Current Trends in the Treatment of Maxillofacial Injuries in the United States

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This report presents the results of a 1997 survey of the members of the American Association of Oral and Maxillofacial Surgeons to assess the current national and regional trends in the management of maxillofacial trauma. Comparisons are made with the nearly identical survey done in 1987. The results show practitioner age-related differences and changes in reported practice across time. The significance of these findings are discussed.

In the spring of 1997, a questionnaire was sent to all members of the American Association of Oral and Maxillofacial Surgeons (AAOMS). The survey was a modification of that used 10 years ago to determine the methods of choice for the treatment of injuries to the face and jaws. In the previous study, changes in philosophy and improvements in technology were found to have affected surgical practice, and it was anticipated that there would be further changes since the last survey.

Materials and Methods

Of the 4,486 questionnaires sent, 1,863 usable questionnaires were returned, for a response rate of 42%. Respondents all had dental degrees, and 4.2% also had an MD degree. Fifteen percent had degrees in addition to DDS or MD. Eighty-eight percent were in private practice, with the next most common practice setting being full-time teaching, a position held by 8.1% of the respondents. Military surgeons constituted 2.5% of the sample, and the remainder were in the Veterans Administration (0.5%) or other practice setting (0.7%). Of the respondents, 26.7% were in the 30- to 40-year age-group, 40% were in the 40- to 50-year age-group, 26.7% were in the 50- to 60-year age-group, and 6.7% were older than age 60 years. Using the midpoints of these ranges, the average surgeon in this survey was 46 years old. All 6 AAOMS districts were represented: District 1 (Northeastern), 18.9%; District 2 (Middle Atlantic), 13%; District 3 (Southeastern), 18.1%; District 4 (Great Lakes), 13.8%; District 5 (Midwestern), 23.6%; and District 6 (Western), 12.7%. Fewer than 100 surgeons in this survey responded to the following question: Did your residency prepare you adequately for managing trauma? These surgeons were equally represented in all districts, but they were disproportionately older. In the youngest age-group, only 2.5% felt unprepared, whereas 9.5% of surgeons older than age 60 years thought that their residency had prepared them inadequately.

More than 40% of surgeons in this survey were affiliated with a level I trauma center. When asked what percentage of their practice involves treating trauma patients, the responses ranged from 0% to 95%, with the median at 5%. This practice percentage did not vary with the district or the age of the surgeon. When asked, “Bearing in mind the increase in motor traffic, the increase in alcohol consumption and personal violence, and the introduction of air bags and car seat belts, do you consider that facial trauma has increased/decreased in the last 10 years?” The median response was that it had decreased by 20%. However, surgeons in districts 1 and 2 saw a larger decrease (25%), and older surgeons also tended to report more of a decrease. This also varied with the practice setting, in that those affiliated with level I trauma centers reported a 16% decrease, whereas those not practicing in these locations reported a 20.3% decrease. In addition, there was a strong relationship between the amount of decrease seen and the percentage of practice involving trauma patients; that is, those reporting the largest decrease had less of their practice involving trauma. The 114 surgeons with more than 25% of their practice involved in treating trauma...
cases reported a median decrease of 10%, but fully a quarter of them perceived an increase in trauma.

The questionnaire results were tabulated by the number and percentage of respondents in each category of each question. The responses were then given a numerical score to determine whether there was a change in the pattern since the last survey, and whether there was any age-related effect on the practice patterns. ANOVA was used to test for group differences, and correlations were calculated for the continuous variables. Because of the large number of questions, a number of spurious results would be expected if an uncorrected P-value were used to determine significance. Therefore, as in the previous study, significant differences are reported only when the nominal P-value was less than .0005.

The following issues are addressed for each question: a description of the 1997 survey responses, a comparison of all 1997 items in a question, a comparison in the responses across time (1997 vs 1987) for each item, and testing for a relationship to age (in 1997).

