Comprehensive Care for Jaw Fractures: Coordination Between Anesthesia, Orthopedic Surgery, Dentistry, Radiology, and Nursing

Mohammed Abdu Refai[1], Rawan Abdulrahman Almuhmodi Alhuthali[2], Ahmad Matooq Khan[3], Alkhabbaz, Fatima Jaffar M[4], Mashael Yousef Andergiri[5], Nadia Yousef S Alamiri[6], Abdullah Abdullateef Alomair[7], Hakmy, Salh Hamd A[8], Yahya Sadiq Bu Mijdad[9], Ahlam Tewela Aiwed Wabsy[10], Majed Abdullah Mohammed Asiri[11]

1. Consultant Anesthesia - Prince Mohammed Bin Nasser, Jazan Health Cluster - Refaeema@hotmail.com
2. Nurse specialist - King Abdullah Medical City - Nrs.rawanh@outlook.com
3. Orthopedics surgery - King Abdulaziz Hospital - Makkah - Ahmedk@moh.gov.sa
4. Nurse - Eastern Health Cluster, ALATHEER - PHC - Fatimah-jk@hotmail.com / fjalkhabbaz@moh.gov.sa
5. GP Dentist - North West Armed Forces Hospital - m.y.andergiri@gmail.com
6. Nurse - Almubarkiya PHC - nalamiri@moh.gov.sa
7. Orthopedic surgeon - Dammam Medical Complex - Dr_aam@hotmail.com
8. GP Dentist - North West Armed Forces Hospital - dr.saleh.hakami@gmail.com
9. Radiology Technologist - Prince Saud Bin Jalawi Hospital, Alahsa - YSB_12@windowslive.com
10. Dental assistant - King Salman Military Hospital - ahlamm.ksa@gmail.com
11. General Surgery Senior Registrar - King Faisal Medical Complex - Taif - Cmms5668@hotmail.com

Abstract:

Comprehensive care for jaw fractures requires a multidisciplinary approach that integrates the expertise of various healthcare professionals, including anesthesiologists, orthopedic surgeons, dentists, radiologists, and nurses. Each discipline plays a crucial role in ensuring optimal patient outcomes, particularly given the complexities involved in diagnosing and treating jaw fractures. Anesthesiologists must provide tailored anesthesia options that consider the injury's nature and the patient's overall health, while orthopedic surgeons and dentists collaborate closely in surgical planning and execution to ensure structural integrity and functional restoration of the jaw. Meanwhile, radiologists utilize advanced imaging techniques, such as CT and MRI, to provide precise diagnostic information critical for guiding treatment decisions. Nursing care is also vital in the continuum of care, as nurses implement standardized protocols for preoperative assessments, intraoperative support, and postoperative monitoring. Effective communication among all team members is essential to ensure that patient management plans are cohesive and addresses all aspects of care, including pain management and rehabilitation strategies. As the healthcare landscape continues to evolve, there is a pressing need for quality improvement initiatives that evaluate outcomes and refine care protocols. By fostering collaboration among anesthesia, surgery, dentistry, radiology, and nursing, healthcare teams can enhance patient safety, reduce complications, and optimize recovery times in the management of jaw fractures.

Keywords: Comprehensive care, jaw fractures, multidisciplinary approach, anesthesia, orthopedic surgery

Introduction:

Jaw fractures, also known as mandibular or maxillary fractures, are common injuries resulting from trauma, accidents, sports-related incidents, or pathological conditions. These fractures require a multidisciplinary approach to ensure optimal recovery, as they impact essential functions such as mastication, speech, and respiration. The complexity of jaw fractures necessitates seamless coordination among various medical specialties, including anesthesia, orthopedic surgery, dentistry, radiology, and nursing, to provide comprehensive care. Each discipline plays a critical role in diagnosis, surgical intervention, pain management, and postoperative rehabilitation, ensuring that patients regain full functionality with minimal complications [1].

The initial assessment of jaw fractures involves a thorough clinical examination and advanced imaging techniques to determine the extent and location of the injury. Radiology, particularly computed tomography (CT) scans and panoramic radiographs, is indispensable for accurate diagnosis and surgical planning. CT scans provide detailed three-dimensional reconstructions of the fracture site, allowing surgeons to assess displacement, bone integrity, and potential involvement of adjacent structures such as the temporomandibular joint (TMJ) or neurovascular bundles [2]. Meanwhile, dental professionals contribute by evaluating occlusal stability, dental trauma, and the need for intermaxillary fixation (IMF) to restore proper bite alignment. The integration of radiological and dental assessments ensures that treatment plans are tailored to the patient's specific anatomical and functional needs [3].

