DIFFICULTIES IN AIRWAY MANAGEMENT OF TRAUMATIZED PATIENTS UNDERGOING MAXILLOFACIAL PROCEDURES: A REVIEW

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Abstract

Background: A review of airway management in maxillofacial trauma, according to the etiology and the affected anatomical location of the injuries has been performed.

Methods: An electronic search was conducted in the MEDLINE on published data from January 1996 to December 2016 with the use of relevant keywords and hand-searching. Initial search yielded 569 potential articles; 67 were studies or case series with titles relevant to the subject and had abstracts. These articles were evaluated to identify those with epidemiological data on the airway management of individuals with maxillofacial trauma. Only 18 publications were derived from retrospective studies. The under review populations were evaluated according to the etiology and anatomical characteristics of the injuries, the airway management conditions (e.g. emergent or elective) and the specific airway management techniques applied.

Results: The cumulative frequencies of specialized airway management techniques applied in general civilian accidental mixed maxillofacial trauma were: fiberoptic tracheal intubation 14.7%, blind nasotracheal intubation 1.5% and surgical airway 6.9% (emergently 3%). The incidence of surgical airway is magnified in laryngeal fractures (cumulative frequency: 49.0%), Le Fort fractures III 43.5%, panfacial fractures 30% and gunshot injuries (cumulative frequency: 23.6%; emergently 11.9%).

Conclusion: Maxillofacial trauma increases the incidence of difficult and/or impossible airway. Incidence of surgical airway is elevated greatly in laryngeal fractures, higher Le Fort fractures, panfacial fractures and gunshot injuries. Blind techniques continue to be applied when special technical facilities are not readily available.

Introduction

Patients undergoing maxillofacial (MXF) procedures due to trauma present unique airway management challenges in the emergent, operative, and postoperative settings. Either the MXF surgeon or the MXF anesthetist are often required to ensure the airway in patients with severe facial injuries, and should be familiar with the available techniques that allow a successful outcome with the most appropriate and safe means. Oral tracheal intubation (TI) remains the primary

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method of securing the emergent airway. Fiberoptic bronchoscope (FOB) assisted nasotracheal intubation has gained popularity in managing difficult airways despite traditional concern for intracranial penetration in patients with severe skull base injuries[1]. When other measures fail, cricothyroidotomy (CTT) is an expedient means of tracheal access[1].

The present review approaches the differences of airway management in MXF trauma patients according to their etiology and the affected anatomical location.

Materials and Methods

An electronic database search was conducted in the MEDLINE for studies published between January 1996 and December 2016, with the use of relevant keywords (: "maxillofacial trauma"; "maxillofacial injuries"; "multiple trauma"; "airway management"; "difficult airway") and hand-searching.

An initial search yielded 569 potential articles. Evaluating their titles and searching for the existence of abstracts, 67 clinical studies or case series, relevant with the studied subject, were selected. These articles were estimated, in order to identify studies or case series with detailed epidemiological data on the airway management of individuals with maxillofacial trauma. Thus, 18 publications[2-19] with data coming only from retrospective series of tertiary centers were identified. Finally, the under review studied populations[2-19] were evaluated according to the etiological (e.g. road traffic accidents, falls, assault or gunshot wounds and other reasons) and anatomical characteristics of the injuries (types of fractures: mandible; maxilla; zygoma; panfacial; nasal complex; Le Fort I, II or III; laryngeal), the conditions of the airway management (e.g. emergent or elective) and the applied specific airway management techniques (oral or nasal TI under direct laryngoscopy (DL) or video-laryngscopy, oral or nasal FOB TI, tracheostomy, CTT, submental TI, etc).

Results

There was no data from prospective studies. The under review populations of traumatized patients were classified into two main categories: (a) general civilian accident victims, where outweigh traffic accidents followed by falls from on high, assault, sport injuries, stab (Tables 1-3)[2-14]; (b) victims with blast injuries and gunshot wounds, either in warfare or due to criminal activity (Table 4)[15-19].

