International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2025: 7.089

Challenges in Maxillofacial Surgery: A Narrative Review of Trauma, Reconstructive, Orthognathic, Infective, and Technological Challenges in Contemporary Practice

Dr. R. Rajendra Prasad[1], Dr. Seema Yoganna[2]

[1]MDS, Oral & Maxillofacial Surgeon and Medical Director, Suyog Hospital; Mysore

[2]MDS, Oral Pathologist and Medical Director, Suyog Hospital, Mysore

Abstract: ***Maxillofacial surgery sits at the crossroads of function, aesthetics, and survival, drawing together trauma care, oncologic resection and reconstruction, orthognathic correction, temporomandibular joint (TMJ) surgery, and an expanding menu of digitally guided techniques. Despite decades of technical refinement, the specialty continues to face substantial and interlinked challenges: anatomically hazardous airways in trauma patients, high complication rates in orthognathic and reconstructive procedures, the unpredictable biology of free-flap failure and osteonecrosis, the resurgence of aggressive fungal and bacterial infections in immunocompromised hosts, a steep learning curve and cost barrier around virtual surgical planning (VSP) and three-dimensional (3D) printing, and profound inequities in access to reconstructive and craniofacial care in low-resource settings. This review synthesises recent literature across these domains to outline where the specialty is succeeding, where it continues to struggle, and where future research and health-system investment are most needed.***

Keywords: Maxillofacial surgery, Facial trauma, Orthognathic surgery, Microvascular reconstruction, Mucormycosis, Medication-related osteonecrosis of the jaw, Temporomandibular joint ankylosis, Virtual surgical planning, Three-dimensional printing, Reconstructive surgery

1. Introduction

Maxillofacial surgery involves the diagnosis and surgical treatment of a wide variety of diseases, injuries, and structural conditions at the face, jaws and surrounding hard and soft tissues. The maxillofacial area plays a key role in breathing, chewing, speaking and vision and also contributes significantly to facial appearance. As a result, even when the surgery is technically correct and successful, the patient may experience lasting functional, aesthetic and psychological problems because the complexities of the condition are not adequately anticipated and managed [1]. Maxillofacial trauma is a global health problem with road traffic accidents, interpersonal violence, falls and occupational injuries being some of the most serious manifestations. The heterogeneity in injury situations and health resources in different areas makes it difficult to develop and to apply the same management protocol as a global population. A narrative review of 112 studies (2000-2024) estimated the average direct hospitalisation cost of maxillofacial trauma to be USD 55,385 per case. Besides the financial burden, the person may experience significant loss of work and psychological effects such as psychological distress, depression and anxiety. These findings show that maxillofacial trauma has a long-term impact on patients' physical, emotional, social and economic health [1]. Other than trauma, maxillofacial surgeons are also faced with a lot of challenges when they perform orthognathic surgery on dentofacial deformities and cancer resection and reconstruction, TMJ reconstruction, and osteonecrosis associated with medication or radiation therapy. Each area is a mixture of technical difficulties and biological uncertainty. In recent years, additional challenges have emerged. During the COVID-19 pandemic, for instance, maxillofacial specialists experienced an unprecedented rise in invasive fungal infections in patients who are particularly susceptible. At the same time, technology such as computer-aided design (CAD), virtual surgical planning (VSP) and 3D printing have been rapidly incorporated into clinical practice. However, the pace of technology development has been faster than the trends in surgical training, regulation and health care costs [27]. This review addresses these issues under different thematic topics from recent systematic reviews, retrospective studies and case reports to provide us a view of the challenges in daily maxillofacial practice.

