The Search for the Ideal Fixation of Palatal Fractures: Innovative Experience with a Mini-Locking Plate

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ABSTRACT

Fractures of the palate have defied conventional management, such that malrotation and disinclination of the palatal shelves occur in a significant number of patients after repair. The fractured palatal shelves of eight patients were first prealigned. To do so, one or more 205-mm ratchet clamps and two intermaxillary fixation (IMF) posts were used. Rigid fixation was then achieved by applying a 2.0-mm mini-locking titanium plate (across the palatal vault) and by applying an adaptation miniplate across the fracture line as it exited the anterior surface of the maxilla. Screws were passed directly through the mucoperiosteum, to engage the palatal shelves and to lock the locking plate into position. Lacerations in the mucoperiosteum were neither used to aid fixation nor used as portals for dissection; incisions and mucoperiosteal flaps in the palatal vault were avoided. Adjuncts, such as intraoral splints, have not been used in cases to date, and early mobilization was allowed. Reconstitution of the craniomaxillofacial buttresses was added in patients with more extensive maxillary injury. The palatal appliance and screws remained rigidly in position in the roof of the mouth, much like an external fixator, until their removal 8 to 12 weeks after the repair. No patient suffered erosion of the mucoperiosteum or other major morbidity, other than a transient fistula of the soft palate. The palatoalveolar segments remained in proper realignment and inclination, and pretraumatic occlusal patterns and the width and depth of the lower face appear to have been restored with one exception. The latter suffered a subtle posterolateral open bite that was corrected orthodontically. Prealignment of fractured palatal shelves with one or more large ratchet clamps and two IMF posts provides several points of forced reduction of the palatal shelves, along the dental arch. In addition, stabilization with mini-locking plate(s) in the palatal vault and an adaptation plate across the fracture line, as it exits the maxilla, appear to have merit, based on this preliminary report ($n = 8$). Outcomes seen on computed tomography and clinical examination during this 3-year experience have been favorable.

KEYWORDS: Palatal fractures, fixation, mini-locking plate(s)

Fractures that sagittally divide the palate and the maxillary alveoli are a notable challenge at surgery, largely because of splaying of the split palate, buccal

version of the palatoalveolar segments, and instability of the lower third of the face. Soft tissue injury (most often of the upper lip) and dental trauma often herald the

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Figure 1 Injury of the upper lip (A) or maxillary dentition heralds the possibility of palatal fracture. Splaying of the palatal shelves and buccal rotation are a common feature on presentation (B).

otherwise occult, underlying skeletal damage. This constellation of injuries (Fig. 1A, B) may be part of a more extensive midfacial comminution.¹⁻³

During World Wars I and II, fractures of the palate were treated differently than they are today.⁴ The fractured dentoalveolar segment in the presence of comminution was deemed to be irreparably damaged and inherently unstable. In those times, the comminuted segment was dissected out and summarily discarded.

After the major wars, attempts to more appropriately harness palatal instability after fracture were made, using intraoral splints, arch bars, K-wires, a palatal bar, or transpalatal wires.^{2,5-10} Improved fixation became possible with small straight plates or “designer X,” “Y,” or “box” plates, placed by way of incisions or lacerations in the roof of the mouth¹¹⁻¹⁴ or after wide flap elevation.¹⁵ In cases with comminution, intraoral splints appear to have offered guarded benefit as an adjunct to this plate-and-screw fixation^{13,16} (Fig. 2A-D).

Despite attempts to avoid them, malrotation and disinclination of the palatoalveolar segments continue to be critically witnessed after surgery, and 1 in 6 (personal experience) or 1 in 10 patients^{10,12-14} suffers malocclusion in the postoperative period. The search for a better means of achieving rigid stability of palatal fractures thus continues toward the goals of more certain healing and more appropriate, reparative dimensions of the lower face.

PALATAL ANATOMY

The hard palate is the platform on which the seven craniomaxillofacial buttresses reside^{17,18} (Fig. 3A, B). The palate is a by-product of two conjoined bones: the (palatine portion of the) maxilla and the (horizontal part of the) palatine. As such, the width¹⁴ and depth¹⁸ of the hard palate and the width and length of the mandible determine the three-dimensional architecture of the lower face.

The palatal bone is thicker anteriorly and progressively thins (Fig. 4A) as the soft palate is approached.¹⁹ Ignoring the crest at the midline, the hard palate is relatively thin in the sagittal and parasagittal regions but becomes progressively thicker toward the alveolus (Fig. 4B). At the alveolus, thicknesses of 12 to 14 mm. are not uncommon. The *average* thickness of the palatal platform, however, is 4.5 mm.²⁰⁻²²

Foramina are near the midline of the palate anteriorly (behind the medial incisors) and are far off the midline posteriorly (near the distal molars). The foramina are diminutive and appear to do little to compromise the structural integrity of the palatal platform. The periosteum more intimately adheres to the mucous membrane of the oral cavity than it does to the bone of the palatal vault; hence, the two are referred to as mucoperiosteum.