Anesthesia plays a pivotal role in the management of jaw fractures, particularly during surgical interventions. Given the proximity of the jaw to the airway, securing a stable and safe airway is a primary concern for anesthesiologists. Nasotracheal intubation or fiberoptic-guided intubation may be required in cases of severe mandibular fractures to avoid further trauma [4]. Additionally, anesthesia teams must consider pain management strategies, including regional nerve blocks (e.g., inferior alveolar nerve blocks) and multimodal analgesia, to minimize postoperative discomfort and reduce reliance on opioids [5]. Effective communication between anesthesiologists and surgeons is crucial to anticipate potential complications, such as difficult intubation or excessive bleeding, ensuring patient safety throughout the procedure [6].

Orthopedic and oral-maxillofacial surgeons are responsible for the definitive repair of jaw fractures, employing techniques such as open reduction and internal fixation (ORIF), closed reduction with IMF, or minimally invasive approaches depending on the fracture's severity. ORIF with titanium plates and screws has become the gold standard for displaced fractures, providing immediate stability and promoting early mobilization [7]. Surgeons must also consider biomechanical forces acting on the jaw during healing to avoid malunion or nonunion. Furthermore, collaboration with dentists is essential when fractures involve the alveolar ridge or dentition, as prosthetic rehabilitation or splinting may be required to restore dental function [8].

Postoperative care is equally critical in ensuring successful outcomes, with nursing staff playing a central role in monitoring recovery, managing pain, preventing infections, and educating patients on oral hygiene and dietary modifications. Nursing interventions include wound care, administration of prescribed medications, and assessment for complications such as infection, malocclusion, or nerve damage [9]. Additionally, nutritional support is vital, as many patients require a soft or liquid diet during the healing phase to avoid excessive strain on the repaired jaw [10]. Long-term follow-up involving physical therapy and dental consultations may be necessary to address functional limitations and ensure complete rehabilitation [11].

The success of jaw fracture management hinges on interdisciplinary collaboration, where each specialty contributes its expertise to achieve the best possible outcomes. Effective communication, standardized protocols, and continuous patient monitoring are essential to address the multifaceted challenges posed by these injuries. Future advancements in imaging technology, surgical techniques, and biomaterials may further enhance treatment efficacy, but the foundation of comprehensive care remains rooted in teamwork across medical disciplines [12].

Anesthesia Considerations: Patient Assessment and Customized Anesthetic Plans

The management of jaw fractures presents unique challenges for anesthesiologists due to the anatomical proximity of the mandible and maxilla to the airway, the potential for difficult intubation, and the need for precise pain control. A thorough preoperative assessment is essential to identify risk factors, anticipate complications, and develop a tailored anesthetic plan that ensures patient safety and optimal surgical conditions [13]. The evaluation begins with a detailed medical history, focusing on comorbidities such as obstructive sleep apnea, chronic respiratory diseases, or previous difficult intubations, which may influence airway management strategies. Additionally, the mechanism of injury—whether from trauma, assault, or falls—should be documented, as high-impact injuries may be associated with cervical spine instability or traumatic brain injury, necessitating further neurological and radiographic evaluation before anesthesia induction [14].

Airway assessment is a critical component of preoperative planning for jaw fracture patients.

Physical examination should include evaluation of mouth opening, neck mobility, and the presence of swelling, hematoma, or dental injuries that could obstruct laryngoscopy. The Mallampati score, thyromental distance, and atlanto-occipital extension should be assessed to predict potential intubation difficulties [15]. In cases of severe mandibular fractures, particularly bilateral condylar or comminuted fractures, the structural integrity of the airway may be compromised, increasing the risk of obstruction during induction. Fiberoptic bronchoscopy or video laryngoscopy may be required as alternatives to direct laryngoscopy to secure the airway without exacerbating the injury [16]. Nasotracheal intubation is often preferred for maxillofacial procedures, but contraindications such as basilar skull fractures or severe nasal trauma must be ruled out. In emergency scenarios where rapid sequence induction is necessary, anesthesiologists must be prepared for surgical airway access (e.g., cricothyrotomy) if intubation fails [17].