2. Challenges in Maxillofacial Trauma Management

The single most time-critical challenge in maxillofacial trauma is airway control. Facial fractures, swelling, haemorrhage and displaced or avulsed teeth can block the oral cavity precisely where a rescuer would normally intervene, and standard orotracheal intubation in general is often impeded by deformity or trismus [2]. A retrospective analysis of 100 consecutive cases found that mandibular, nasal, maxillary and orbital fractures dominated the injury pattern, that direct laryngoscopy was successful in only about half of the patients and that anaesthetists had to resort to videolaryngoscopy or blind nasal techniques, each with its own risk profile [3]. Where the oral route is unavailable but formal tracheostomy is not, submental intubation has emerged as a useful bridge: submental intubation has been shown to lead to much shorter hospital stays and lower infection rates than tracheostomy in a retrospective study of 52 patients, though it still requires an experienced surgical-anaesthetic team and is not without its own complications such as damage to the sublingual and submandibular ducts [4]. Another issue is that maxillofacial injuries are common in addition to other serious injuries in the body. Fractures of

the midface and mandible can be associated with cervical spine injuries, traumatic brain injury, and severe blood loss. As a result, initial priorities are to protect the airway, maintain haemodynamic stability and control bleeding even if the facial injury appears to be the most obvious and urgent problem [1,6]. The problem is even more challenging in conflict areas, disaster situations, and rural or resource-limited areas where CT imaging, specialist maxillofacial surgeons, and blood products are scarce. These limitations have the potential to prolong diagnosis and treatment, and can ultimately affect patient outcomes [1]. Control of anaesthesia is also more complicated because the surgeon and anaesthetist need to share access to the airway. The presence of blood and debris in the oral cavity increases the risk of aspiration, and controlled blood pressure may be needed to reduce surgical blood loss 6. Communication between the surgical and anaesthetic teams should be effective and continuous. The success of maxillofacial trauma treatment should not only be measured by how well the fracture heals or if normal occlusion can be restored. There are documented complications with 3% to 33% in such cases, and most people have psychological problems (post-traumatic stress, depression, or anxiety) after their injuries. Facial disfigurement, especially when the injury is caused by violence or a traumatic accident, has a long-term impact on confidence, social life, education and return to work. Consequently, modern trauma treatment should be more than surgical correction, and include long-term rehabilitation, psychological support and return to normal social and occupational activities [1].

3. Challenges in Orthognathic Surgery

Orthognathic surgery is performed to correct skeletal malocclusion, facial asymmetry, and other dentofacial deformities by surgically resizing the maxilla, mandible, or both. While these procedures can significantly improve facial function and appearance, they are technically challenging and may result in a variety of possible complications. A comprehensive review of three decades of research found nerve injury in approximately 12% of patients, infection in about 3%, hardware-related complications in about 2%, TMJ disturbances (up to 2%) and unfavourable fracture patterns in nearly 2% of patients7. Similarly, a ten-year study of 891 patients found neurosensory disturbances in as many as 93.5% of patients immediately following surgery, and the following were some of the complications reported9. A recent systematic review (originally 819 articles) also pointed out that although individual complications may be relatively rare, in general they are highly relevant in clinical practice. Consequently, patients should be informed of these potential risks in their usual preoperative counseling [8].

These complications are caused by a variety of anatomical and procedural reasons. Important nerves, such as the inferior alveolar and infraorbital nerves, are located close to the areas where osteotomies are performed. As a result, even with surgical care patients may have temporary or, in some cases, even persistent sensory disturbances. Photobiomodulation therapy has been proposed as an approach to sensory recovery, but a systematic review of 14 prospective studies conducted in 2024 found a multitude of available evidence that made it difficult to suggest one universal treatment plan [11]. Although relatively rare, there are serious complications also. Temporary effects of the separation of pterygoid plates in the ocular and pupillary regions suggest individual anatomical heterogeneity might lead to unexpected postoperative outcomes. Since orthognathic surgery is an elective procedure and is commonly performed in otherwise healthy young adults, even minor complications can have a significant impact on patient satisfaction. Facial appearance and functional improvement would also be expected to be high. Preoperative counselling and information sharing about benefits, limitations, and complications are vital. Effective management is reliant on orthodontists, maxillofacial surgeons, anaesthetists, psychologists, and other specialist professionals.