Results

TREATMENT OF MANDIBULAR FRACTURES

The first question asked was "When the indications are present for the treatment of mandibular fractures, do you use..." Six treatment methods were considered. These included noncompression plates, compression plates, lower border wiring, upper border wiring, external pins, and Kirschner wires (Fig 1). Of those who responded, 69.4% often use noncompression bone plates, 25.7% seldom use noncompression bone plates, and 4.8% never use noncompression bone plates. By comparison, in the 1987 survey, noncompression bone plates were often used by 44% of oral and maxillofacial surgeons (Fig 1). An asterisk in the figures indicates that there was a significant difference between the 1987 and 1997 survey results. The use of compression bone plates also increased since 1987 (often increased from 30.3% to 48.6%). All of the other methods significantly decreased in use.

In Figure 1, the percentage of nonresponders is low, except for the Kirschner wire option. In 1987, 4.4% of those surveyed did not respond, whereas in this survey over 6.4% did not respond. This seems to correspond to the general removal of Kirschner wires from oral and maxillofacial surgery practice. In the 1997 survey, Kirschner wires were almost never used (0.5% never and 13.1% seldom).

External pins and lower border wiring were used seldom to never, whereas compression bone plates and upper border wires were used often to seldom. The most commonly used treatment for a mandibular fracture was the noncompression bone plate (69.4% often), followed by the compression plate (48.6%). This is a switch away from lower-border wiring, the most common treatment in 1987. Over time, the use of both types of bone plates has increased, and other forms of treatments for mandibular fractures have decreased. Younger practitioners more often use both noncompression and compression bone plates, whereas older surgeons use lower and upper border wiring or Kirschner wires. Indeed, of the 9 surgeons reporting often use of Kirschner wires, 5 were in the 50- to 60-year age range.

OPEN REDUCTION OF MANDIBULAR CONDYLAR FRACTURES

The second question asked was, "Do you do an open reduction on a mandibular condylar fracture in a dentate patient who..." The results showed that it is most common to do an open reduction when the patient has bilateral fractures with the condyles displaced but in contact with the distal segment, but to operate on only 1 side (Fig 2). It is rarer to operate on...
both sides, and more than 38% of the respondents in this survey did not select this option. The next most common indication for open reduction is when the patient "has radiographic evidence of apparent displacement of the condyle without contact with the distal segment," followed by patients who have "condyle significantly displaced but still in contact with the distal segment." An open reduction is performed least often when the patient "has minimal displacement radiologically, but has a posterior open bite, mandibular deviation, and swelling." There was a significant increase in the use of all of the options between 1987 and 1997 (Fig 2). No relationship existed between the age of the surgeon and 2 of the options; that is, the use of an open reduction was unrelated to age in the case of minimal displacement and for operation on both sides in the case of bilateral fractures. In all other cases of displacement and fractures, older surgeons had a higher likelihood of using these methods.

**SIMPLE DISPLACED BODY FRACTURE WITH CONTRALATERAL CONDYLAR FRACTURE IN A DENTATE PATIENT**

Next, surgeons were asked, "For a simple displaced body fracture with a contralateral intracapsular mandibular condylar fracture, assuming an appropriate dental state, are you most likely to use . . .?" The results are shown in Figure 3. The most common treatment was arch bars, with their use reported as often over 93% of the time. This was a slight but significant decrease from that reported in 1987. Next most common was a new option, rigid fixation, that was not included in the 1987 survey. This method was often used by 57.7% of respondents. Both plastic splints and eyelet wires are used less often than other options, and their use is decreasing over time. The surgeon's age is strongly related to use of rigid fixation, with younger surgeons using this method more often. Older surgeons tend to prefer eyelet wires more often than younger surgeons.

Of the 3 anesthesia options used during treatment, the most common is general anesthesia, followed by local anesthesia with sedation (Fig 4). General anesthesia use has remained high over the last decade, whereas both forms of local anesthesia—alone and with sedation—have decreased. The age of the practitioner was related to the reported use of these options. Older surgeons tend to use local anesthesia, whereas younger surgeons use general anesthesia more often.

