

A Critical Review of the Literature and an Evidence-Based Approach for Life-Threatening Hemorrhage in Maxillofacial Surgery

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Background: Life-threatening facial hemorrhage in Maxillofacial Surgery (MFS) has an approximate incidence of 1% in the trauma patient and in elective surgery. The treatment of acute life-threatening hemorrhage in MFS to prevent hypovolemic shock or airway obstruction forms the basis of emergency care and necessitates the need for further analysis given the multitude of options proposed for treatment. A systematic review of the literature was undertaken to formulate an evidence-based approach to the treatment of life-threatening hemorrhage in MFS.

Materials and Methods: A comprehensive search of journal articles was performed using PubMed and Ovid databases. Keywords and phrases used were “life threatening facial hemorrhage,” “life threatening facial bleeding,” “external carotid artery ligation,” and “external carotid artery embolization.” Our search yielded 1441 articles. In an attempt to focus on hemorrhage exclusively from traumatic and operative events, articles that cited hematological disorders as the underlying cause of bleeding were excluded from the study. There were 40 articles which met the full inclusion criteria and form the basis of this systematic review. The articles were rated based on the level of evidence. There was 1 Level II, 21 Level III, 12 Level IV, and 6 Level V papers.

Result: Seven Level III evidence-based studies noted a high association between midface injuries, particularly Lefort III fractures and massive oronasal hemorrhage. One Level II study, 8 Level III studies, and 3 Level IV studies concluded that the internal maxillary artery was most frequently associated with intractable posttraumatic hemorrhage. One Level II, 16 Level III, 3 Level IV, and 3 Level V articles cited anterior and posterior nasal packing and conservative measures as the first attempt to manage traumatic hemorrhage. Subsequently, 8 Level III studies re-enforced the importance of temporary reduction of facial fractures as an effective means to control massive hemorrhage early in the algorithm. Seven Level III studies, 4 Level IV, and 2 Level V studies documented the importance of ligation of arteries as one of the absolute measures to manage facial hemorrhage, whereas 1 Level II, 14 Level III, 2 Level IV, and 3 Level V studies alluded to embolization as the most reliable technique for control of the hemorrhage. In orthognathic surgery, the internal maxillary artery was most frequently the source of massive hemorrhage according to 2 Level III, 4 Level IV, and 1 Level V studies. Two Level III, 5 Level IV, and 1 Level V study proposed packing as the first attempt to tamponade the hemorrhage. Two Level IV and 1 Level V study cited pseudoaneurysm as a potentially life-threatening vascular complication after elective surgery.

Conclusions: Management of facial hemorrhage should be performed in a sequential and consistent manner to optimize outcome. An evidence-based algorithm for posttraumatic and elective life-threatening hemorrhage in MFS based on this critical review of the literature is presented and discussed.

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Life-threatening facial hemorrhage is defined as hemorrhage associated with facial trauma or recent elective maxillofacial surgery resulting in hypovolemic shock, tachycardia (HR >100 bpm), hypotension (SBP <100) and a drop in hematocrit to 24% or hemoglobin to 8 g/dL, thus necessitating resuscitation and acute transfusion as per current ATLS guidelines.

Uncontrolled hemorrhage resulting in hemodynamic instability or profuse bleeding responsible for airway compromise from facial vasculature is a rare event with an incidence of approximately 1%.^{1–6} The increased vascularity of the face and the abundant anastomoses that exist along the midline between the arteries of the face can obscure the source of bleeding and delay the control of hemorrhage.¹ These issues are of dire concern to the maxillofacial surgeon in unexpected traumatic events such as penetrating and blunt trauma of the face and during elective orthognathic surgery alike.

MATERIALS AND METHODS

Literature Search Strategies

A systematic review was undertaken to answer the following questions: (1) What is the best management strategy for life-threatening facial hemorrhage from trauma and elective orthognathic surgery? (2) What is the quality of evidence to support this strategy in clinical practice? (3) What is the overall scientific quality of the literature?

In an attempt to answer the questions previously mentioned, a comprehensive search of journal articles was performed using MEDLINE/PubMed and Ovid databases. Keywords and phrases used were “life threatening facial hemorrhage,” “life threatening facial bleeding,” “external carotid artery ligation,” and “external carotid artery embolization.”