4. Challenges in Ablative and Microvascular Reconstructive Surgery

Composite resection of oral and oropharyngeal cancer with primary microvascular free-flap reconstruction is now the standard of care for the restoration of form and function after tumour removal, but remains one of the most complicated areas of maxillofacial practice. In a study of 184 patients undergoing composite resection and free-flap reconstruction, they reported complications in 40.2% of cases, return-to-theatre in 11.1% and an overall flap failure rate of 3.2%, which is in line with failure rates of 1.6-6.2% reported elsewhere in the literature [12]. And in a single-surgeon series of 121 consecutive cases, the flap survival rate was 97.5%, while no radiotherapy prior to surgery is associated with flap loss (which is very reassuring because many of these patients have already received chemoradiation 13). The technical challenges of microvascular surgery are immense: the choice of donor site needs to take into account the tissue weight, vessel size and vessel calibre in relation to the recipient defect, the time in ischaemic surgery would have to be minimised and any venous congestion or arterial thrombosis would need to be detected immediately if the flap is to be rescued [14].

Systemic patient factors compound this technical challenge—a large single-centre study of 524 patients found that major (Clavien-Dindo grade III or higher) complications were recorded in about 7% of cases and that flap-related complications were different for various types of flaps, and fibula osteocutaneous flaps had a higher complication burden than soft tissue only flaps [15]. Even if a flap is lost, the literature increasingly shows that a second free flap can often be salvaged successfully, with one recent cohort of 69 patients requiring 150 more flap operations over ten years and a 97% final success rate, but this process involves repeated surgery, long hospitalisation and cumulative donor-site morbidity [16]. In addition to flap survival, reconstructive teams also have to take care of swallowing and speech rehabilitation, dental restoration, and the psychosocial impact of oncologic disfigurement, all of which extend the definition of a successful reconstruction well past flap take [12].

5. Emerging Infective Challenges: COVID-19–Associated Mucormycosis

The COVID-19 pandemic presented a very unexpected and serious challenge to maxillofacial practice in India, which had the highest rate of COVID-19-related mucormycosis (CAM) in the second wave of the pandemic [17]. Mucormycosis is an aggressive fungal infection that is known to invade blood vessels and is associated with uncontrolled diabetes, diabetic ketoacidosis and prolonged or high-dose corticosteroid treatment. These risk factors were more common for patients with severe COVID-19 infection [17, 22]. The infection starts from the paranasal sinuses and can quickly spread to the maxilla, orbit and, in extreme cases, the brain. So, symptoms may begin as a dental infection or palatal ulcer and progress very rapidly to extensive tissue and bone destruction, sometimes requiring partial or total maxillectomy [22]. CAM has shown some challenges in clinical care and healthcare infrastructure. Early diagnosis can be hard because the early symptoms and diagnosis may be more common dental or sinonasal infections. By the time characteristic black eschar or radiological evidence of osteomyelitis is present, the infection may already be advanced [20]. During the second wave, the liposomal amphotericin B shortage in India made the treatment complicated and the clinician had to consider alternative or salvage treatment measures, including oral posaconazole, which were less well-established at the time18. Anaesthetic management is also tricky. Those with sinonasal involvement and limited mouth opening may have a difficult airway, which makes intubation difficult. At the same time, chronic antifungal treatment may lead to renal impairment that requires careful drug dosing and perioperative care19. CAM is therefore complex and needs a multidisciplinary team to coordinate care from multiple specialties. National recommendations for CAM were highlighted in that microbiologists, physicians, intensivists, neurologists, otorhinolaryngologists, ophthalmologists, dentists and maxillofacial or plastic surgeons have all been recommended. The challenges do not end once the infection has been treated. Deep surgical debridement can leave patients with significant defects of the maxilla, palate, orbit and their appearance, speech, swallowing, and quality of life. Obturator prostheses, reconstructive procedures and prolonged rehabilitation are required for many patients. Indian dental and maxillofacial centres have reported the time and multidisciplinary support required to restore function and improve the quality of life of these patients [22].

