered (5–7). Other described consequences are trauma to the periodontium and increased surgical time in placement and removal, which are painful for the patient and compromise oral hygiene (8, 9). Furthermore, arch bars are less appropriate when treating fractures in partially or totally edentulous patients.

In 1989, Arthur and Berardo (10) introduced a simplified technique for IMF using cortical bone screws. These screws offered several advantages over traditional IMF with arch bars, including speed of application, increased comfort for the patient, minimal hardware, less complicated oral hygiene, and decreased trauma to the periodontium. In contrast to arch bars with wires, the cortical bone screws reduced the risk of needle stick and percutaneous transmission of blood-borne infectious diseases. Patients with extensive crown and bridgework were also less complicated to treat.

Bone screws can be placed under local anesthesia and removed relatively painlessly. Wires or elastics can be used between the bone screws for temporary intraoperative or postoperative IMF. Additionally, orthodontic anchorage control can be performed with bone anchor screws (11).

Since their introduction, bone screws have been received with both enthusiasm and criticism. The first studies on bone screws described the placement of 2.0-mm self-tapping cortical bone screws, in a location above the root apices in the maxilla and near the piriform rim area or the zygomatic buttress region. In the mandible, they utilized the region below the root apices between the mental foramina (5, 8–10, 12, 13). Technical notes and case reports have described bone anchor screws placed in

the alveolar bone adjacent to dental roots with the predrilled technique (14–19) and a decrease in trauma with the drill-free technique (20–23). Fabbroni et al. (24) were the first to described the screw approach in the alveolar bone as transalveolar. The main concern with bone anchor screws has been the potential for iatrogenic damage of the dental roots.

To our knowledge, there have been no previous studies that focused on a comparison between predrilled transalveolar bone anchor screws and drill-free, self-cutting, and self-tapping transalveolar bone anchor screws with a focus on iatrogenic injury to dental roots. Therefore, the aim of this study was to evaluate these two surgical techniques with regard to injury to dental roots.

Materials and methods

Subjects

This retrospective, dual-center study comprised 123 consecutive patients (97 men and 26 women) who required treatment for facial fractures. The follow-up period was 8 years (2000–2008). The patients were treated with open reduction and internal fixation or conservatively with closed reduction and guided elastics. The data were collected from the patient's medical records and X-rays.

Surgical techniques

Two surgical techniques were compared. Bone anchor screws with predrilled holes that used a twist drill prior to insertion (Stryker Leibinger screws 2.0 × 12–16 mm, Freiburg, Germany; Walter Lorenz IMF screws 2.0 × 5–7 mm, Jacksonville, FL, USA) were compared with drill-free, self-cutting, and self-tapping bone anchor screws (Synthes Inc., IMF screws, 2.0 × 8–12 mm, Monument, CO, USA; Biomet Microfixation IMF screw 2.0 × 5–7 mm, Warsaw, IN, USA; Stryker Leibinger maxillo mandibular fixation (MMF) screws 2.0 × 8–12 mm, Freiburg, Germany). All screws were inserted between dental roots by a transalveolar approach. Temporary IMF was achieved using wires or elastic bands. On some occasions, the screws were removed directly after surgery. However, the majority of the bone anchor screws were retained for several weeks for the correction of small discrepancies in the occlusion. In cases of open reduction and internal fixation, phenoxymethylpenicillin or clindamycin therapy was routinely maintained for 1 week postoperatively.

Follow up

Clinical examination and radiographs were used to reveal the results of fracture treatment. Profile, frontal, or orthopantomogram X-rays were performed as needed. Further follow up with clinical examination and intraoral X-rays was performed only in case of complications. In these cases, patients were followed up with a second clinical examination and intraoral X-rays were taken. One single examiner performed all radiographic analyses.

Statistical analysis

All statistical analyses were performed with the SAS Statistics software program, version 19.1. Injuries related to the patient were treated as categorical data and were analyzed using crosstabs and Fisher's exact test. Injuries related to the teeth were analyzed with basic descriptive statistics.

Results

Subjects

The data collected for the two groups were comparable with regard to the number of patients, age, and sex.

Surgical technique

No injuries to the dental roots were noted in the group that received drill-free transalveolar bone anchor screws. All iatrogenic injuries to the dental roots were associated with the twist drill and predrilled transalveolar bone anchor screws (Fig. 1). Twenty-nine patients (45.3%) and 59 teeth were injured at the time of surgery.