RESULTS

The search yielded 1441 articles. In an attempt to focus on hemorrhage exclusively from traumatic and operative events, articles that cited hematological disorders as the underlying cause of bleeding were excluded from the study. There were 40 articles which met the full inclusion criteria and form the basis of this systematic review. The articles were rated and based on the level of evidence. The Oxford Center for Evidence-Based Medicine classifies evidence based on the susceptibility of bias in the study and the quality of the study. The modified version of the Oxford Center for Evidence-Based Medicine was used to rate the articles that met the inclusion criteria.⁷ There was 1 Level II, 21 Level III, 12 Level IV, and 6 Level V papers. In the instances where it was possible, an attempt was made to pool the data to provide more vital information.

Seven Level III evidence-based studies noted a high association between midface injuries, particularly Lefort III fractures and massive oronasal hemorrhage.^{6,8–13} One Level II study, 8 Level III studies, and 3 Level IV studies concluded that the internal maxillary artery was most frequently associated with intractable posttraumatic hemorrhage.^{5,8,10,14,15}

TABLE 1. Summary of Variables Calculated From Pooled Data From Literature Review

No.	Variables: Life-Threatening Facial Hemorrhage: Trauma	Incidence, %
1	Blunt trauma	2.3
2	Penetrating trauma	1.43
3	Mortality rates*	20.21
4	Patient's requiring emergent airways	79.81

*Mortality rates were attributed to LTFH accompanied by concomitant neurological compromise in certain studies.

One Level II, 16 Level III, 3 Level IV, and 3 Level V articles cited anterior and posterior nasal packing and conservative measures as the first attempt to manage traumatic hemorrhage.^{5,6,9,10,15-18} All authors were in agreement, that posterior packing using Foley catheters was a highly reliable technique for control of mild to moderate epistaxis. Subsequently, 8 Level III studies re-enforced the importance of temporary reduction of facial fractures as an effective means to control massive hemorrhage early in the management.^{12,13,19}

If facial hemorrhage resulted in hypovolemic shock and conservative measures failed it was most often treated via transcatheter arterial embolization (TAE) or ligation.^{2,5,8,10,11,14,15,17,18,20,21} When used early, TAE was associated with high survival rates and low incidence of complications.^{2,5} Seven Level III studies, 4 Level IV, and 2 Level V studies documented the importance of ligation of arteries as one of the absolute measures to manage facial hemorrhage, whereas 1 Level II, 14 Level III, 2 Level IV, and 3 Level V studies

alluded to embolization as the most reliable technique for control of the hemorrhage.^{2,5,8,10,11,14,15,17,18}

In orthognathic surgery, the internal maxillary artery was most frequently the source of massive hemorrhage according to 2 Level III, 4 Level IV, and 1 Level V studies.²²⁻²⁸ Two Level III, 5 Level IV, and 1 Level V study proposed packing as the first attempt to tamponade the hemorrhage. Two Level IV and 1 Level V studies cited pseudoaneurysm as a potentially life-threatening vascular complication after elective surgery.²⁷⁻²⁹

The sporadic occurrence of facial fracture hemorrhage resulted in an identifiable delay in recognition of the extent and nature of the hemorrhage. An obvious association was noted between mortality rates and a delay in management of the facial hemorrhage.^{5,6} Five level III and 2 level V evidence-based studies proposed algorithms to manage life-threatening hemorrhage.

All algorithms emphasized establishing a definitive airway as soon as possible, if indicated. Lack of establishment of a definitive airway correlated with poor survival rates in 7 level III, 2 level IV, and 1 level V studies.^{5,6,10,15,30-32}

DISCUSSION

The infrequent occurrence of life-threatening hemorrhage from facial fractures has made it challenging to establish a standardized protocol to guide and manage such situations. There are several studies that address this issue but the small sample sizes of patients with life-threatening facial hemorrhage makes this a formidable task.^{2,5,6,9,10,15} The incidence of uncontrolled hemorrhage from the pooled data was 128 patients in a total of 7950 trauma patients with facial fractures, yielding an incidence of 1.61% which is consistent with the literature.^{3,6,9-11,31,33,34} Blunt trauma accounted for