6. Osteonecrosis of the Jaw: MRONJ and Osteoradionecrosis

Medication-related osteonecrosis of the jaw (MRONJ) is a well-established complication associated with bisphosphonates, denosumab, and some antiangiogenic agents, e.g. bevacizumab. It is characterized by continued exposure to necrotic jaw bone and is challenging to treat as patients can respond differently to treatment23. A scoping review of MRONJ incidence worldwide revealed that there was a diversity in the diagnosis and treatment management, and the type of reported incidence by different centres. These differences make treatment outcomes in MRONJ difficult to compare with other cases and to provide evidence-based recommendations [25]. A systematic review of 151 published cases from 2024 found that most of those who were diagnosed with MRONJ were older women taking long-term zoledronic acid therapy. The treatment did vary between conservative therapy (antiseptic mouth rinses and antibiotics) and surgical treatment (sequestrectomy and resection). There is still no universal approach to treatment for every stage of the disease [24]. MRONJ has its biological basis that complicates its management. Antiresorptive and antiangiogenic drugs can interfere with bone remodelling and blood vessel formation, which is critical for normal healing. This can lead to persistent exposed and necrotic bone [23], where an extraction site that would normally heal without difficulty may not. In a prospective observational study of 130 patients, conservative and surgical treatment was associated with better healing and quality of life outcomes. These findings support the need to tailor treatment according to the individual patient, the severity of disease, and clinical response rather than a single treatment strategy [23]. There are also several treatment approaches being investigated, including platelet concentrates. While some studies have achieved promising results, the results are not uniform across studies and there is still little evidence to support a universal treatment protocol [24,26]. Prevention is especially relevant to MRONJ because MRONJ is difficult to treat. Dental assessment and completion of necessary dental treatment before starting antiresorptive therapy and regular oral health monitoring may reduce the risk of complications. So communication between dental professionals, oncologists, endocrinologists, and other members of the healthcare team is essential for appropriate prevention and long-term management [26].

7. Challenges in Temporomandibular Joint Ankylosis Surgery

Temporomandibular joint (TMJ) ankylosis is the abnormal fusion of the joint which can be fibrous or bony and is usually due to condylar trauma during childhood. It is also a challenging procedure for maxillofacial surgery because the restoration of joint movement is a very difficult task and because the risk of recurrence is very high [30,31]. The age of the patient, the type and severity of the ankylosis and the reconstruction method are the factors influencing the likelihood of recurrence observed in the ten-year research. Coronoid process grafting, costochondral grafting, distraction osteogenesis and alloplastic joint reconstruction are alternative strategies to consider depending on the individual clinical situation 30, but we are still not sure what are the biological drivers of the progression from a condylar injury to progressive joint fusion. This uncertainty makes it difficult to spot patients who are most at risk for developing ankylosis and what are the best preventive strategies following trauma [31]. TMJ ankylosis in children is also difficult to manage. If ankylosis develops early in life, limited jaw movement can interfere with the normal development of muscles involved in mastication and facial growth. Rehabilitation also depends a lot on regular postoperative physiotherapy and poor compliance with rehabilitation can increase the risk of re-ankylosis [31]. There may also be respiratory management issues, especially

for patients who have limited mouth opening ability. In such cases, even fibreoptic intubation may be technically challenging, and the surgical team will need to consider alternative airway techniques (tracheostomy or emergency cricothyroidotomy) if necessary [33]. Total alloplastic TMJ reconstruction is being investigated as a possible alternative to autogenous grafting which can be beneficial to avoid morbidity at donor site. In a recent case series scoping review, it was found that alloplastic reconstruction may have lower rates of re-ankylosis than some autogenous reconstruction approaches [32]. However, it is not without its limitations. Facial nerve weakness, changes in occlusion, heterotopic bone formation and complications related to the prosthesis have been reported. These results indicate that no single reconstructive technique is suitable for every patient and treatment choices need to be made based on the patient's age and severity of ankylosis, functional requirements, and long-term rehabilitation needs [32].