The publications that compose the content of Tables 1-3 depict civilian victims with facial and/or laryngeal fractures[2-14]. The anatomical characteristics of the referred fractures and the etiology of the relevant injuries were presented in details in eight articles[2-4,6,8,12-14]. Only three populations are unmixed, as regards the affected anatomical features (Table 3) and consist, either of victims with laryngeal fractures due to blunt trauma[12,13], or three equivalent groups of victims with Le Fort fractures type I, II and III due to blunt trauma or penetrating injuries[14]. All the other types of facial fractures (FFs) are jointly involved as a part of each mixed surgical population[2-11] and the respective partial ratios are approximately similar, with the exception of the panfacial fractures which show higher prevalence of variance. Concretely, the following partial ratios of FFs have been recorded: mandibular 24-54%, maxillary 15-23%, zygomatic 12-20% and panfacial 6-61%[3-6,8]. Finally, tables 1 and 2 show mixed populations, as to the anatomical characteristics of FFs, and in great majority are composed of victims of road traffic accidents.

The publications of table 1[2-8] show in details all the applied airway management techniques in injured victims of civilian accidents with various FFs. The use of FOB presents enormous variation up to 55%[2], while the nasotracheal intubation (blind or with DL) was applied mainly in tertiary centers of developing countries, where it is not very frequent the use of FOB[3,5,8].

The conditions of the overall airway management (emergent or elective) were clarified in three populations of mixed FFs[2,5,8], where 59 of 464 victims (12.7%) emergently required establishment of a definitive secure airway, secondary to airway obstruction (Table 1).

Three similar and relatively larger series of victims of civilian accidents[9-11], have been classified in table 2 separately, because they are focusing only at the frequencies of tracheostomy. Generally, the

Table 1

Injured victims of civilian accidents with various facial fractures presented with data on the causes, the anatomical characteristics (type of fractures) and the total of the applied airway management techniques

Journal	RFN	n	Anatomical characteristics	Etiology of injuries	Emergency conditions of Aw M
Anesth Essays Res 2015; 9: 44	2	288	trauma with facial #	traffic accidents 206 (71.5) fall 60 (20.8) assault 12 (4.2) gunshot 7 (2.4) other 3 (1.1)	48 (16.7) vs. 240 (83.3)
Niger J Surg 2015; 21: 26	3	51	mandibular # 24 (47.1) maxillary # 12 (23.5) zygomatic # 6 (11.8) panfacial # 6 (11.8) nasal # 3 (5.9)	traffic accidents 47 (92.2) fall 1 (1.9) assault 2 (3.9) gunshot 1 (1.9)	-
J Clin Diagn Res 2014; 8: 77	4	487	panfacial # 194 (39.8) mandible # 116 (24.0) maxilla # 72 (14.8) zygoma # 65 (13.3) nasal # 40 (8.2)	traffic accidents 404 (83.0) fall 40 (8.2) assault 21 (4.4) gunshot 12 (2.4)	-
J Maxillofac Oral Surg 2012; 11: 138	5	49	panfacial # 30 (61.2) Le Fort # 13 (26.5) other # 6 (12.3)	accidents generally	4 (8.2)‡ vs. 45 (91.8)
Saudi J Anaesth 2011; 5: 9	6	177	mandible # 95 (53.7) maxilla # 37 (20.9) zygoma # 34 (19.2) panfacial #11 (6.2)	traffic accidents 119 (67.2) sport 27 (15.3) fall 27 (15.3) other 3 (1.7)	-
J Oral Maxillofac Surg 2011; 69: 2001	7	674*	trauma with facial #	accidents generally	-
Ind J Anaesth 2008; 52: 311	8	127	mandible # 65 (51.2) maxilla # 19 (14.9) zygoma # 25 (19.7) mixed # 9 (7.1) panfacial # 9 (7.1)	accidents generally 118 (92.9) gunshots 9 (7.1)	7 (5.5)‡ vs. 120 (94.5)
Total:		1853			59/464 (12.7)