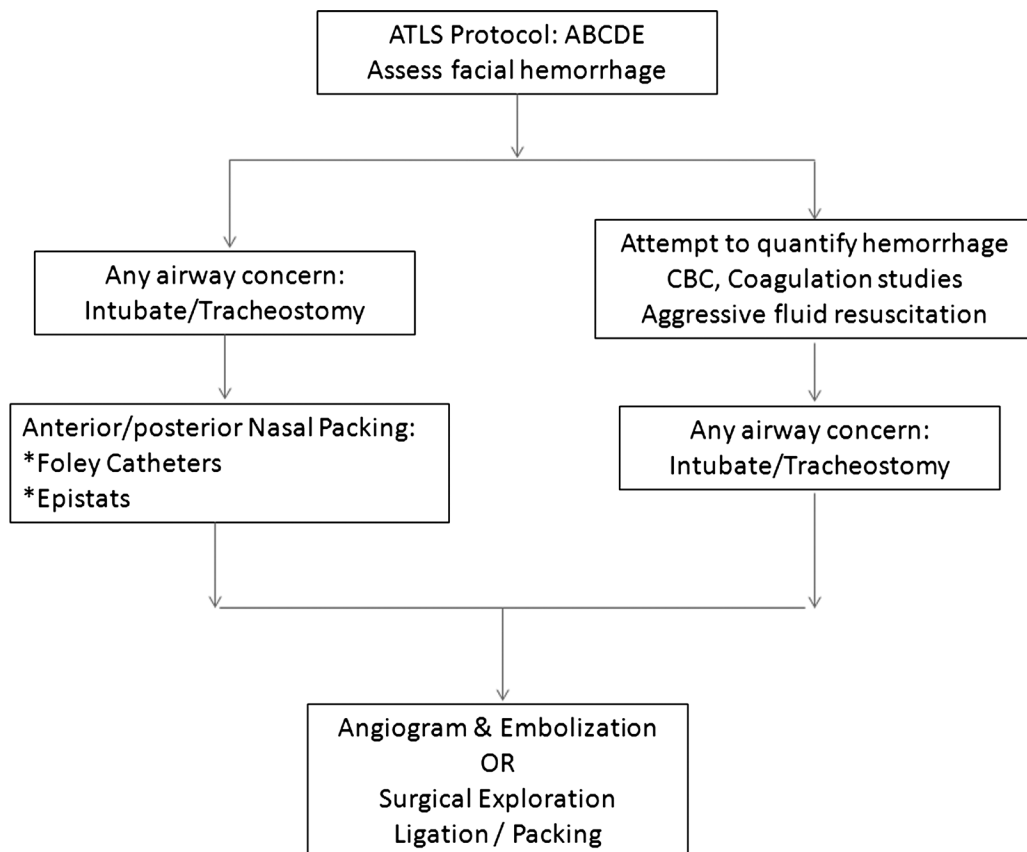


FIGURE 1. Algorithm for management of life-threatening facial hemorrhage from trauma.

most life-threatening hemorrhage at 2.3% with penetrating trauma close behind at 1.43%.^{5,6,9-11} The mortality rate among the post-traumatic patients with massive facial hemorrhage from the studies where it could be calculated was 20.21%.^{3,5,6,9,11,15,35,34} (Table 1).

Elective maxillofacial surgical procedures such as orthognathic surgery may be associated with significant blood loss and infrequently life-threatening hemorrhage. Lanigan et al²² (1991) reported that major vascular complications arose in less than 1% of the orthognathic cases. In a recent systematic review of the literature, the average blood loss associated with orthognathic surgery was quoted to be 436.11 mL (± 207.89 mL).³⁶ The total number of patients undergoing orthognathic surgery was not present in any of the articles retrieved in our literature review. As a result, the combined incidence of life-threatening facial hemorrhage in orthognathic surgery could not be calculated.