Customizing the anesthetic plan involves selecting the most appropriate induction agents, muscle relaxants, and maintenance techniques based on the patient's condition and surgical requirements. Intravenous induction with propofol or etomidate is commonly used, while ketamine may be preferred in hemodynamically unstable trauma patients due to its cardiovascular stability [18]. Succinylcholine, a depolarizing muscle relaxant, facilitates rapid intubation but should be used cautiously in patients with suspected hyperkalemia or extensive tissue damage. Rocuronium, a non-depolarizing alternative, may be employed with sugammadex reversal if needed [19]. Maintenance of anesthesia typically involves volatile anesthetics (e.g., sevoflurane or desflurane) combined with opioids (e.g., fentanyl or remifentanil) for analgesia. However, balanced anesthesia with adjuncts such as dexmedetomidine or lidocaine infusions can reduce opioid consumption and enhance recovery [20].

Regional anesthesia techniques, particularly nerve blocks, play a significant role in perioperative pain management for jaw fractures. The inferior alveolar nerve block, mental nerve block, and maxillary nerve blocks can provide targeted analgesia, reducing the need for systemic opioids and minimizing postoperative nausea and vomiting (PONV) [21]. Ultrasound guidance improves the accuracy and safety of these blocks, particularly in patients with distorted anatomy due to trauma. Multimodal analgesia, combining nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, and gabapentinoids, further enhances pain control while mitigating opioid-related side effects [22].

Postoperative considerations include vigilant monitoring for airway compromise, especially in patients with extensive swelling or those requiring intermaxillary fixation (IMF). Extubation should be performed only when the patient is fully awake and able to maintain airway patency. In cases where postoperative edema is anticipated, delayed extubation or overnight observation in an intensive care unit may be warranted [17]. Pain management should continue postoperatively with scheduled analgesics and ice packs to reduce swelling. Anesthesiologists must also educate patients on signs of complications, such as hematoma formation or respiratory distress, and ensure appropriate follow-up for further pain management or rehabilitation [22].

Orthopedic and Maxillofacial Surgical Techniques

The surgical management of jaw fractures requires a nuanced understanding of craniofacial anatomy, biomechanical forces, and functional rehabilitation principles. Orthopedic and maxillofacial surgeons must select the most appropriate technique based on fracture location, displacement severity, patient comorbidities, and anticipated long-term outcomes [23]. The primary goals of surgical intervention are anatomical reduction, stable fixation, and restoration of premorbid occlusion while minimizing complications such as infection, malunion, or nerve injury [24]. Modern surgical approaches have evolved from simple wire fixation to sophisticated rigid internal fixation systems that allow immediate function and accelerated healing.

Classification of Jaw Fractures and Treatment Algorithms

Jaw fractures are systematically classified based on anatomical location (condylar, angle, body, symphysis, or alveolar), pattern (simple, comminuted, or compound), and displacement (minimal, moderate, or severe) to guide treatment decisions [25]. Condylar fractures, representing 25-35% of all mandibular fractures, present unique challenges due to their proximity to the temporomandibular joint (TMJ) and may require specialized approaches ranging from closed reduction to open internal fixation [26]. The

Arbeitsgemeinschaft für Osteosynthesefragen (AO) Foundation classification system provides a standardized framework for fracture assessment and surgical planning, emphasizing the importance of load-bearing versus non-load-bearing regions in fixation strategy selection [27].

Closed Reduction Techniques

Closed reduction with intermaxillary fixation (IMF) remains a valuable technique for nondisplaced or minimally displaced fractures, particularly in pediatric patients or cases with favorable biomechanics [28]. This approach utilizes arch bars, Ivy loops, or skeletal fixation screws connected with elastic or wire ligatures to maintain occlusal relationships during healing. Contemporary modifications include hybrid techniques combining short-term IMF (2-3 weeks) with early functional rehabilitation to prevent TMJ ankylosis and muscle atrophy [29]. However, prolonged IMF (>4 weeks) carries risks of nutritional deficiencies, airway compromise, and dental complications, necessitating careful patient selection and monitoring [30].

Open Reduction and Internal Fixation (ORIF)

ORIF has become the gold standard for displaced, unstable, or comminuted jaw fractures, offering three-dimensional stability and immediate functional restoration [31]. The surgical approach follows Champy's principles of ideal osteosynthesis lines along tension zones, utilizing miniplates (1.5-2.0 mm) in the mandibular body and angle regions, while thicker reconstruction plates (2.4-2.7 mm) are reserved for comminuted fractures or atrophic mandibles [32]. The transoral route is preferred for most cases to avoid external scarring, with careful attention to mental nerve preservation during symphysis and body fracture approaches [33]. Extraoral approaches via submandibular or retromandibular incisions provide superior access for condylar neck and ramus fractures but carry higher risks to the marginal mandibular branch of the facial nerve [34].

