Endoscopically Assisted Diagnosis and Treatment of Maxillofacial Fractures

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Abstract

The increased availability of endoscopic instrumentation has enabled a number of surgeons to re-evaluate certain traditional open approaches to the treatment of multiple medical conditions. Our favourable early experience with the use of endoscopes in maxillofacial traumatology will be reviewed.

Sommaire

La disponibilité croissante de l'instrumentation pour endoscopie a permis de réévaluer certaines approches ouvertes pour le traitement de multiples conditions médicales. Nous présentons notre expérience limitée mais favorable dans l'utilisation des endoscopes en traumatologie maxillo-faciale.

Key words: condyle, endoscopic, fracture, LeFort, mandible, maxillofacial, trauma, zygoma

The expanding recent interest in minimal access surgery has spearheaded the development of a number of endoscopic techniques in aesthetic facial plastic surgery.[1–4] The increased availability of endoscopic instrumentation coupled with widespread technical expertise has led a few surgeons to investigate the potential utility of endoscopic techniques in maxillofacial traumatology.[5–7] Management of maxillofacial injuries has long sought to strike a balance between minimally invasive and often less stable closed reduction techniques and techniques associated with broad exposure, open reduction, and rigid internal fixation. The adjunctive use of endoscopes ideally has the potential to provide for increased visualization without necessarily increasing surgical exposure. This article reviews the author's initial experience with the use of endoscopes in maxillofacial trauma evaluation and treatment.

Methods and Materials

All maxillofacial fractures treated or evaluated with an endoscope by the author over a period of 3 years were retrospectively reviewed. A determination was carried out for each case as to whether treatment was affected, whether the endoscope assisted with fracture repair and/or diagnosis, and any complications that could be attributed to the use of the endoscopes. Finally, we analyzed whether, in the surgeon's opinion, the added use of the endoscopic technique represented time savings within the operating room or whether, in fact, it seemed to prolong the procedure.

In all cases, a 4-mm 30-degree rigid endoscope with an extended phalange sheath was used. Visualization was significantly enhanced with the use of the overlying sheath, which allowed the creation of an optical cavity by tenting the facial soft tissues away from the end of the endoscope. It is critical to torque the endoscope firmly away from the fracture site. This allows for the creation of an enhanced field of view. The 30-degree angled lens provides the surgeon with a direct view of the fracture line. This view is the one with which most maxillofacial trauma surgeons should be familiar as it duplicates the view afforded by external, transcutaneous approaches, thus facilitating intraoperative orientation. The use of the overlying sheath also allows for normal saline irrigation of the surgeon's endoscopic field, enabling continuation of the operation without the need for removal of the endoscope for cleaning during the case.

Significant frontal sinus fractures that will require surgical exploration and repair are generally exposed through a standard bicoronal flap unless a significant frontal laceration is present that will provide direct access to the fracture site. Traditionally, evaluation of nasofrontal duct patency has posed significant challenges to the facial trauma surgeon. In those cases where one

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needs to determine the need for frontal sinus obliteration, evaluation of the nasofrontal duct is traditionally carried out by instillation of methylene blue or other similar dye within the frontal sinus and examination of the intranasal mucosa for timely passage of the marker. Unfortunately, dye may still pass in nasofrontal ducts that have significant mucosal tears that may secondarily heal with synechiae formation, causing subsequent nasofrontal duct blockage. In addition, if there is significant edema present, dye may not pass intranasally. Presumably, however, once the edema has resolved, the nasofrontal duct patency would be expected to return to normal functional status in the absence of significant mucosal or bony disruption. It is for this reason that the author routinely endoscopically examines the superior portion of the duct through an osteoplastic flap or through removed fractured anterior wall fragments (Figs. 1 and 2). Topical 4% cocaine solution is applied at the entrance to the nasofrontal duct prior to endoscope insertion. The nasal portion of the nasofrontal duct is examined with a 70-degree angled endoscope used intranasally after topical decongestion using 4% topical cocaine solution. If significant mucosal lacerations or underlying osseous fragments are present within the duct, obliteration with either a pedicled pericranial flap or a free adipose tissue graft is performed.[8–10] The endoscope appears more valuable than the methylene blue marker as it appears to enable the surgeon to clearly differentiate between simple duct edema that is invariably present in most significant frontal sinus fractures and mucosal and bony disruption within the duct that would mandate obliteration of the sinus in most cases. It is critical to decongest both ends of the nasofrontal duct prior to endoscopic assessment; otherwise, visualization is difficult.