**NONCOMPONDED, DISPLACED FRACTURE OF THE MANDIBULAR BODY IN AN EDENTULOUS PATIENT**

Next, surgeons were asked, "In a middle-aged edentulous patient with a noncompounded, displaced fracture of the body of the mandible, would you use . . .?" and 7 options were given. The results are shown in Figure 4. The most commonly used option was splints made from existing dentures, although preference for this option has decreased in the last decade. This option is more common with older surgeons. Intraoral plating has become the next most common treatment. Its use has increased, and it is more preferred by younger surgeons. Unchanged over time is the common use of extraoral plating. Younger surgeons report more use of both intraoral and extraoral plating. Custom-made Gunning splints are seldom used. The least used are lower and upper border wiring, whose use continues to decrease, and the use of a soft diet with no fixation, which is never used by over 50% of respondents. Older surgeons report more use of upper and lower border wiring.
TRENDS IN TREATMENT OF MAXILLOFACIAL INJURIES

FIGURE 5. When you use rigid internal fixation for mandibular fractures, do you use maxillomandibular fixation postoperatively . . .

- Often; □, Seldom; □, Never; □, NR.

USE OF MAXILLOMANDIBULAR FIXATION AFTER RIGID FIXATION

The next question was new in the 1997 survey and therefore could not be compared with 1987. It asked, “When you use rigid internal fixation for mandibular fractures do you use maxillomandibular fixation (MMF) postoperatively . . .” and for how long? It is rather uncommon to use such fixation for several hours (only 14% do this); it is more common to use it for several days (34% report doing this) and it is most common to use MMF for 1 or 2 weeks (54% report always doing this) (Fig 5). Older surgeons have a stronger preference for the longest postoperative fixation.

RIGID INTERNAL FIXATION FOR MANDIBULAR ANGLE FRACTURE

This question was also new in 1997. It asked, “When treating a mandibular angle fracture in a dentate patient using rigid internal fixation, do you usually use . . .” and gave 7 options. The results are shown in Figure 6. The most commonly used method is the superior border miniplate, used often by more than 55%. It is used significantly more than either the inferior border compression and noncompression plate, both used often by approximately 40%. Two noncompression miniplates are less commonly used, with only 15% reporting that they often use them. The least used methods of internal fixation are the lag screw, mini-dynamic compression plates, and reconstruction plates, with over 50% reporting that they never use them.

THE USE OF SKELETAL FIXATION

The next question stated, “A suggestion has been made that fixation, other than MMF, is too frequently used in midface fractures. Where there is appreciable mobility, do you use skeletal fixation . . .” and 6 options were given. With 1 exception (fractured palatal bones), skeletal fixation is still common use, with over 65% in the combined “always” and “often” categories (Fig 7). However, it has had significantly less use in 4 areas since 1987: Le Fort I and II cases, fractured palatal bones, and association with comminuted mandibular fractures. Older surgeons report using skeletal fixation when the mandibular condyles are also fractured, there is evidence of a cerebrospinal fluid (CSF) leak, or when there is association with a comminuted mandible. When skeletal fixation is used, oral and maxillofacial surgeons clearly prefer internal skeletal fixation to extraoral cranial fixation (99% vs 1%, up from 96.8% in the 1987 survey). All of these methods were used relatively more often by older surgeons.

In middle third fractures, which have a good chance of CSF leak, the use of penicillin or sulfonamide is reported by 34.3%, ampicillin is used by 37.5%, and other antibiotics are preferred by 28.2%. There was no significant change since 1987.

METHODS OF EXTRAORAL FIXATION

The 1987 survey reported that, except for a halo frame (27%), cranial pins, a box frame, and cheek wires with a head cap were hardly ever used by the respondents for treating midface fractures. This re-

FIGURE 6. When treating a mandibular fracture in a dentate patient using rigid internal fixation, do you usually use . . .

- Often; □, Seldom; □, Never; □, NR.

FIGURE 7. A suggestion has been made that fixation, other than MMF, is too frequently used in midface fractures. Where there is appreciable mobility, do you use skeletal fixation . . .

- Always; ■, Often; □, Seldom; □, Never; □, NR.
FIGURE 8. Which extraoral method do you use most frequently?

METHODS OF INTERNAL SKELETAL FIXATION

When internal skeletal fixation is used to treat midface fractures, the most common method is bone plates, a significant increase since the 1987 survey (Fig 9). Bone plate use doubled in the past decade, with it being often used by 43.8% of surgeons in the 1987 survey and by 89.4% in the 1997 survey (Fig 9). The most common methods in the 1987 survey, circumzygomatic wires and direct wires at fracture sites, significantly decreased in use, but were still the next most common methods used for internal skeletal fixation (over 40% often). The often use of frontal suspension wires decreased from 59% to 26% in this survey. Frontal sinus screws are the least used, but increased from 1.7% in 1987 to 5.1% in 1997. Older surgeons tend to report more use of these methods.