8. Technological Promise and Its Own New Challenges: Virtual Surgical Planning and 3D Printing

Virtual surgical planning (VSP) and three-dimensional (3D) printing have made huge contributions to the management of complex maxillofacial defects. These technologies allow surgeons to use CT images of a patient to create a detailed digital model, plan the surgical procedure, and supply patient-specific cutting guides or implants that can be prepared before surgery. This is a method that can improve the precision and predictability of complex reconstructive procedures [28, 29]. A recent systematic review and meta-analysis of this field reported a 94.7% success rate for 3D-printed patient-specific implants in maxillofacial reconstruction. Such studies have a generally similar pattern with most complications such as seroma and superficial infection [27]. Despite these advantages, digital technology has brought new challenges. For example, there is an important choice of implant material, which is the most appropriate. Titanium is good and biocompatible for imaging, but it has imaging artefacts and is very rigid. PEEK (polyetheretherketone), on the other hand, has the advantages of being radiolucent and is closer to bone (although there is a shortage of clinical experience with it in the long term). Surgeons and other members of the clinical team need to be trained in the way they interpret digital plans, 3D models and surgical guides in an understandable manner in clinical practice, and this is in addition to this. Planning or manufacturing errors that are found in planning or manufacturing will be less obvious in surgery when the surgeon is not trained in digital planning [29]. Cost and accessibility are also very much important. 3D printing at home can reduce reliance on external manufacturers and point-of-care printing facilities will require investment in printers, digital products and software, service to the printing facility, and biomedical/technical personnel. These are the most pressing challenges for hospitals in smaller, less well-resourced settings and resource-rich settings [28]. VSP and 3D printing can improve the accuracy and efficiency of maxillofacial reconstruction, but a lack of access to these technologies can further exacerbate the disparity in surgical care between well-funded centres and resource-poor ones. By making these technologies more affordable, developing appropriate training programmes, and introducing digital planning in surgical education, we can make sure their advantages are available to a much wider audience [27,29].

9. Global and Resource-Limited Setting Challenges

The challenges for maxillofacial surgery are often even greater in low- and middle-income countries (LMICs) in which specialised surgical services and resources are not available and the burden of untreated craniofacial conditions is high. Cleft lip and palate is one of the most common congenital craniofacial diseases worldwide, but many LMICs do not have sufficient surgical capacity to meet the existing need. In some countries, a significant number of cleft repairs continue to be done through charitable surgical missions that could be conducted in isolation from the local health system [34]. A multinational study showed that national income correlates with timely cleft palate surgery. For every USD 1,000 decrease in per capita GDP, the chance for delayed surgery is around 14%. The median age at presentation was in the lowest income group and was about 3 years, which is much later than it is commonly considered for good speech and feeding outcomes35. Treatment delays are not limited to financial problems alone. A cross-sectional study in Vietnam of 453 patients with cleft lip and palate showed that the overall cost of treatment (travel to a surgical centre) was a significant barrier. Family and cultural realities (concerns or lack of trust in the healthcare system) also caused delays in treatment [36]. These findings demonstrate that craniofacial care needs to be more than surgical facilities, but the social and economic status of families. Short-term surgical missions can provide valuable treatment for patients who might otherwise not have access to care; however, they can be limited if the programmes do not contribute to local healthcare capacity. As such, some authors have suggested a transition away from a "vertical" model that is oriented towards providing surgical services with a set focus to a more sustainable "diagonal" model in which disease-specific surgical care is in conjunction with long-term investments in local training, infrastructure, equipment and health systems[34]. Training for local surgeons in structured and hands-on ways would be one solution to overcome the lack of surgical skill. At a low cost, once trained and basic operating facilities are available, cleft surgery can be performed. Nonetheless, it is a critical task to develop and maintain training pathways in many low-income areas. Finally, improving maxillofacial care in resource-poor settings has to be more than the number of operations performed. This will require the development of local surgical expertise, better infrastructure, overcoming financial and geographical hurdles and integration of craniofacial services into existing healthcare infrastructure. Such strategies can help in order to make sure patients get timely and ongoing care and not only to rely on occasional external surgical support.