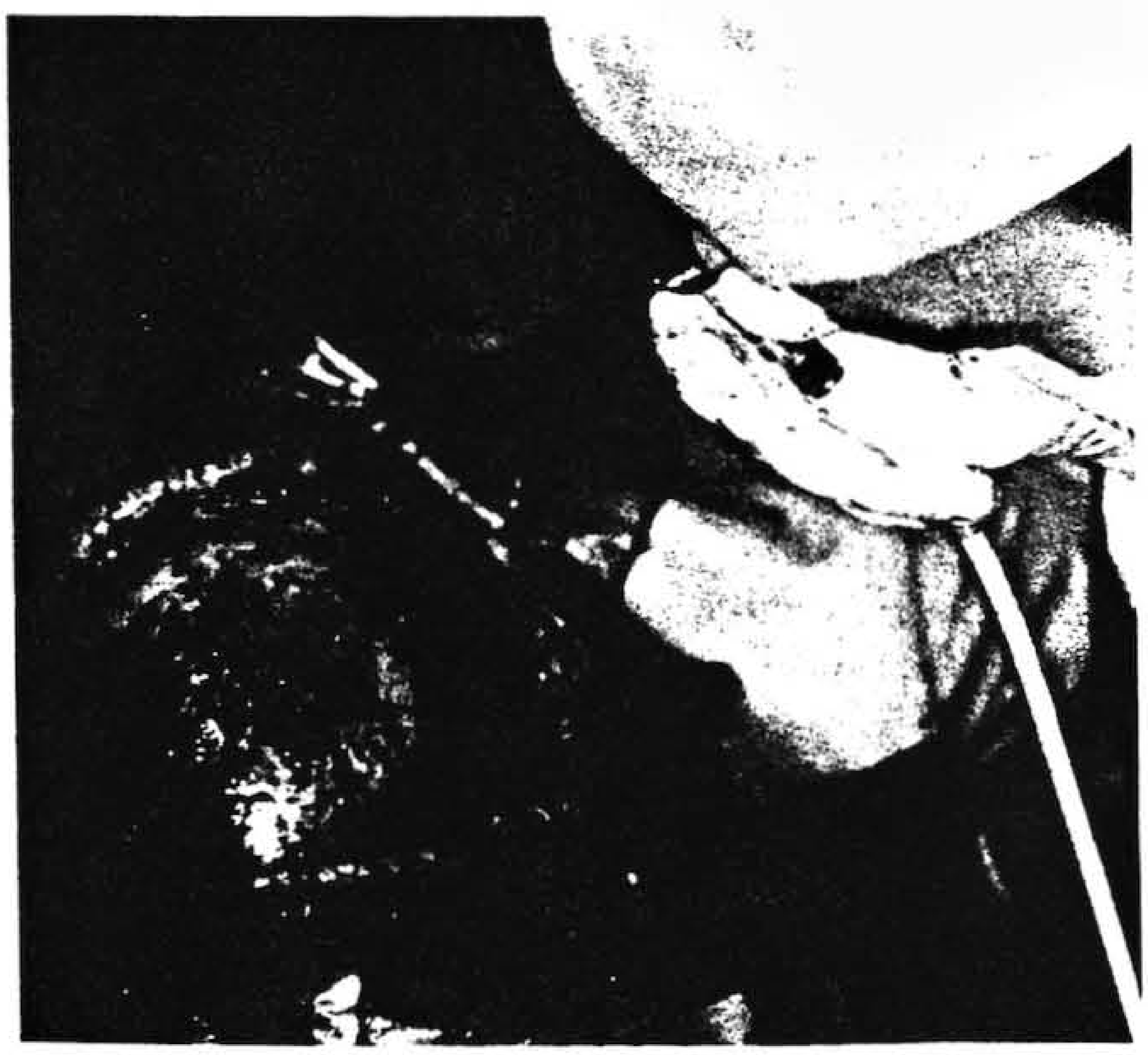

Figure 1 Surgeon positioning during endoscopic examination of the nasofrontal duct.