Follow up

Ten patients (15.6%) and 16 teeth were considered permanently injured up to 1 year after surgery in the predrilled group. Thirteen teeth required endodontic treatment, and one tooth was extracted because of the injury. Forty-three teeth recovered spontaneously after 1 year of follow up with radiographic evidence of cementum healing (Fig. 2).

Fig. 1. Follow-up X-ray immediate postoperatively demonstrating root injury complications.

Fig. 2. Follow-up X-ray of healing after 1 year (the same patient as in Fig. 1).

Statistical analysis

Injuries related to the teeth were analyzed as basic descriptive statistics. Fisher's exact test showed a statistically significant difference with a two-sided probability between the predrilled and drill-free groups, at the time of surgery $P < 0.001$ and ≥1 year after surgery $P < 0.001$ (Table 1).

Discussion

This retrospective study, which compared two treatment alternatives with transalveolar bone anchor screws, confirmed previous reports that the drill-free technique is considered safe. Coletti et al. showed this prospectively and Roccia et al. also demonstrated a similar outcome in a retrospective report (25, 26). Furthermore, this study showed that the twist drill is hazardous to dental roots and should therefore be avoided in the transalveolar approach. The need to drill a hole before the insertion of a self-tapping bone anchor screw was evaluated by Fabbroni et al. (24), who described dental damage through minor or major contact and concluded that clinically significant dental injury appeared to be low. In contrast, our study showed obvious damage to the patients, with permanent injuries to the teeth, notwithstanding that there was a possibility of healing injured dental roots over time in the predrilled group. The healing pattern of the dental injuries is difficult to predict with regard to the severity of the damage to the root cementum. A minor damage will most probably heal with a restored cementum layer, albeit the contour of the dentin still being affected of the original injury. If the injury comprise of a larger surface of the root, ingrowth of alveolar bone will supersede the root cementum and hence induce a possible replacement resorption process. To study this, a long-term study with at least 5- to 10-year follow up would be recommended.

Table 1. Demographic data ($n = 123$)

	PD	DF	*P*-value
Number of patients	64	59	
Number of screws	445	337	
Number of men/women	51/13	46/13	
Mean age (SD)	38 (16, 29)	39 (20, 84)	
Median age (range)	34 (15–100)	33 (11–87)	
Number of injured patients at surgery	29 (45, 3%)	0	<0.001*
Number of injured patients after ≥1 year	10 (15, 6%)	0	<0.001*
Number of injured teeth at surgery	59	0	
Number of injured teeth after ≥1 year	16	0	

PD, predrilled; DF, drill-free; SD, standard deviation.
*Fisher's exact test.

Drill-free screws offer significant advantages over arch bars and eyelets when temporary IMF is required for treating simple fractures. The technique is quick, and the bone anchor screws are easy to insert. The risk of needlestick injury and transmission of blood-borne infectious diseases are reduced. Complex equipment is not required, and drill-free screws can be used even when teeth are heavily restored or damaged. The screws may be placed under local or general anesthesia and can be removed quickly and painlessly. They give tactile feedback when inserted, which allows the surgeon to sense whether the tip of the screw is entering the alveolar bone or is touching the dental root, in which case the insertion position can be changed (23). Operating time is significantly reduced, from 45 min for arch bars to approximately 10 min for the bone anchor procedure (14).

The indications for predrilled screws are orofacial trauma, orthognathic surgery, and orthodontic anchorage. Contraindications include pediatric patients with unerupted teeth and in transalveolar positions. Our clinic has experience using drill-free screws during orthognathic surgery as a reinforced, rigid emergency anchor for IMF, when orthodontic brackets occasionally loosen during surgery. Drill-free screws can occasionally be used in comminuted fractures. However, if the number of fracture sites makes placement of screws difficult, and if multiple screws are required, the arch bar technique should be considered. Arch bars remain the golden standard for re-establishing a stable occlusion in the case of comminuted fractures with extensively mobile teeth and severe alveolar bone fractures.

Complications may occur when drill-free screws are positioned in the mandible, and care must therefore be taken to avoid critical anatomical structures, such as the mental foramina, neurovascular bundles, and misaligned teeth. Other disadvantages are fractures of the screws, bony sequestra, and mucosal wounds (27). Therefore, the drill-free screws for IMF, with a thread diameter of 2.0 mm and a large screw head, may not be recommended to use postoperatively because they can cause severe trauma to the mucosa tissues (Figs 3 and 4). To

Fig. 3. Postoperative mucosal wounds (Synthes Inc., intermaxillary fixation screw 2.0 × 8–12 mm).