RFN: reference number, n: number of traumatized individuals, ( ): %, -: unspecified data, #: fracture, ‡emergent surgical airway, Aw M: airway management, *674 of 3,149 maxillofacial trauma patients were submitted to operating room

Table 1. (continued)

Journal	RFN	n	TI (O or N) with DL	TI (O or N) with FOB	TI (N) blind awake	Submental TI	Tracheostomy
Anesth Essays Res 2015; 9: 44	2	288	N: 39 (13.6) O: 29 (10.0)† VL: 13 (4.5)	159 (55.2)	0 (0)	45 (15.6)§	48 (16.6)‡
Niger J Surg 2015; 21: 26	3	51	N: 33 (64.7) O: 8 (15.7)	N: 4 (7.8) O: 2 (3.9)	2 (3.9)	2 (3.9)	0 (0)
J Clin Diagn Res 2014; 8: 77	4	487	393 (80.7)	52 (10.7)	0 (0)	12 (2.5)	30 (6.2)
J Maxillofac Oral Surg 2012; 11: 138	5	49	N: 24 (49.0)	N: 8 (16.3)	0 (0)	5 (10.2) & RM 3 (6.1)	5 (10.2) Em SAw 4 (8.2)
Saudi J Anaesth 2011; 5: 9	6	177	130 (73.5)	47 (26.5)	0 (0)	0 (0)	0 (0)
J Oral Maxillofac Surg 2011; 69: 2001	7	674*	N: 449 (66.6), O: 204 (30.3)	0 (0)	0 (0)	15 (2.2)	6 (0.9)
Ind J Anaesth 2008; 53: 311	8	127	N: 22 (17.3) O: 71 (55.9)	2 (1.6) after failed TI (N) blind	25 (19.7)	0 (0)	Em SAw 7 (5.5)
Total:		1853	1412 (76.2)	274 (14.7)	27 (1.5)	82 (4.5)	100 (5.4)

RFN: reference number, n: number of traumatized individuals, TI: tracheal intubation, O: oral, N: nasal, DL: direct laryngoscopy, FOB: fiberoptic, VL: video-laryngoscopy, ( ): %, Em SAw: emergent surgical airway, Aw M: airway management, †in 3 of 29 cases OTI was applied in the emergency department, §submental TI was performed after normal OTI, ‡surgical airway was applied in the emergency department in 45 of 48 cases, *674 of 3,149 maxillofacial trauma patients were submitted to operating room

Table 2

Incidence of tracheostomy in injured victims of civilian accidents with various facial fractures

Journal	RFN	n	Tracheostomy	Comments
J Oral Maxillofac Surg 2008; 66: 1404	9	222*	8 (3.6)	222 of 356 MXF trauma patients were submitted to OR
J Oral Maxillofac Surg 2007; 65: 2005	10	1079	125 (11.6)*	TS at the same time as the FF repair
J Oral Maxillofac Surg 1996; 54: 292	11	399	TS 7 (1.8) EmCTT 6 (1.5)	
Total of table 1	2-8	1853	100 (5.4)	
Total:		3553	246 (6.9)	

RFN: reference number, n: number of traumatized individuals, *comment, ( ): %, MXF: maxillofacial, TS: tracheostomy, FF: facial fracture, CTT: cricothyroidotomy, Em: under emergency conditions, OR: operating room

incidence of tracheostomy in civilian victims with FFs ranges between 0% and 17%[2-11]. The cumulative rate is 6.9% (246/3553[2-11]; Tables 1 and 2), but only three articles[5,8,11] provide clear information about the conditions (emergent or elective) that prevailed during application of surgical airway and the cumulative incidence of emergent tracheostomy or CTT was at 3.0% (17 of 575). Tracheostomy is more common (about 30%) in populations with high incidence of panfacial fractures[4,5]. This was mainly influenced by publication of Vidya et al[5], where nine of 30 victims the panfacial fractures required a tracheostomy.