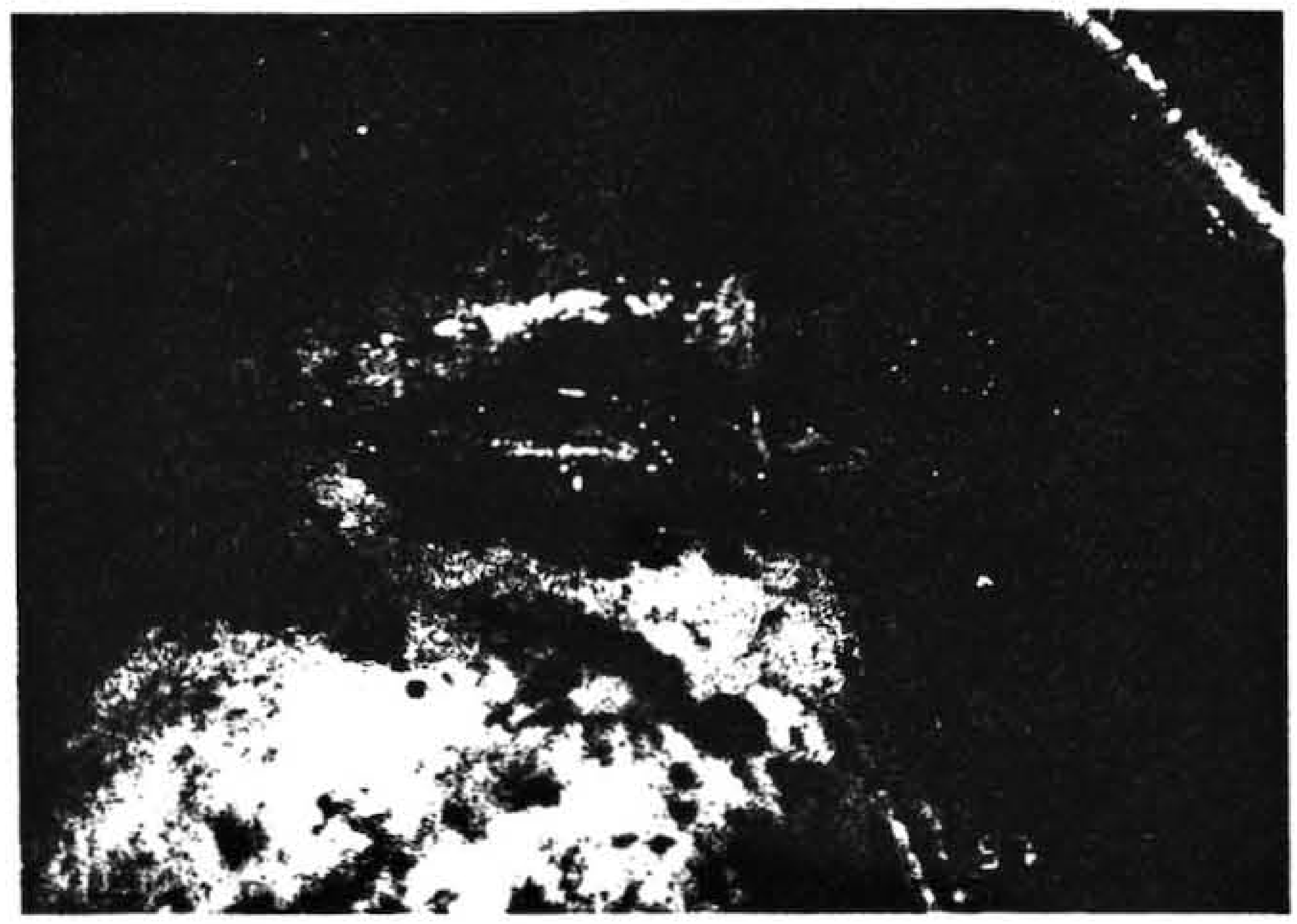

Figure 2 Endoscope passing through an anterior frontal sinus wall fracture into the area of the nasofrontal duct.