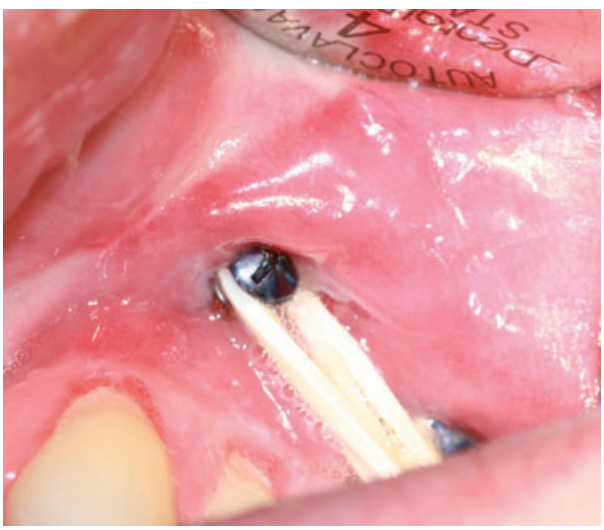

Fig. 4. Postoperative mucosal wounds (Biomet Microfixation intermaxillary fixation screw 2.0 × 5–7 mm).

minimize postoperative complications in the dentoalveolar bone, we believe that the bone anchor screws should be inserted directly into the junction of the free and attached mucosa without an incision and with at least one screw in each quadrant (Fig. 5). In this study, it was difficult to determine whether the bone anchor screws were inserted monocortically or bicortically in the dental arches. Therefore, we have described the approach as transalveolar, as did Fabbroni et al. (24). Instead, to the 12- and 16-mm bone anchor screws, we believe that the optimal length is 7–8 mm, thus avoiding unnecessary trauma to the alveolar tissues (Fig. 6). We have recent experience with the new orthodontic bone anchor (OBA) screws (Synthes Inc., OBA screws 1.55 × 6–8 mm). They have a thinner thread diameter and smaller screw heads, compared with the intermaxillary screws (Synthes Inc., IMF screws, 2.0 × 8–12 mm; Biomet Microfixation IMF

Fig. 5. Transalveolar bone screw inserted at the junction of the free and attached mucosa between dental roots.

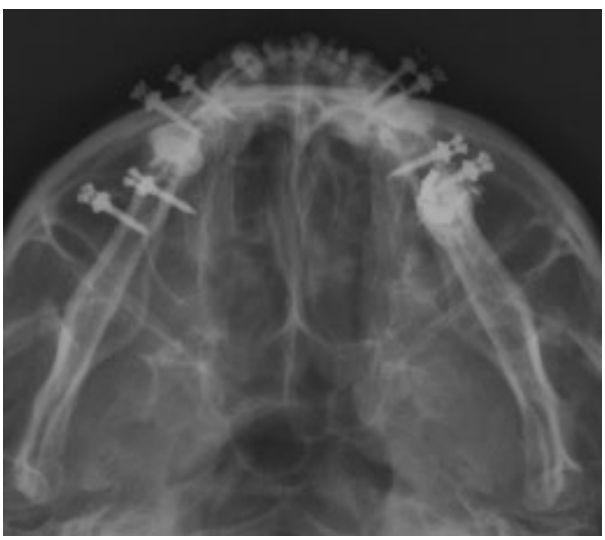

Fig. 6. Axial view showing transalveolar bone screws.

Fig. 7. Titanium orthodontic bone anchor screws with 1.5 mm thread diameter for placement between dental roots.

screw 2.0 × 5–7 mm, Warsaw, IN, USA; Stryker Leibinger MMF screws 2.0 × 8–12 mm, Freiburg, Germany). The OBA screws are therefore more forbearing to the

Fig. 8. Titanium orthodontic bone anchor screws used for intermaxillary fixation in orofacial trauma, 2 weeks postoperatively; notable lack of mucosal wounds.

adjacent mucosa, and this makes it possible to use with guided elastics for several weeks without causing mucosal wounds (Figs 7 and 8).

However, IMF is not always necessary in the reduction of fractures confined to the mandibular bone. In 1999, Fordyce et al. reported that avoidance of IMF at surgery is more economical in time and cost, safer for the operator, and more comfortable for the patient (2). Furthermore, the avoidance of IMF produces comparable results using IMF in the long term with few early complications. These findings were confirmed by Bell et al. and Dimitroulis et al. (3, 4).

In conclusion, our results clearly indicate that there is a potential risk of iatrogenic injury and permanent damage to dental roots when using a twist drill before inserting self-tapping transalveolar bone anchor screws. We suggest not using the twist drill in the transalveolar position between dental roots. Drill-free transalveolar bone screws are considered a safe alternative with many advantages as mentioned previously.

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