Victims with laryngeal fractures required surgical airway in a cumulative frequency of 49.0% (24/49), emergently 4.1% (2/49) (Table 3)[12,13]. Similarly high frequency of tracheostomy (43.5%) has been recorded in victims with Le Fort fracture III[14]. The incidence of tracheostomy was lower, but remarkable, in victims with Le Fort injuries I or II (13.6% and 9.1%, respectively).

Victims with blast injuries and gunshot wounds, either in warfare[15] or due to criminal activity[16-19] composed a total population of 490 individuals (Table 4). The conditions of the overall airway management (emergent or elective) are clarified in all papers, but obviously the criteria were not always the same, since there were cases, where the indication of the emergency is not compatible with the corresponding frequencies of surgical airway[16]. Nevertheless, the airway management in MXF gunshot victims involved the need for surgical airway most frequently (cumulative frequency of surgical airway: 103 of 437, 23.6%; emergently 52 of 437, 11.9%), when compared to the mixed MXF trauma of civilian accidents. Evaluating the separate frequencies of tracheostomy in gunshot victims (Table 4) indicates that the military trauma[15]

Table 3

Incidence of tracheostomy in victims of civilian accidents with specific types of neck or maxillofacial injuries (laryngeal and Le Fort fractures)[12-14]

Journal	n	Primary cause	Anatomical characteristics (type of #)	Etiology of injuries	Surgical airway
J Oral Maxillofac Surg 2006; 64: 203	27* [20]	laryngo-tracheal trauma	laryngeal 27 (100)	blunt trauma 23 (85.2)	TS 14 (51.9) & CTT 1 (3.7) emergently CTT
Yonsei Med J 2012; 53: 992	22 [4]	laryngo-tracheal trauma	laryngeal 22 (100)	stab 7 (31.8) traffic accident 5 (22.7) fall down 4 (18.2) other accidents 6 (27.3)‡	TS 8 (36.4) at OR & 1 (4.6) at ED emergently
J Oral Maxillofac Surg 2005; 63:1123	67	trauma with Le Fort #	Le Fort I: 22 (32.8) II: 22 (32.8) III: 23 (34.3)	blunt trauma 64 (95.5) Penetration 3 (4.5)	I: TS 3 (13.6) II: TS 2 (9.1) III: TS 10 (43.5) total: 15 (22.4)
Total:	116				39 (33.6)

n: number of traumatized individuals; ( ): %; *37 of 16,465 patients with head, neck or maxillofacial injuries presented laryngeal fractures (0.22%), but 10 patients were without full details; [ ]: number of emergent surgical airway management interventions applied (cumulative frequency: 24/49, 49.0%); #: fracture; TS: tracheostomy; CTT: cricothyroidotomy; OR: operating room; ED: emergency department; ‡machinery accidents 3, workplace safety accidents 2, sport 1

Table 4
Victims of maxillofacial blast injuries and gunshot wounds presented with data on their etiology, as well as the conditions and the techniques of the applied airway management

Journal	RFN	n	Etiology of injuries	Emergency Aw M†	TI with DL	Surgical Aw	Comments
Otolaryng Head Neck Surg 2015; 153: 532	15	239* [196]	blast injuries & gunshot (warfare)	22 (11.2)§	123 (62.8)	TS 73 (37.2)	239 severe MXF injuries (of 1345 MXF cases), that required Aw M
World J Surg 2007; 31: 2104	16	40* [30]	gunshot (crime)	30 (100)‡	Oral 28 (93.3)	CTT 2 (6.7)	40 of 55 victims submitted to OR
J Oral Maxillofac Surg 2003; 61: 1390	17	44*	gunshot (crime)	4 (9.1)‡	-	TS 4 (9.1)	2 shotgun, 28 bullet, 10 shrap-nel, 3 landmine, 1 breech block injuries
S Afr Med J 2002; 92: 803	18	92*	gunshot (crime)	8 (8.7)	84 (91.3)	TS 5 (5.4) CTT 3 (3.3)	20 cases had a threatened Aw at ED admission
J Oral Maxillofac Surg 2001; 59: 277	19	75*	gunshot (crime)	16 (21.3)‡	-	EmTS 16 (21.3)	75 of 84 victims submitted to OR
Total:		490 [437]		80 / 437 (18.3)	235 / 318 (73.9)	103/437 (23.6)	