THE TREATMENT OF MALAR FRACTURES

In the treatment of zygomaticomaxillary fractures, the most commonly reported approach in this survey was through the brow, with over 80% reporting that they often use this incision (Fig 10). The use of this approach increased since 1987. Use of a lower lid approach has also increased and is now often used by 63.3% of oral and maxillofacial surgeons. The most common incision when using a lower lid approach is a subciliary incision (57% often): an infraorbital incision is often used by approximately one third of surgeons, and the transconjunctival incision is used by less than a quarter (Fig 10). The use of the Gilles and antral approach has remained stable across time and is often used by approximately 35%. The least-used method (55% never) was the hook or screw through the skin approach; however, its use has increased since 1987. There are no age-related effects.

Consultation with an ophthalmologist to rule out orbital injuries is often done by 71.5% of the responding oral and maxillofacial surgeons, seldom by 27.4%, and never done by 1.1%.

EXPLORING THE FLOOR OF THE ORBIT IN A MALAR FRACTURE

There are various opinions about exploring the floor of the orbit when treating malar fractures (Fig 11). Except in cases with evidence of muscle tethering (in

FIGURE 9. If you are more likely to use internal skeletal fixation, do you use...
which 68% always explore), and when a fracture occurs with no other complications (in which 90% seldom or never explore), there does not seem to be any consensus. However, there has been an increase in orbital exploration over the past decade when there is muscle tethering or great displacement (Fig 11). If one considers the percentage of oral and maxillofacial surgeons who always or often explore the orbital floor, the most common reasons are great displacement of fragments (89%), diplopia with little sign of muscle tethering (72%), a suitably placed laceration (63%), and infraorbital nerve paresthesia (48%). In all cases, younger surgeons report exploring the orbit more often.

When asked about who normally performs orbital floor exploration in their hospital, various specialists were listed (Fig 12). One obvious change in the last decade is the percentage of nonresponses. In the 1997 survey, more than twice as many oral and maxillofacial surgeons did not report who normally explores the orbital floor (less than 10% in 1987 vs nearly 20% in 1997). The greatest change since 1987 was in the percentage of oral and maxillofacial surgeons who responded that they alone explored the orbital floor (up from 10.5% always to 25.4% always) (Fig 12). Ophthalmologists alone or with an oral and maxillofacial surgeon were reported to have less involvement in this procedure, as were otolaryngologists working with an oral and maxillofacial surgeon. There were no age-related effects other than the tendency of older surgeons to work with ophthalmologists when exploring the orbital floor.

SUPPORTING THE ORBITAL FLOOR

Different products are used to support the orbital floor (Fig 13). Because of low reported use, 2 items in the 1987 survey were removed from the 1997 survey (bone from the hip and rib), and 3 new items were added (cranial bone, Medpor [Porex Surgical, College Park, GA], and metal mesh). In those items included on both surveys, the use of Silastic (Dow Corning, Midland, MI) sheet, Teflon, antral packing, and an inflatable catheter decreased, and use of bone from the contralateral antral wall increased (Fig 13). A large number of oral and maxillofacial surgeons indicated the use of other materials not included in the survey, but few indicated what these other materials were. The most commonly described other materials were: Gelfilm (Pharmacia & Upjohn, Kalamazoo, MI) or other resorbable products (n = 18), freeze-dried bone (n = 6), autologous bone from sites other than those listed (n = 5), cartilage (n = 2), and a combination of collagen, tricalcium phosphate, and hydroxyapatite (n = 2).