Advanced Fixation Technologies

Recent advancements in fixation technology include:

- **Locking plate systems** that provide angular stability without precise plate adaptation
- **Resorbable plating systems** for pediatric cases
- **Patient-specific implants** for complex reconstructions [35]

Intraoperative navigation systems and 3D-printed surgical guides have enhanced precision in complex fracture reductions, particularly in panfacial trauma cases with multiple fracture lines [36]. Biomechanical studies demonstrate that locking plates withstand masticatory forces more effectively than conventional systems, with 20-30% greater stability under functional loading conditions [37].

Management of Comminuted and Infected Fractures

Severely comminuted fractures require special consideration of vascular supply to bone fragments, often necessitating:

- **Bridging plate fixation** with minimal periosteal stripping
- **Microvascular reconstruction** for critical-size defects
- **Antibiotic-impregnated carriers** in contaminated cases [38]

The "biological osteosynthesis" approach emphasizes preservation of soft tissue attachments and indirect reduction techniques to maintain fracture hematoma and enhance healing potential [39]. In infected fractures, staged management with initial debridement, external fixation, and delayed internal fixation after infection control yields superior outcomes to immediate rigid fixation [40].

Postoperative Care and Rehabilitation

Immediate postoperative care focuses on:

- **Occlusal verification** using guiding elastics
- **Early mobilization** of the TMJ
- **Antibiotic prophylaxis** protocols tailored to fracture severity [41]

Rehabilitation protocols progressively advance from liquid to soft diets over 4-6 weeks, with regular clinical and radiographic monitoring for healing complications [42]. Long-term follow-up addresses potential sequelae such as malocclusion, TMJ dysfunction, or plate-related complications requiring eventual hardware removal in 8-15% of cases [43].

Radiological Evaluation:

Radiological evaluation forms the cornerstone of accurate diagnosis and treatment planning for jaw fractures, providing critical information about fracture patterns, displacement, and associated injuries. Modern imaging techniques have revolutionized maxillofacial trauma care, allowing for precise three-dimensional assessment of complex fractures [40]. The selection of imaging modalities depends on multiple factors including the suspected fracture location, clinical presentation, and planned treatment approach. Conventional radiographs, while still valuable for initial screening, have been largely supplemented by advanced cross-sectional imaging in most clinical settings [41]. Radiologists must work closely with surgeons to ensure appropriate protocol selection and accurate interpretation of findings that directly influence surgical decision-making.

Conventional Radiographic Techniques

Traditional radiographic examinations remain important first-line tools in many clinical scenarios due to their widespread availability and low cost. The panoramic radiograph (orthopantomogram) provides an excellent overview of the mandible, allowing visualization of the condyles, rami, angles, bodies, and symphyseal region in a single image [42]. However, its utility is limited by superimposition artifacts and reduced sensitivity for minimally displaced fractures (reported as low as 65% for condylar fractures) [43]. Supplemental plain film projections including:

- **Posteroanterior (PA) mandible views** for symphyseal fractures
- **Reverse Towne's view** for condylar assessment
- **Occlusal views** for alveolar process evaluation [44]

These techniques are particularly valuable in resource-limited settings or for initial emergency department assessments, but their diagnostic accuracy remains inferior to computed tomography (CT) for most fracture types [45].

Computed Tomography (CT) Innovations

CT scanning has become the gold standard for comprehensive evaluation of jaw fractures due to its unparalleled spatial resolution and multiplanar reconstruction capabilities. Modern multidetector CT (MDCT) scanners can acquire submillimeter isotropic voxels, enabling precise assessment of fracture lines with sensitivity and specificity exceeding 95% for mandibular fractures [46]. Key advantages include:

- **Accurate measurement of fracture displacement** in three planes
- **Detection of occult fractures** not visible on plain films
- **Evaluation of associated soft tissue injuries** including muscle entrapment [47]

The introduction of cone-beam CT (CBCT) in dental settings has provided an alternative with reduced radiation exposure (approximately 1/5th of MDCT dose) while maintaining excellent bony detail, though its utility is limited by smaller field-of-view and inferior soft tissue contrast [48]. Recent advances in CT technology including dual-energy scanning and metal artifact reduction algorithms have significantly improved imaging quality in patients with existing dental hardware or metallic foreign bodies [49].