In the case of orbital floor fractures, if the patient has any significant entrapment of extraocular muscle movement, endophthalmos, or exophthalmos, exploration is carried out through a standard transconjunctival approach with or without the adjunctive use of a lateral canthotomy/cantholysis.[11] If the patient has a classic displaced orbitozygomatic complex fracture without significant orbital findings preoperatively, reduction of such a fracture may, on occasion, result in some degree of entrapment of orbital contents between the reduced orbital floor fragments. In cases where the surgeon is content with the adequacy of reduction and where there is no significant comminution present at the frontozygomatic, inferior orbital rim or lateral buttress, the orbital floor may be explored via existing fractures within the anterolateral maxilla. The degree of herniation or presence of entrapment of the orbital contents within the maxillary sinus may occasionally be difficult to determine based solely on preoperative coronal computed tomography scans or intraoperative forced duction testing. By passing a 30-degree endoscope through the anterolateral maxillary sinus wall, the orbital floor is easily evaluated (Figs. 3 and 4). Entrapped orbital floor contents may be reduced by this approach. Gelfilm may be introduced from this approach to prevent repeated herniation in orbital floor fractures with a dimension less than 1.0 cm. In the presence of greater degrees of herniation, bone grafting or the application of various alloplastic materials will be necessary to reconstruct the orbital floor defect. Such implants should always be secured anteriorly at the level of the orbital rim to prevent postoperative displacement posteriorly into the orbital apex. This should be performed via standard transconjunctival, subciliary, or midlid approaches to the orbital floor. In such circumstances, the endoscope is occasionally useful to assist with reduction of orbital contents.

Exposure of subcondylar fractures is achieved following re-establishment of premorbid occlusal relation-

Figure 3 A 30-degree endoscope introduced through an existing LeFort disruption of the anterolateral maxilla to allow examination and treatment of an orbital floor blowout fracture.

ships with the application of Erich arch bars to achieve maxillomandibular fixation. Any concomitant mandibular arch (noncondylar) fractures are first treated with standard open reduction and internal fixation. We favour transoral approaches for the vast majority of mandible fractures. Next, a determination is made as to the need for open reduction of a concomitant subcondylar injury.[12] Intraoral exposure is provided by a buccal sulcus incision centred over the oblique line of the mandible. Soft-tissue elevation is completed in the subperiosteal plane over the lateral aspect of the ascending ramus of the mandible (Figs. 5 and 6). Often, closed reduction of a displaced subcondylar fracture does not result in optimal alignment of the fractured segments. Excellent reduction may be achieved with the assistance of the endoscope. If the reduction is unstable, percutaneous screw placement with the use of a transbuccal trocar is carried out (Leibinger system 1.7-mm titanium plate with 4-mm length screws, Stryker-Leibinger, MI) to achieve rigid fixation. The cutaneous puncture site for trocar placement is directed along a perpendicular vector in relation to the fracture line. To avoid injury to the facial nerve, the skin is first incised with a scalpel followed by blunt dissection through the substance of the parotid gland and masseter muscle with a hemostat. The natural tendency of broad surgical exposure should be avoided with endoscopic exposure of this fracture. Only limited periosteal elevation should be performed around the fracture line, as the periosteal attachments assist with maintaining intraoperative alignment of the fractured segments.

Most zygomatic arch fractures associated with a classic zygomatic complex fracture may be treated by adequate reduction and fixation of the malar eminence, orbital rim, and lateral buttress.[11] In such a case, often the zygomatic arch fragments are aligned appropriately within their periosteal sleeve, allowing for adequate reversal of the injury without the need for open reduction and internal fixation at this level. However, on occasion, an adequate reduction of the fractured arch segments cannot be achieved. Classically, these have been exposed via a bicoronal flap. The need for such broad exposure is obviated by the use of an endoscope. Zygomatic arch fractures may be exposed via a limited supra-auricular incision within the temporal scalp, as is performed for endoscopic midface rhytidectomy. Dissection with the endoscope should specifically identify the superficial temporal fat pad. Inferior to this level, dissection should pass deep to the deep temporal fascia, immediately superficial to the fat pad down to the level of the zygomatic arch. Adding an ipsilateral gingivobuccal incision with dissection along the anterolateral maxilla across the malar eminence to the anterior

Figure 4 Coronal CT scan demonstrating fluid within the maxillary sinus following a small orbital floor fracture with extraocular muscle entrapment through a trapdoor deformity. This was treated with endoscopic transantral reduction.