OSSIFICATION

Ossification of the median palatine suture lags behind other facial sutures and is seldom complete before the third decade,^{19,23,24} which, in part, explains the higher incidence of sagittal fractures of the palate in adolescence and early adulthood. Ossification of the suture line begins posteriorly and progresses more quickly in the oral than in the nasal aspect of the palate.¹⁹ The initially broad and Y-shaped median suture becomes increasingly tortuous and interdigitated as ossification advances with age.²⁵

PATTERNS OF FRACTURE

Radiographic studies (Fig. 5), notably computed tomography (CT) scans with three-dimensional reformatting, have provoked numerous classifications.^{3,11-13} A simplification of the classification by Hendrickson et al¹³ (Table 1) has been an effective aid to understanding the patterns of fracture, the categorization of the injury, and our formulations of surgical repair (Fig. 6).

Figure 2 Historically, instability of the fractured palatal shelves has been managed with splints (A); arch bars; transpalatal bars or wires (B,C); or designer plates and screws (D), despite their potential bias toward a postoperative open bite or other malocclusion.

Figure 3 (A,B) The palatal platform (depicted here after drilling away the anterior midfacial buttresses) is a key structure that, along with the mandible, defines the width, depth, and height of the lower face.

Figure 4 Palatal bone is thicker anteriorly and tapers toward the soft palate, as seen in sagittal views (A). Serial coronal sections (B) reveal that sagittal and parasagittal bone is relatively thin compared with that in the palato-alveolar areas. The average thickness of the hard palate is 4.5 mm.

SURGICAL PREALIGNMENT OF THE SPLIT PALATE

Prealignment at surgery is a key, two-step process. A gingivobuccal incision first allows exposure of the fracture line at the piriform or other exit site on the face of the maxilla. A large, ratcheted, pelvic orthopedic reduction clamp (Fig. 7A) is applied in the area of the distal molars to stabilize the palatal shelves. The surgeon's hands are freed after the ratchet clamp is applied, unlike experience with the Hayton-Williams clamp (Fig. 7B). The handles of the ratchet clamp may be rotated or shifted to three-dimensionally realign the palatal fragments, as the ratchet is progressively advanced (Fig. 7C–E). A second ratchet clamp may be applied in the area of the premolars, in a similar manner,

as needed. Third, an intermaxillary fixation (IMF) post is applied to each side of the exit fracture line. Wire connecting the posts is progressively tightened.

Prestabilization, it should be appreciated, applies some six points of force along the dental arch before stabilization. In comminuted fractures, additional points of contact may be desirable. Posterolateral and transverse fractures may require additional manipulation to consummate the prestabilization, even to the point of preapplying a segmental arch bar or plates and screws to the lateral craniofacial buttress to curb a wayward alveolus.

The progressive reduction of the gap between the palatal shelves restores the proper width and depth of the upper dental arch. The ratchet strategically allows the hands of the surgeon to be free to apply an IMF post to each side of the fracture line as it exits the face of the maxilla, as described previously, and to tighten the wire connecting the posts before finally applying fixation appliances.

Figure 5 Computed tomography scan depicts right palatoalveolar and bilateral Le Fort I maxillary fractures. Note the typical outward (buccal) cant of the contralateral palatal shelf and intact alveolus.

RIGID STABILIZATION OF THE PALATAL SHELVES

A 2.0-mm locking plate of 1- or 1.3-mm thickness is contoured to match the hard palate (Fig. 8A, B). Templates are an aid to this contouring effort, but, notably, spacers are placed in the apertures of the plate before using the bending pliers. More than one locking plate would be chosen with oblique or comminuted fractures of the palate because of their greater inherent instability.

Lacerations of the mucoperiosteum are not used as portals for the placement of the plates; rather, the margins are approximated. Incisions in, and elevation of, the mucoperiosteum are avoided unless a fistula requires acute local transposition. Lacerations of the soft palate are meticulously closed in layers.

Locking screws secure the plate(s) in position. Screws 4 or 5 mm in length are chosen to avoid penetrating the floor of the nose, particularly in the

Figure 6 The typical patterns of fracture of the palate are depicted.

thinner sagittal and parasagittal zones. As a comparison, 6-mm screws are used in the palatoalveolar areas because the bone there tends to be much thicker. The screws traverse the locking plate and mucoperiosteum to engage the bone of the palatal shelves. A drill guide if possible is placed at 90 degrees to the plate, so the locking screw can be aligned to precisely “lock” into position. A 1.3- or 1.5-mm adaptation plate some five or six holes in length is next applied across the exit fracture line on the anterior face of the maxilla.

The occlusal pattern is then best checked. To do so, opposing IMF posts are placed in the mandible, and the upper and lower dental arches are engaged. Once the occlusion and the appropriate width and depth of the maxillary dental arch have been assured, the mandible and the lateral and medial craniomaxillofacial buttresses are then constructed. The IMF posts are removed.

Table 1 Classification of Fractures of the Palate

Sagittal
Parasagittal
Palato-alveolar
Anterior
Anterolateral
Posterolateral
Transverse or oblique
Comminuted (polydirectional)

Intermaxillary fixation may be maintained if instability of other fractures of the craniofacial skeleton requires it. It is otherwise discontinued. Motion and soft diet are permitted in the immediate postoperative period. The locking plate(s) and screws assembly is readily removed some 8 to 12 weeks after their application, under local or general anesthesia.