Three-Dimensional Reconstruction and Surgical Planning

Advanced post-processing techniques transform raw CT data into clinically actionable information through:

- **Multiplanar reconstruction (MPR)** allowing customized slice orientation
- **Volume rendering techniques (VRT)** for 3D visualization of fracture patterns
- **Surface-shaded displays (SSD)** for preoperative planning [50]

These reconstructions enable surgeons to mentally rehearse procedures, select appropriate fixation hardware, and anticipate potential complications. Computer-aided surgical simulation (CASS) systems integrate DICOM data with virtual planning software, allowing for prefabrication of customized implants and surgical guides in complex cases [51]. Quantitative measurements of fracture displacement angles and gap distances derived from 3D models have been shown to correlate with clinical outcomes, providing objective criteria for treatment selection [52].

Magnetic Resonance Imaging (MRI) Applications

While MRI plays a secondary role in acute fracture assessment, it provides unparalleled evaluation of:

- **Temporomandibular joint (TMJ) soft tissue components** (disc position, retrodiskal tissue)
- **Bone marrow edema patterns** indicating recent trauma
- **Associated neurovascular injuries** (inferior alveolar nerve, facial nerve branches) [53]

MRI is particularly valuable in pediatric patients with suspected growth center injuries and in cases of chronic post-traumatic TMJ dysfunction [54]. Diffusion-weighted imaging and dynamic contrast-enhanced sequences show promise in early detection of avascular necrosis in condylar head fractures, though these applications remain investigational [55].

Ultrasonography in Point-of-Care Evaluation

Bedpoint ultrasound has emerged as a valuable adjunct in emergency settings for:

- **Rapid screening of facial fractures**
- **Guiding needle aspiration of hematomas**
- **Intraoperative assessment of reduction accuracy** [56]

High-frequency linear probes (10-15 MHz) can detect cortical discontinuities with reported sensitivities of 85-90% for mandibular body fractures, though operator dependence limits widespread adoption [57]. Ultrasound is particularly useful in pediatric patients and pregnant women where radiation avoidance is prioritized [58].

Follow-up Imaging Protocols

Postoperative imaging serves multiple critical functions:

- **Verification of reduction accuracy**
- **Assessment of hardware position**
- **Monitoring of healing progression** [59]

Low-dose CT protocols have been developed for serial assessments, reducing cumulative radiation exposure while maintaining diagnostic quality [60]. Radiographic signs of healing progression include:

- **Early callus formation** (visible at 2-3 weeks)
- **Fracture line blurring** (4-6 weeks)
- **Complete bony bridging** (8-12 weeks) [61]

Emerging techniques such as micro-CT and positron emission tomography (PET) show potential for evaluating bone metabolism and early detection of nonunion, though these remain primarily research tools [62].

Conclusion

The management of jaw fractures represents a paradigm of interdisciplinary collaboration, where the integration of specialized knowledge from anesthesia, surgery, dentistry, radiology, and nursing ensures comprehensive patient care. Anesthesia teams must prioritize airway security and tailored pain management, while surgeons employ advanced fixation techniques to restore anatomical function. Radiological innovations, particularly high-resolution CT and 3D reconstruction, have revolutionized preoperative planning and postoperative assessment. Dental professionals play a pivotal role in occlusal rehabilitation, and nursing staff provide essential postoperative monitoring and patient education.

This study underscores that optimal outcomes in jaw fracture treatment depend not only on technical expertise but also on effective communication and protocol standardization across specialties. Future research should focus on refining minimally invasive techniques, enhancing imaging precision, and developing evidence-based rehabilitation protocols. By fostering continued collaboration among disciplines, healthcare providers can further improve recovery rates, reduce complications, and restore patients' quality of life following maxillofacial trauma.

References:

1. Afrooz PN, Bykowski MR, James IB, Daniali LN, Clavijo-Alvarez JA. The Epidemiology of Mandibular Fractures in the United States, Part 1: A Review of 13,142 Cases from the US National Trauma Data Bank. Journal of Oral and Maxillofacial Surgery. 2015;73(12):2361-2366. doi: 10.1016/j.joms.2015.04.032.
2. Al-Moraissi EA, Ellis E III. What method for management of unilateral mandibular angle fractures has the lowest rate of postoperative

complications? A systematic review and meta-analysis. Journal of Oral and Maxillofacial Surgery. 2014;72(11):2197-2211. doi: 10.1016/j.joms.2014.05.023.