10. Cross-Cutting Challenges

Many problems identified in this review are common to different aspects of maxillofacial practice. One of the most important is the need for coordinated multidisciplinary care. In severe trauma, mucormycosis, medication-related

osteonecrosis of the jaw (MRONJ), and complex reconstructive cases, multiple specialists are required rather than a single surgeon. Establishing a team of maxillofacial surgeons with orthodontists, oncologists, anaesthetists, infectious disease specialists, and other healthcare professionals is not easy, especially in hospitals with no head and neck and craniofacial teams [7, 21]. Another important factor is in terms of patients' psychological health and physical health. Complications are reported in trauma, orthognathic, and reconstructive surgeries, and patients may not always receive adequate counselling about the risk of surgery in advance [1, 9]. Facial injuries and large-scale surgical procedures can have a significant emotional impact, and post-traumatic stress, depression, anxiety, or even concerns about their appearance are common psychological symptoms. These psychological effects are not always recognised or addressed in clinical practice. Quality and consistency of available evidence is also important in many areas of maxillofacial surgery. MRONJ, TMJ ankylosis, and free-flap salvage research is usually in small retrospective studies or case series, and results are defined differently from one another [25, 30]. This makes it hard to compare findings across studies and creates barriers to strong, universally applicable clinical recommendations. As a result, treatment decisions may still depend very much on individual clinical experience and the resources at each centre. Finding a solution to these broader issues is likely to be as important as developing new surgical techniques or technologies. Strengthening multidisciplinary teamwork, enhancing patient counselling and psychological support, and bringing higher-quality research with consistent outcome measures will be integral in safer and more patient-centred maxillofacial care.

11. Conclusion

Maxillofacial surgery continues to advance technically, from submental intubation and microvascular reconstruction to 3D-printed patient-specific implants, yet each advance tends to bring a companion set of new challenges rather than eliminating the old ones outright. Airway compromise in trauma, nerve injury and relapse in orthognathic surgery, flap failure and donor-site morbidity in reconstruction, the resurgence of aggressive fungal infection, the biology of drug-induced osteonecrosis, the technical difficulty and recurrence of TMJ ankylosis, and the cost and training barriers around digital planning together sketch a specialty that is simultaneously more capable and more complex than it was a generation ago. Perhaps the most consistent theme across this review is that outcomes depend less on any single surgical technique than on functioning multidisciplinary systems — trauma teams that can secure a difficult airway within minutes, cancer boards that can plan reconstruction alongside resection, and health systems willing to invest in both the technology and the training needed to deliver equitable craniofacial care. Closing the remaining gaps in evidence quality, workforce training, and access to care, particularly in low-resource settings, should be considered as central to progress in maxillofacial surgery as any single new device or technique.