Figure 5 Endoscopic view of a displaced subcondylar fracture. Note the ascending ramus of mandible on the left, condyle on the right, and a large space separating them.

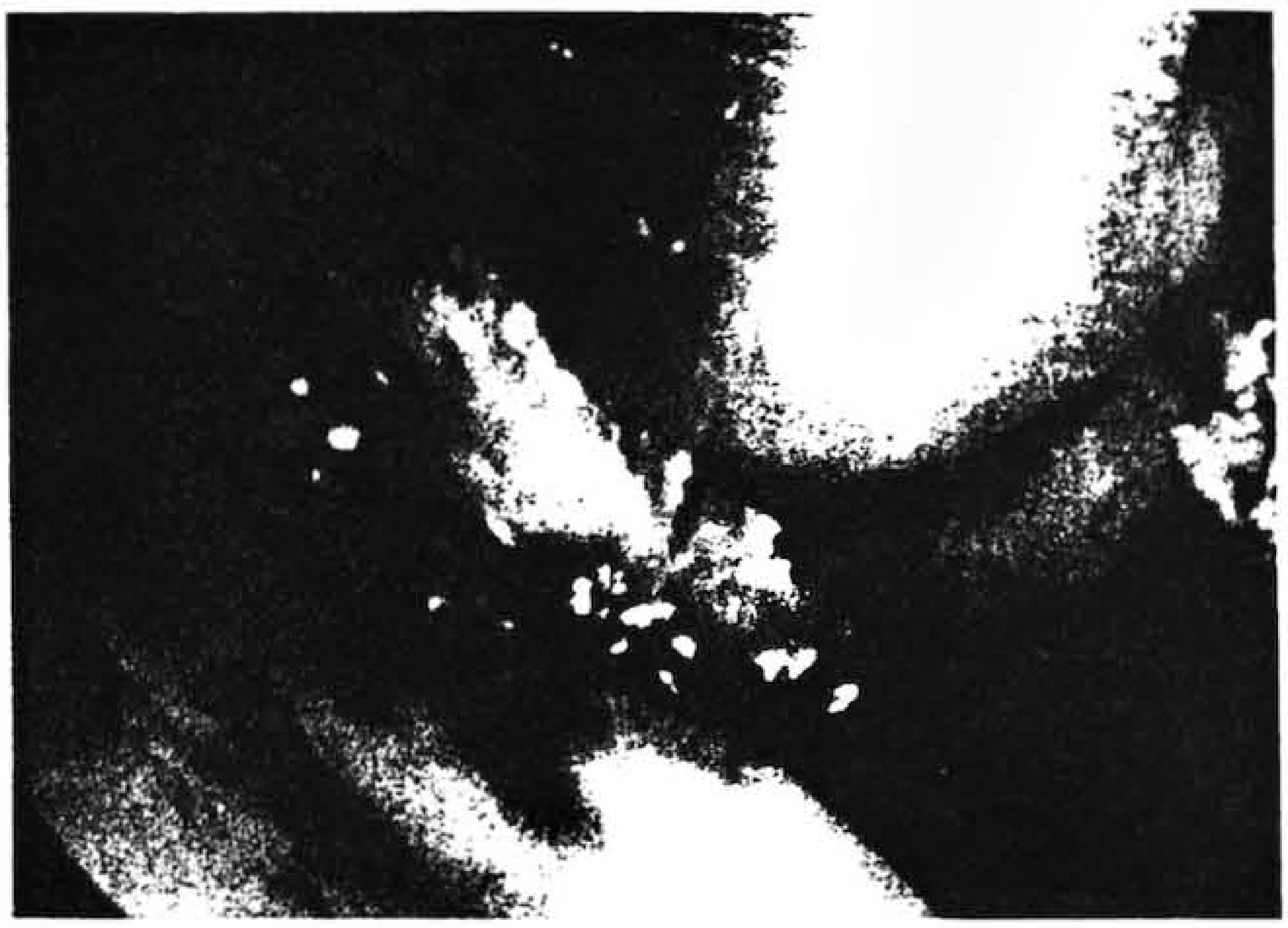

Figure 6 Endoscopic view of the same patient following endoscopic reduction. Note realignment of the two bony cortices across the fracture line.