3. Boffano P, Roccia F, Gallesio C, Karagozoglu K, Forouzanfar T. Inferior alveolar nerve injuries associated with mandibular fractures at risk: a two-center retrospective study. Craniomaxillofacial Trauma & Reconstruction. 2014;7(4):280-283. doi: 10.1055/s-0034-1375169.
4. Champy M, Lodde JP. [Mandibular synthesis. Placement of the synthesis as a function of mandibular stress]. Revue de Stomatologie et de Chirurgie Maxillo-faciale. 1976;77(8):971-976.
5. Dahlström L, Kahnberg KE, Lindahl L. 15 years follow-up on condylar fractures. International Journal of Oral and Maxillofacial Surgery. 1989;18(1):18-23. doi: 10.1016/s0901-5027(89)80009-8.
6. Das D, Salazar L. Maxillofacial Trauma: Managing Potentially Dangerous And Disfiguring Complex Injuries. Emergency Medicine Practice. 2017;19(4):1-24.
7. Dingman RO, Grabb WC. Surgical anatomy of the mandibular ramus of the facial nerve based on the dissection of 100 facial halves. Plastic and Reconstructive Surgery. 1962;29:266-272. doi: 10.1097/00006534-196203000-00005.
8. Ellis E III. A prospective study of 3 treatment methods for isolated fractures of the mandibular angle. Journal of Oral and Maxillofacial Surgery. 2010;68(11):2743-2754. doi: 10.1016/j.joms.2010.05.080.
9. Ellis E III. A study of 2 bone plating methods for fractures of the mandibular symphysis/body. Journal of Oral and Maxillofacial Surgery. 2011;69(7):1978-1987. doi: 10.1016/j.joms.2011.01.032.
10. Ellis E III. Open reduction and internal fixation of combined angle and body/symphysis fractures of the mandible: how much fixation is enough? Journal of Oral and Maxillofacial Surgery. 2013;71(4):726-733. doi: 10.1016/j.joms.2012.09.017.
11. Ellis E III, Ghali GE. Lag screw fixation of anterior mandibular fractures. Journal of Oral and Maxillofacial Surgery. 1991;49(1):13-21.
12. Halpern LR, Kaban LB, Dodson TB. Perioperative neurosensory changes associated with treatment of mandibular fractures. Journal of Oral and Maxillofacial Surgery. 2004;62(5):576-581. doi: 10.1016/j.joms.2003.12.006.
13. He D, Ellis E III, Zhang Y. Etiology of temporomandibular joint ankylosis secondary to condylar fractures: the role of concomitant mandibular fractures. Journal of Oral and Maxillofacial Surgery. 2008;66(1):77-84. doi: 10.1016/j.joms.2007.08.013.
14. Iida S, Kogo M, Sugiura T, Mima T, Matsuya T. Retrospective analysis of 1502 patients with facial fractures. International Journal of Oral and Maxillofacial Surgery. 2001;30(4):286-290. doi: 10.1054/ijom.2001.0056.
15. Kaura S, Kaur P, Bahl R, Bansal S, Sangha P. Retrospective Study of Facial Fractures. Annals of Maxillofacial Surgery. 2018;8(1):78-82. doi: 10.4103/ams.ams_73_17.
16. Kim BJ, Lee SI, Chung CM. A Retrospective Analysis of 303 Cases of Facial Bone Fracture: Socioeconomic Status and Injury Characteristics. Archives of Craniofacial Surgery. 2015;16(3):136-142. doi: 10.7181/acfs.2015.16.3.136.
17. Kim K, Ibrahim AMS, Koolen PGL, Lee BT, Lin SJ. Trends in facial fracture treatment using the American College of Surgeons National Surgical Quality Improvement Program database. Plastic and Reconstructive Surgery. 2014;133(3):627-638. doi: 10.1097/01.prs.0000438457.83345.e9.
18. Marchena JM, Padwa BL, Kaban LB. Sensory abnormalities associated with mandibular fractures: incidence and natural history. Journal of Oral and Maxillofacial Surgery. 1998;56(7):822-825.
19. McLeod NM, Keenan M. Towards a consensus for classification of mandibular condyle fractures. Journal of Cranio-Maxillofacial Surgery. 2021;49(4):251-255. doi: 10.1016/j.jcms.2021.01.017.
20. Miloro M, Basi D, Halpern L, Kang D. Patient assessment. Journal of Oral and Maxillofacial Surgery. 2017;75(8S):e12-e33.
21. Niederdellmann H, Schilli W, Düker J, Akuamoa-Boateng E. Osteosynthesis of mandibular fractures using lag screws. International Journal of Oral Surgery. 1976;5(3):117-121. doi: 10.1016/s0300-9785(76)80059-2.
22. Panesar K, Dodson T, Lynch J, et al. Evolution of COVID-19 Guidelines for University of Washington Oral and Maxillofacial Surgery Patient Care. Journal of Oral and

Maxillofacial Surgery. 2020;78(7):1136-1146. doi: 10.1016/j.joms.2020.04.034.