The vessels commonly injured in maxillary osteotomies include the pterygoid plexus of veins, descending palatine arteries, the sphenopalatine arteries or the maxillary artery itself with postoperative hemorrhage presenting as acute epistaxis.²³ Our pooled data yielded that in 72% of the Lefort osteotomies, an arterial source was

the culprit, whereas in almost 19% of the cases the source of hemorrhage was venous. In the remaining cases, the exact source was unidentifiable. In mandibular sagittal split osteotomies, an arterial source was the cause of hemorrhage in 48.2% and a venous source in 20.6% of the cases. In cases where damage to the inferior alveolar artery, internal maxillary artery, or facial artery was suspected, blood loss ranged from 1500 to 3000 mL.²²

The most critical step management of life-threatening facial hemorrhage is recognition of the event itself. A significant volume of blood can be swallowed by the patient, and this may attribute to the delay in recognition of the face as a source of hemorrhage.⁶ In polytrauma patients, it is very unlikely that the facial fractures are the lone-standing cause of the hypovolemic shock but this assumption has often led to delay in management of the hemorrhage.⁶

The first step in the management of intractable hemorrhage from the maxillofacial complex is establishing an airway as per the ATLS protocol. This often necessitates an emergent airway and up to 93% of the patients will require a definitive airway.^{3,5} Results from our pooled data indicated that almost 80% of patients with life-threatening facial hemorrhage underwent establishment of an