aspect of the zygomatic arch will allow the surgeon improved access to achieve adequate reduction of the fractured segments and aid in their stabilization during rigid fixation (Figs. 7, 8, and 9). Screws are placed percutaneously with the aid of a trocar. Generally, 1.2- or 1.7-mm titanium plates with 6-mm screws are applied across the fractured segments. Elevation of the periosteum is facilitated with the use of malleable, angled periosteal elevators and angled scissors as are standard in endoscopic brow lift or midface lift instrumentation. As for subcondylar fractures, one should always limit the dissection to maintain some periosteal attachments to the fractured segments as this will greatly assist in the maintenance of reduction during rigid fixation.

Results

Results are reported in Table 1.

Figure 8 Supra-auricular minimal access incision used for endoscopic access.

Discussion

In attempting to critically review results with the use of endoscopes in maxillofacial traumatology, the author has attempted to determine whether this technology represents a clinically useful tool or simply a technology looking for an application. Although difficult to quantify and allowing for a reasonable learning curve,

Figure 7 Preoperative view of a patient with a depressed left malar eminence.

Figure 9 Postoperative result with re-establishment of the left malar projection and facial width.

Table 1 Outcomes of Endoscope Use in Various Fractures of the Maxillofacial Skeleton

Fracture Type	*Area Evaluated*	*Number of Cases*	*Affected Treatment (Y/N)*	*Assist with Repair (Y/N)*	*Assist with Diagnosis (Y/N)*	*Complications (Y/N)*	*Saves Time (Y/N)*
Frontal sinus	Nasofrontal duct	12	Y (n = 9)	N	Y (n = 9)	N	Y
Orbit floor	Diagnosis of degree of herniation	9	Y (n = 9)	Y	Y (n = 9)	N	Y
Zygomatic arch	Adequacy of reduction	6	Y (n = 4)	Y	N	N	N
Subcondylar	Adequacy of reduction	6	Y (n = 4)	Y	N	N	N

the data presented seem to favour the adjunctive use of rigid endoscopes in certain instances.

The assessment of the nasofrontal duct in frontal sinus fractures has been inaccurate and time consuming in the past with such tests as methylene blue flushing of the duct to determine its patency. Direct visualization of the entire duct from above with a 30-degree scope and from below with a 70-degree scope is a precise, expedient, reliable, and effective method of determining duct integrity. It is presently the author's preferred method in determining the need for sinus obliteration in frontal sinus fractures.

Large blowout fractures of the orbital floor require open reduction and application of either autogenous bone grafts or various alloplasts (titanium mesh, resorbable mesh) placed via a transconjunctival or external transfacial (midlid, subciliary) approach. The endoscope is of no added benefit in this scenario. However, in small fractures associated with midfacial fractures requiring exploration or in suspected trapdoor deformities (minimal orbital floor fractures associated with entrapped inferior rectus or inferior oblique muscles), manipulation of the orbital floor contents (reduction of entrapped musculature) under the continuous visualization provided by a 30-degree rigid endoscope introduced via the gingivobuccal access incision is both useful and expeditious. It negates the need for adjunctive periorbital incisions. In isolated orbital floor injuries, the author still prefers direct exposure via the transconjunctival approach.

In both zygomatic arch fracture and subcondylar fracture treatment, the use of endoscopes appears to represent a useful technique in simple, noncomminuted injuries. Access incisions are small and hidden. Visualization is excellent. A significant learning curve is present in the treatment of these injuries. Verification of the adequacy of reduction of subcondylar injuries may be more accurately performed than with simple closed reduction. However, in comminuted injuries, manipulation of the multiple osseous fragments in both of these injuries is tedious and very time consuming under endoscopic guidance. In such cases, we continue to prefer bicoronal flap exposure for zygomatic injuries and a preauricular approach for subcondylar injuries that are comminuted. As further experience is gained with the use of this technique, indications for their use may be extended.

Conclusions

In summary, endoscopes appear to be useful in assessing nasofrontal duct integrity and treatment of small orbital floor fractures and noncomminuted subcondylar and zygomatic arch fractures. Although further experience is required with the use of endoscopes in maxillofacial traumatology, initial experience appears to be quite favourable.

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