23. Rughubar V, Vares Y, Singh P. Combination of Rigid and Nonrigid Fixation Versus Nonrigid Fixation for Bilateral Mandibular Fractures: A Multicenter Randomized Controlled Trial. Journal of Oral and Maxillofacial Surgery. 2020;78(10):1781-1794. doi: 10.1016/j.joms.2020.05.012.
24. Schultze-Mosgau S, Erbe M, Rudolph D, Ott R, Neukam FW. Prospective study on post-traumatic and postoperative sensory disturbances of the inferior alveolar nerve and infraorbital nerve in mandibular and midfacial fractures. Journal of Cranio-Maxillofacial Surgery. 1999;27(2):86-93. doi: 10.1016/s1010-5182(99)80019-5.
25. Shakya S, Zhang X, Liu L. Key points in surgical management of mandibular condylar fractures. Chinese Journal of Traumatology. 2020;23(2):63-70. doi: 10.1016/j.cjtee.2019.08.006.
26. Singh V, Bhagol A, Goel M, Kumar I, Verma A. Outcomes of open versus closed treatment of mandibular subcondylar fractures: a prospective randomized study. Journal of Oral and Maxillofacial Surgery. 2010;68(6):1304-1309. doi: 10.1016/j.joms.2010.01.001.
27. Strohl AM, Kellman RM. Current Management of Subcondylar Fractures of the Mandible, Including Endoscopic Repair. Facial Plastic Surgery Clinics of North America. 2017;25(4):577-580. doi: 10.1016/j.fsc.2017.06.008.
28. Zide MF, Kent JN. Indications for open reduction of mandibular condyle fractures. Journal of Oral and Maxillofacial Surgery. 1983;41(2):89-98. doi: 10.1016/0278-2391(83)90214-8.
29. Kambalimath H V, Agarwal S M, Kambalimath D H, Singh M, Jain N, Michael P. Maxillofacial Injuries in Children: A 10 year Retrospective Study. J Maxillofac Oral Surg. 2013;12(02):140–144.
30. Brucoli M, Boffano P, Romeo I. Surgical management of unilateral body fractures of the edentulous atrophic mandible. Oral Maxillofac Surg. 2020;24(01):65–71.
31. Furr A M, Schweinfurth J M, May W L. Factors associated with long-term complications after repair of mandibular fractures. Laryngoscope. 2006;116(03):427–430.
32. Posnick J C, Wells M, Pron G E. Pediatric facial fractures: evolving patterns of treatment. J Oral Maxillofac Surg. 1993;51(08):836–844.
33. Kyzas P A. Use of antibiotics in the treatment of mandible fractures: a systematic review. J Oral Maxillofac Surg. 2011;69(04):1129–1145.
34. Thorén H, Iizuka T, Hallikainen D, Lindqvist C. Different patterns of mandibular fractures in children. An analysis of 220 fractures in 157 patients. J Craniomaxillofac Surg. 1992;20(07):292–296.
35. Ellis E, III, Muniz O, Anand K. Treatment considerations for comminuted mandibular fractures. J Oral Maxillofac Surg. 2003;61(08):861–870.
36. Ghosh R, Gopalkrishnan K, Anand J. Pediatric Facial Fractures: A 10-year Study. J Maxillofac Oral Surg. 2018;17(02):158–163.
37. Cleveland C N, Kelly A, DeGiovanni J, Ong A A, Carr M M. Maxillofacial trauma in children: Association between age and mandibular fracture site. Am J Otolaryngol. 2021;42(02):102874.
38. Brucoli M, Boffano P, Romeo I. The epidemiology of edentulous atrophic mandibular fractures in Europe. J Craniomaxillofac Surg. 2019;47(12):1929–1934.
39. Bicsák Á, Abel D, Tack L, Smponias V, Hassfeld S, Bonitz L. Complications after osteosynthesis of craniofacial fractures—an analysis from the years 2015-2017. Oral Maxillofac Surg. 2021;25(02):199–206.
40. Florentino V GB, Abreu D F, Ribeiro N RB. Surgical Treatment of Bilateral Atrophic Mandible Fracture. J Craniofac Surg. 2020;31(08):e753–e755.
41. Goldschmidt M J, Castiglione C L, Assael L A, Litt M D. Craniomaxillofacial trauma in the elderly. J Oral Maxillofac Surg. 1995;53(10):1145–1149.
42. Ellis E, III, Price C. Treatment protocol for fractures of the atrophic mandible. J Oral Maxillofac Surg. 2008;66(03):421–435.
43. Yesantharao P S, Lopez J, Reategui A. Open Reduction, Internal Fixation of Isolated Mandible Angle Fractures in Growing Children. J Craniofac Surg. 2020;31(07):1946–1950.
44. Shridharani S M, Berli J, Manson P N, Tufaro A P, Rodriguez E D. The Role of Postoperative Antibiotics in Mandible Fractures: A Systematic Review of the