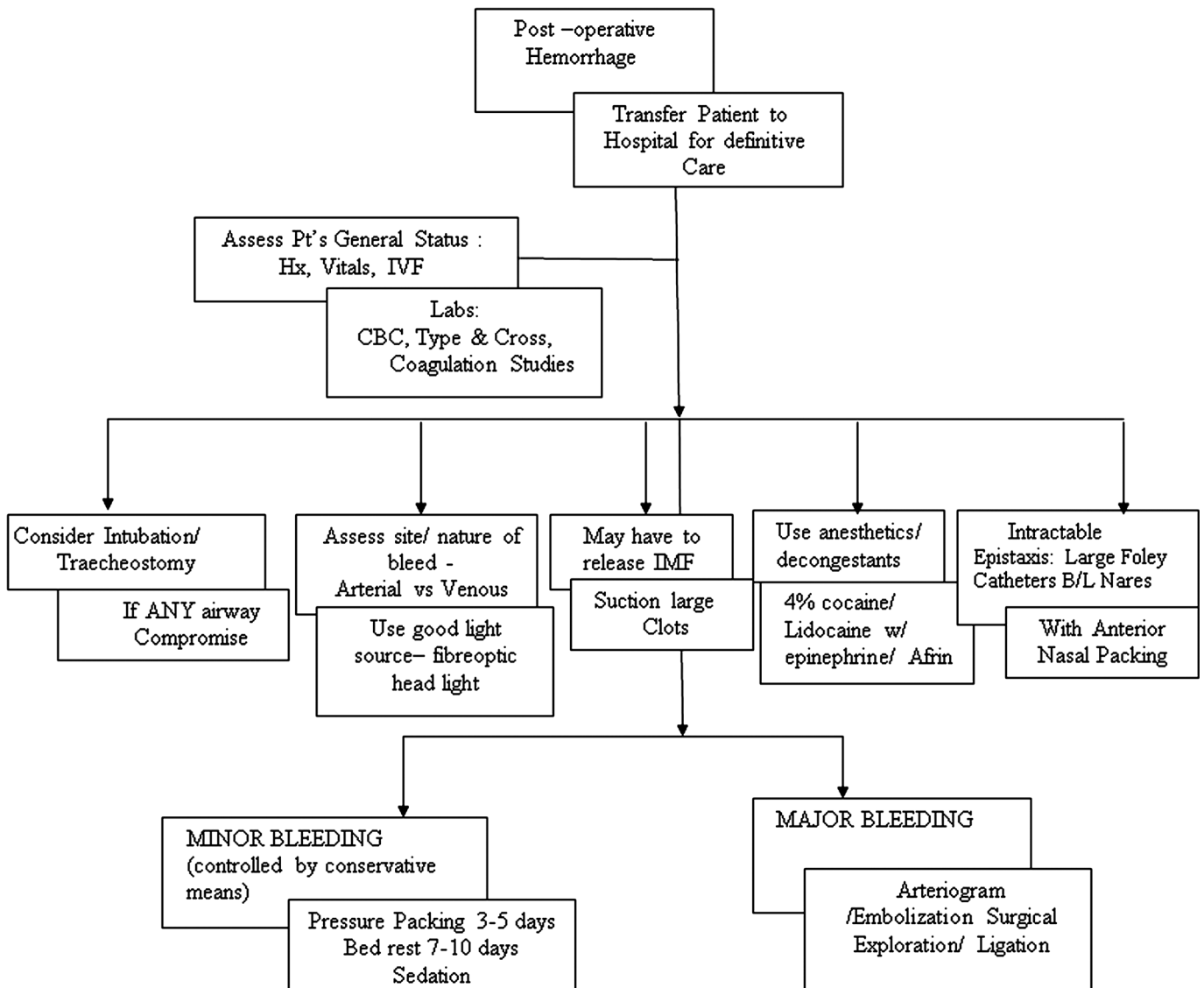


FIGURE 2. Algorithm for management of life-threatening facial hemorrhage from orthognathic surgery.

emergent airway via intubation, cricothyrotomy, or tracheostomy.^{5,6} After resuscitation, the initial management is commenced with conservative measures including anterior and posterior nasal packing or balloon tamponade, oral packing, digital pressure, local vasoconstrictive agents, cautery, and emergent intermaxillary fixation.^{5,9,33}

In trauma patients, the literature supported anterior and posterior nasal packing as the initial measure to manage massive facial hemorrhage. It controlled the bleeding in 29% of patients and decreased it in another 44% of patients.⁵ In a large retrospective study from a level I trauma center, balloon catheters successfully arrested the hemorrhage in 93% of their multitrauma patients.¹⁸ These catheters may serve as a preliminary and at times as a definitive measure to control bleeding probably by applying pressure both on the proximal and distal end of blood vessels.^{6,37} Nasal packing with temporary fracture reduction by intermaxillary fixation has been shown to control massive oronasal bleeding in 2 Level III evidence-based studies, although it is more effective in controlling mild to moderate epistaxis.^{3,5}

The literature supports selective ligation of facial vessels where possible as a means to control hemorrhage when packing is not successful. The most common combinations of ligation in orthognathic surgery have included ligation of the terminal branches of the IMA (posterior nasal, sphenopalatine, and descending palatine arteries) through a transantral approach or the IMA and superficial temporal artery at the retromandibular fossa.^{22,23,27,36,38} The level of ligation of the artery is critical and doing so at the origin of the external carotid artery is ineffective in controlling hemorrhage secondary to the extensive collateral circulation of the face.^{18,36,38}

Transcatheter arterial embolization has largely replaced surgical ligation in institutions where this modality is available.^{5,18,39–42} Transcatheter arterial embolization is not only more selective but can also access sites inaccessible to surgical ligation.^{27,31,43} Angiography is able to accurately determine the exact source of bleeding and can detect the presence of a false aneurysm or an arteriovenous malformation.^{22,25,29,34,44,45} Furthermore, in orthognathic surgery, it precludes the need for re-downfracture of the maxilla that could disrupt the healing process.²³

In multiple studies, TAE has proven very successful in arresting bleeding in patients with severe life-threatening hemorrhage with a success rate of up to 96% and a major complication rate of 3%.^{5,9,11,25,46} Complications of TAE include skin and mucosal necrosis, cranial nerve injury, cerebrovascular accidents, and death.^{5,11,27,44,45,47} It is currently indicated in patients who have had a blood loss in excess of 1500 mL or are in hypovolemic shock.^{2,9}

An algorithm for life-threatening hemorrhage from trauma was formulated based on this literature review (Fig. 1). This management strategy is supported by the evidence-based studies. The overall scientific quality of the literature was based on case-control, case series, and case reports.

An algorithm for life-threatening hemorrhage for orthognathic surgery was formulated based on this literature review (Fig. 2). This management strategy is also supported by evidence-based data.

CONCLUSIONS

Life-threatening facial hemorrhage is a rare but serious situation from its recognition as a potential source of life-threatening hemorrhage to its definitive management. When conservative measures fail, the evidence supports TAE over selective surgical ligation. The overall scientific quality of the literature is poor and based on individual case-control studies, cohort studies, outcomes research papers, and case reports. Until a high-quality multicenter randomized control trial is conducted comparing the efficacy of various treatment modalities, the proposed management algorithms are based on the best available evidence.

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