RESULTS

The fractures of eight patients, two of whom are depicted in Fig. 9A–C and Fig. 10A–D, were managed with locking plate technology, using the sequence outlined in Fig. 11. One fracture by CT was sagittal, three were parasagittal, three were para-alveolar, and one was oblique. The data were not subjected to statistical analysis because of the small number.

Pretraumatic occlusion—partly based on wear facets and postoperative alignment and partly based on dental assessment and radiographs—appears to have been restored in seven of the eight patients. In one instance (a posterolateral fracture that was difficult to manipulate distally), the patient suffered a modest posterior open bite that has been corrected orthodontically. The screw puncture wounds in the roof of the mouth healed quickly in all patients, following removal of the locking plate assembly, aided by warm saline rinses. Follow-up spanned 3 months to 3 years.

Figure 7 A 205-mm pelvic reduction forceps (A) with ratchet (Synthes 399.98) is key to prealignment of the palatal shelves and frees the hands of the surgeon to, among other things, apply fixation devices. It compares favorably with the Hayton-Williams clamp (B) that has no ratchet and features a screw-stop, thus limiting its utility. The clamp is first applied distally, and the palatal shelves are progressively reduced by advancing the ratchet (C–E); a second clamp may be applied more mesially. Intermaxillary fixation posts are then applied across the exit fracture and wired. A locking plate assembly and an adaptation plate follow, as described in the text.

DISCUSSION

The Synthes Mini-Locking System (Synthes Maxillofacial, Paoli, PA) is a product first made available clinically in 2003.^{25–27} The self-tapping 2.0-mm screw has a unique double thread—one thread to engage the bone of the palatal shelves, the other to lock into corresponding threads in the titanium miniplate (Fig. 8A), usually five holes in length.

As the screws to each side of the palatal fracture engage both bone and plate, a three-dimensional frame-like assembly with a high level of stability is created. Forces off loaded to the palatal platform are favorably distributed over the entirety of the construct and to each side of the fracture, a process referred to as *load sharing*. Significantly, with in vitro models and in vivo usage,

movement and loosening of the screws are minimized.^{26,28} In cases of obliquity or comminution, multiple locking plates should be considered.

The plate-and-screw assembly (Fig. 8A) is much like a classic, external fixator because after insertion, it projects into the oral cavity (Fig. 9B). Further, the plate parallels the contour of the vault without intimately engaging the mucoperiosteum. It follows that the blood supply within the mucoperiosteum is not subject to pressure necrosis. The mucoperiosteum need only recover from the puncture of the self-tapping screws once the assembly is removed, some 8 to 12 weeks after surgery.

The high degree of stability of the assembly favors early mobilization. In all eight cases, ingestion

Figure 8 Photograph depicts the features of the locking system assembly, including the threaded locking plate and dual-threaded locking screws (A). The plate is bent to match the contour of the hard palate before it is inserted (B).

of food was initiated early; however, in two cases, elastic traction was utilized because of concomitant mandibular fractures. Oral hygiene was readily achieved by all patients because of the clearance above the locking plate beneath the mucoperiosteum. Pre-

alignment of the palatal shelves with forceps was first reported in 1963,²⁹ as the author was recently informed by oral surgery colleagues. The Hayton-Williams forceps, however, features a screw-stop (Fig. 7B) rather than a ratchet, and thus is cumbersome, because it does

Figure 9 Patient suffered comminution of the midface and parasagittal fracture of the palate. Note the restoration of midfacial height and width (A). A locking plate assembly is noted in the palatal vault (B). Appropriate dimensions of the palate are apparent (C) following elective dental extraction 2 years after the repair.

Figure 10 Patient suffered a left anterolateral fracture of the hard palate. The patient is pictured 1 year following the repair, with restored lower facial width and height (A). Restoration of pretraumatic occlusion is depicted (B–D) with appropriate dimensions of the palatal platform.

not free the hands of the surgeon to apply plates and screws in the repair of the fractures. Our use of a ratchet clamp for this purpose is the first to be reported in the literature.

The number of palatal fractures in this study is small ($n=8$), and none of the injured palates were severely comminuted. The spectrum of potential injuries is therefore conceivably greater than our experience to date. Nevertheless, transpalatal locking plate fixation appears to significantly improve stability, to restore the width *and* depth of the palatal platform, and to limit rotation and disinclination (splaying) of the palatoalveolar segments.

The stability of the repair has been such that dental models, intraoral splints, prolonged intermaxillary fixation, and secondary procedures have been avoided in our initiation-and-evaluation of this technique. In more

comminuted cases, these adjuncts may still be necessary (despite the vagaries, caveats, and biases regarding their use¹⁶), and outcomes after using locking plate technology in a broader spectrum of injury (i.e., comminution) and in a larger number of cases may yet prove to be less favorable.

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Figure 11 Algorithm of suggested management of palatal fractures. IMF, intermaxillary fixation.

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