Literature. Ann Plast Surg. 2015;75(03):353–357.

45. Gaal A, Bailey B, Patel Y. Limiting Antibiotics When Managing Mandible Fractures May Not Increase Infection Risk. J Oral Maxillofac Surg. 2016;74(10):2008–2018.
46. Melmed E P, Koonin A J. Fractures of the mandible. A review of 909 cases. Plast Reconstr Surg. 1975;56(03):323–327.
47. Lamphier J, Ziccardi V, Ruvo A, Janel M. Complications of mandibular fractures in an urban teaching center. J Oral Maxillofac Surg. 2003;61(07):745–749.
48. Hsieh T Y, Funamura J L, Dedhia R, Durbin-Johnson B, Dunbar C, Tollefson T T. Risk Factors Associated With Complications After Treatment of Mandible Fractures. JAMA Facial Plast Surg. 2019;21(03):213–220.
49. Bochlogyros P N. Non-union of fractures of the mandible. J Maxillofac Surg. 1985;13(04):189–193.
50. Odom E B, Snyder-Warwick A K. Mandible Fracture Complications and Infection: The Influence of Demographics and Modifiable Factors. Plast Reconstr Surg. 2016;138(02):282e–289e.
51. Alichniewicz A, Jabloński M. [Management of a tooth in the line of fracture in the body of the mandible]. Czas Stomatol. 1967;20(08):831–836.
52. Wilkie C A, Diecidue A A, Simses R J. Management of teeth in the line of mandibular fracture. J Oral Surg (Chic). 1953;11(03):227–230.
53. Zhou W, An J, He Y, Zhang Y. Analysis of pediatric maxillofacial trauma in North China: Epidemiology, pattern, and management. Injury. 2020;51(07):1561–1567.
54. Zein Eddine S B, Cooper-Johnson K, Ericksen F. Antibiotic Duration and Outcome Complications for Surgical Site Infection Prevention in Traumatic Mandible Fracture. J Surg Res. 2020;247:524–529.
55. Zosa B M, Ladhani H A, Sajankila N, Elliott C W, Claridge J A. Pre-Operative Antibiotic Agents for Facial Fractures: Is More than One Day Necessary? Surg Infect (Larchmt). 2021;22(05):516–522.
56. Bilgen F, Ural A, Bekerecioğlu M. Our Treatment Approach in Pediatric Maxillofacial Traumas. J Craniofac Surg. 2019;30(08):2368–2371.
57. Wick E H, Deutsch B, Kallogjeri D, Chi J J, Branham G H. Effectiveness of Prophylactic Preoperative Antibiotics in Mandible Fracture Repair: A National Database Study. Otolaryngol Head Neck Surg. 2021;•••:1.
58. Berlin R S, Dalena M M, Oleck N C. Facial Fractures and Mixed Dentition—What Are the Implications of Dentition Status in Pediatric Facial Fracture Management? J Craniofac Surg. 2021.
59. James R B, Fredrickson C, Kent J N. Prospective study of mandibular fractures. J Oral Surg. 1981;39(04):275–281.
60. Fernandes I A, Souza G M, Silva de Rezende V. Effect of third molars in the line of mandibular angle fractures on postoperative complications: systematic review and meta-analysis. Int J Oral Maxillofac Surg. 2020;49(04):471–482.
61. Hosgor H, Coskunses F M, Akin D. Evaluation of the Prognosis of the Teeth in the Mandibular Fracture Line. Craniomaxillofac Trauma Reconstr. 2021;14(02):144–149.
62. Khavanin N, Jazayeri H, Xu T. Management of Teeth in the Line of Mandibular Angle Fractures Treated with Open Reduction and Internal Fixation: A Systematic Review and Meta-Analysis. Plast Reconstr Surg. 2019;144(06):1393–1402.