There were strong age-related differences in preference for use of the various materials in all cases except for bone from the contralateral antral wall. Oral and maxillofacial surgeons of all ages consistently reported few instances of the use of this material. As might be expected, younger oral and maxillofacial surgeons reported a much more frequent use of the 3 new items added to this survey (cranial bone, Medpor, and metal mesh). Older oral and maxillofacial surgeons reported much more frequent use of Silastic sheet, Teflon, Supramid, antral packing, and inflatable (Foley) catheters. As a result, there is a difference in the pattern of preference that is strongly age-related (Fig 14). In 30- to 40-year-old oral and maxillofacial surgeon group (n = 481), the most popular material is metal mesh. It is preferred over all others except cranial bone, and cranial bone is preferred over all others except Medpor and Silastic sheet. In the mid-range of preference are Supramid (J. Jackson Inc, Alexandria, VA), antral packing, and bone from the contralateral antral wall. Least preferred are inflatable catheters and Teflon. The 40- to 50-year-old oral and maxillofacial surgeons (n = 720) have the strongest preference for Silastic sheet, favoring it over all other
FIGURE 14. Methods to support an unstable orbital floor (means ± 95% CI).

FIGURE 15. In the management of a grossly comminuted nasal complex fracture, do you employ the following techniques . . . ■, Often; □, Seldom; □, Never; □, NR.

FIGURE 16. In the area in which you practice, assuming there is ophthalmic and neurosurgical cooperation when needed, is facial trauma treated . . . ■, Always; ■, Often; □, Seldom; □, Never; □, NR.

 materials. Next in preference are metal mesh, antral packing, and Supramid. Medpor and cranial bone are less preferred. Least preferred are Teflon, bone from the contralateral antral wall, and an inflatable catheter. Oral and maxillofacial surgeons older than age 50 (n = 601) prefer Silastic sheet to all other materials. Next in preference is antral packing, followed by metal mesh, Teflon, Medpor, and cranial bone. Significantly less preferred than cranial bone are an inflatable catheter and bone from the contralateral antral wall.

MANAGEMENT OF A GROSSLY COMMINUTED NASAL COMPLEX FRACTURE

The techniques used in the management of a grossly comminuted nasal complex fracture are listed in Figure 15. Because of a lack of reported use in the 1987 survey, plaster of Paris molds were removed for this survey, and plastic splints were added. The latter proved to be the most popular method (59.3%). In the 1987 survey, no consensus was found on the use of lead plates. In the 1997 survey, there was a decrease in their use, often from 34% to 13% (Fig 15). This decline is related to the age of the oral and maxillofacial surgeon, in that even those over 50 years of age seldom use them, and the youngest surgeons rarely use them.

The use of both midline and lateral incisions for open operations has increased since 1987. However, the increase was not in the often category; rather, the seldom use of open operations increased from less than 16% to greater than 40%. The use of a midline incision is not related to the surgeon’s age, but a lateral incision is used more often by surgeons younger than age 50 years than those older than 50 years. Use of coronal flaps has increased significantly, and this is strongly age-related; younger surgeons use them much more often.

OPHTHALMOLOGIC AND NEUROSURGICAL COOPERATION

The treatment of maxillofacial injuries is affected by local custom and by specialist inclination and availability. Oral and maxillofacial surgeons responding to this survey reported that facial trauma is treated by them always or often over 85% of the time (Fig 16). This high level of involvement has remained over the past decade. Uniform cooperation with ophthalmologic surgeons and neurosurgeons in all forms of facial trauma has remained at the 30% level, but there has been a decrease in the level of reported cooperation for all 3 specific fracture types listed. Cooperation with these surgeons for mandibular fractures decreased from 37.4% always or often to 22.3% in 1997; cooperation for maxillary fractures decreased from 36.6% to 27.8%, and cooperation for middle-third facial fractures decreased from 53% to 44.1%. Cooperation in cases of exceptional difficulty remained at 69.4%. Similarly, handling facial trauma cases by these special-
ists without oral and maxillofacial surgical input remained low at approximately 36.7% always or often.

**Timing of Calling Oral and Maxillofacial Surgery Housestaff**

As in the 1987 survey, 89% of the respondents reported that housestaff are always or often called on admission of the patient (Fig 17). However, there was a significant increase in the reported percentage who are always called, up from 23% to 34%, although, as in 1987, over 52% are called the next day. Oral and maxillofacial surgeons are seldom called later than the day after admission of the patient. The respondents indicated that 56.7% are called for all facial trauma, as opposed to only being called for cases involving teeth and jaws.