RFN: reference number, n: number of traumatized individuals, ( ): %, [ ]: final number of individuals with detailed data, Aw M: airway management, TI: tracheal intubation, DL: direct laryngoscopy, MXF: maxillofacial, TS: tracheostomy, CTT: cricothyroidotomy, ED: emergency department, OR: operating room, *comment, †definition of emergency conditions includes only surgical Aw in RFs 14 & 16-18, while it encompasses more techniques of Aw M in RF 15, §TSs performed on initial presentation of the victims at the ED (22/73, 30.4% of total number of TSs), ‡only emergent cases with threatened Aw are analyzed, -: unspecified data

takes precedence (37.2%) over crime trauma[16-19] (6.7-21.3%; cumulative frequency: 30 of 241, 12.4%).

Discussion

The failure to maintain a patent airway after the induction of general anesthesia is a major concern for anesthetists. For securing the airway, tracheal intubation using direct laryngoscopy remains the method of choice in most cases. However, tracheal intubation with direct laryngoscopy is difficult in 1% to 4%, and impossible in 0.05% to 0.35%, of patients who have seemingly normal airways[20]. In contrast to the above basic principle, which is valid for the average of the surgical patients who are admitted in the operating room to undergo any surgical procedure except MXF, the present analysis indicates that the MXF trauma generally increases extremely the incidence of difficult and/or impossible airway.

The proportion of patients with MXF trauma, which was transferred from the emergency department to the operating room, varies greatly. It ranges between 21.4% and 62.4% in the civilian accidental mixed MXF trauma population[7,9],

The cumulative frequencies of specialized airway management techniques (fibroptic tracheal intubation 14.7%, blind nasotracheal intubation 1.5%, and surgical airway 6.9%) that have been applied in general civilian accidental mixed MXF trauma (panfacial fractures excluded) are particularly remarkable.

Laryngeal fractures are quite rare and represent only 0.22% (about 1:5,000) of the MXF injuries[12].

However, readiness is required for this minimum, but crucial subset of MXF trauma, since the total incidence of surgical airway is magnified up to seven times (49.0%) compared with general civilian accidents. Le Fort fractures type III (43.5%) and panfacial fractures (30%) follow closely in terms of surgical airway frequencies.

Patients with higher Le Fort injuries were characterized by an overall greater severity of injuries, as measured by the average Injury Severity Score and a higher chance of requiring neurosurgical intervention or of experiencing vision-threatening ocular trauma[14]. Immediate operative intervention and/or ICU care was more frequently indicated in this sub-group of patients[14].

The total incidence of surgical airway is magnified up to more than three times in victims with blast injuries and gunshot wounds (23.6%), when compared to general civilian accidents (panfacial fractures excluded). About half of tracheostomies and/or cricothyroidotmies were urgently applied, both in general civilian accidents and gunshots or blast injuries (3% vs. a total of 6.9% and 11.9% vs. a total of 23.6%, respectively).

During surgery for major MXF fractures, tracheostomy is presented as a solution, although it carries a relatively high incidence of complications[21]. However, the submandibular tracheal intubation substitutes for the tracheostomy[2,3,7], since tracheal intubation is straightforward, safe, and quick to carry out. It can be an alternative to tracheostomy, as it allows operative techniques and postoperative airway protection without the risks and side effects of tracheostomy[21].

Blind techniques, such as the blind naso-tracheal intubation, were recommended twenty years ago[22], but have ceased to be widely accepted after the year 2000[23-25], since the advancements in airway management have made this practice obsolete. However blind nasotracheal intubation remains popular, since it continues to be applied when special technical facilities (e.g. FOB) are not readily available[26], mainly in tertiary centers of developing countries[3,5,8].

In conclusion, it appears that anesthetists should be familiar with all airway management techniques for trauma patients undergoing maxillofacial procedures due to the large variations of injuries and relevant available techniques for airway management.

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