**Pattern of Assistance**

The survey asked whether oral and maxillofacial surgeons were assisted by any of the following 6 persons (oral and maxillofacial surgery residents, oral and maxillofacial surgery interns, other surgical residents, other surgical interns, clinical associates, or students) or "no other staff." Those surveyed could individually check each of the 6 options as yes or no. The pattern of assistance was determined in 2 locations: main hospital and other hospitals. The results are shown in Table 1. Of the 1,863 respondents, 71.6% received assistance from one or more professional associates while in the main hospital and 19.4% received no assistance. An additional 9% did not respond to the question. Of the 1,344 oral and maxillofacial surgeons receiving some form of assistance in the main hospital, 31.0% received it from either oral and maxillofacial surgery residents or interns or both. However, oral and maxillofacial surgery residents were about twice as likely to assist (30.7%) than interns (17.5%), and rarely did both render assistance. Other surgical residents or interns assisted 13.6% of oral and maxillofacial surgeons, with 11.8% being residents and 6.6% being interns. The largest group of assistants came from clinical associates, which was reported by 73.9% of oral and maxillofacial surgeons who received any form of assistance. Students assisted 8.5% of oral and maxillofacial surgeons in the main hospital.

There was a 45% nonresponse rate in reference to assistance in other hospitals, indicating that approximately 55% of oral and maxillofacial surgeons practice only in their main hospital. Of those with a secondary practice setting, 41.2% received some form of assistance from other staff. Of the 768 oral and maxillofacial surgeons who received some form of assistance, 17.2% reported that it was from either oral and maxillofacial surgery residents or interns or both. Other surgical residents or interns assisted 7.8% of oral and maxillofacial surgeons, and 43.4% were assisted by clinical associates or students.

**Discussion**

The results of this survey indicate that there have been a number of significant changes in the manner in
which maxillofacial injuries are treated in the United States in the last 10 years. Many of these changes have been related to the increased use of plates and screws for the rigid fixation of fractures. This has been reflected particularly in the treatment of mandibular fractures, in which such use showed an approximately 25% general increase; as well as specific increases in dentate patients with simple displaced body fractures and a contralateral condylar process fracture: edentulous patients with noncompounded, displaced body fractures; and patients with mandibular angle fractures. There also has been a significant increase in the use of bone plates for the fixation of facial bone fractures. In the latter instance, it not only has generally replaced other methods of internal fixation, but it has also replaced the use of external fixation.

The availability of small plates and screws, which makes fixation of mandibular condylar process fractures more stable than wire osteosynthesis, has also resulted in a greater use of open reduction for the management of such fractures than in the past. It has also had a similar effect on the treatment of malar fractures, with open reduction using a brow and lower lid incision generally replacing the Gilles and antral approaches. When the lower lid incision is used, the subciliary approach is usually favored over the infraorbital and transconjunctival approaches. This trend toward more aggressive treatment of facial fractures is also seen in the increase in orbital floor exploration in patients with suspected intraocular muscle tethering and extensive displacement of the fractured segment, and in the greater use of the coronal flap for exposure of midface fractures.

Many of the reported differences in the management of maxillofacial trauma since 1987 are related to the age of the surgeon. This is particularly true for the general use of rigid fixation for the treatment of mandibular fractures, and its use for simple displaced mandibular body fractures associated with a contralateral condylar process fracture and for displaced body fractures in edentulous patients, in whom this is done more often by younger practitioners. This is also true for orbital exploration and the use of coronal flaps. Conversely, older surgeons more frequently use such procedures as upper and lower border wiring, Kirschner wires, eyelet wires, and internal skeletal fixation. However, in some situations, such an open reduction of condylar process fractures with minimal displacement, operating on both sides of bilateral condylar process fractures, or the treatment malar fractures, there is no age-related difference in the treatments used by younger and older oral and maxillofacial surgeons. From these findings, it appears that training and experience during the residency program are at least a partial explanation for many of the age-related variations reported, with most surgeons generally continuing to rely on those procedures with which they are most familiar.

It is evident that, in general, changes in the management of maxillofacial trauma that have occurred in the past 10 years mainly represent a response to the changes in materials and technology that have occurred during the same period. Along with this has come increased cost. However, whether using such new, more expensive technology really improves functional and aesthetic results in all instances, or whether it is merely more convenient for the patient and the surgeon, still need to be established by appropriate outcome studies. In a time when managed care and cost containment dominate our professional lives, such studies are definitely needed.

References