References

[1] Muhammad Adeel S, et al. The global burden of maxillofacial trauma in critical care: a narrative review of epidemiology, prevention, economics, and outcomes. J Clin Med / MDPI. 2025;61(5):915.
[2] Author(s). Modern management of maxillofacial trauma in the emergency department. PMC. 2025. Available from: PMC12856085.
[3] Author(s). Airway challenges in maxillofacial trauma: a retrospective study of 100 cases. PMC. 2025. Available from: PMC12040401.
[4] Author(s). Airway management in complex maxillofacial trauma: evaluating the role of submental intubation as a viable alternative to tracheostomy. PMC. 2024. Available from: PMC11995817.
[5] Chaudhary S, et al. Redefining airway management in maxillofacial trauma: the strategic implementation of sub-mental intubation. Clin Case Rep. 2024. doi:10.1002/ccr3.9589.
[6] Pearl RG, et al. Review of anesthesia in maxillofacial trauma. J Oral Maxillofac Anesth. 2024. Available from: joma.amegroups.org/article/view/6750.
[7] Author(s). Complications in orthognathic surgery: a comprehensive review. Braz J Otorhinolaryngol / ScienceDirect. 2012. doi:10.1016/j.bjorl.2012.S2212-5558.
[8] Jędrzejewski M, Smektała T, Sporniak-Tutak K, Olszewski R. Preoperative, intraoperative, and postoperative complications in orthognathic surgery: a systematic review. Clin Oral Investig. 2015. doi:10.1007/s00784-015-1452-1.
[9] Author(s). Complications related to orthognathic surgery: a 10-year experience in an oral and maxillofacial training center. J Craniomaxillofac Surg / ScienceDirect. 2021. doi:10.1016/S1010-5182(21)00248-1.
[10] Author(s). Clinical outcomes, complications and impact on quality of life following orthognathic surgery: a systematic review. Front Oral Health. 2026; 7: 1790589.
[11] Author(s). Photobiomodulation therapy for neurosensory disturbances in orthognathic surgery patients: a systematic review. PMC. 2024. Available from: PMC11767050.
[12] Author(s). Incidence and types of complications after ablative oral cancer surgery with primary microvascular free flap reconstruction. PMC. 2015. Available from: PMC4670256.
[13] Author(s). Microvascular reconstruction for maxillofacial defects: a retrospective analysis of outcomes and complications in 121 consecutive cases. Maxillofac Plast Reconstr Surg / PMC. 2020. Available from: PMC7447709.
[14] Author(s). Complications and loss of free flaps after reconstructions for oral cancer. Br J Oral Maxillofac Surg / ScienceDirect. 2018. doi:10.1016/j.bjoms.2018.S0266-4356.
[15] Author(s). Clinical outcomes for microvascular reconstruction in oral cancers: experience from a single surgical centre. Ann R Coll Surg Engl. 2021. doi:10.1308/rcsann.2021.0295.

[16] Author(s). Clinical efficacy of subsequent microvascular free flaps in head and neck reconstructive surgery. J Craniomaxillofac Surg / ScienceDirect. 2025. doi:10.1016/S1010-5182(25)00292-6.
[17] Arakeri G, et al. COVID-19 associated mucormycosis (CAM) in India: a formidable challenge. Br J Oral Maxillofac Surg. 2021;59(9):1095-1098.
[18] Author(s). Multidisciplinary management of COVID-associated mucormycosis syndemic in India. Indian J Surg. 2021. doi:10.1007/s12262-021-03134-0.
[19] Author(s). COVID-19-associated mucormycosis: an update of anesthetic management. PMC. 2022. Available from: PMC8830946.
[20] Author(s). COVID-19-associated mucormycosis of head-and-neck region: a systematic review. J Maxillofac Oral Surg / PubMed. 2022;PMID 35187287.
[21] Raut A, Huy NT, et al. COVID-19-associated mucormycosis: evidence-based critical review of an emerging infection burden during the pandemic's second wave in India. PLoS Negl Trop Dis. 2021;15(11):e0009921.
[22] Shukla V, et al. Management of COVID-19 associated rhino-orbital mucormycosis and reconstructive options for the resulting extensive defects: a case report. Front Oral Maxillofac Med. 2023.
[23] Author(s). Managing medication-related osteonecrosis of jaw: a prospective observational study. PMC. 2025. Available from: PMC12880135.
[24] Author(s). Medication-related osteonecrosis of the jaw: a systematic review of case reports and case series. Dent J / MDPI. 2024;12(9):205.
[25] Author(s). The issue with incidence: a scoping review of reported MRONJ incidence around the globe. PMC. 2024. Available from: PMC11973752.
[26] Baghalipour N, Moztarzadeh O, Samar W, Gencur J, Volf V, Hauer L. Comprehensive review of prevention and management strategies for medication-related osteonecrosis of the jaw (MRONJ). Oral Health Prev Dent. 2025.
[27] Author(s). 3D-printed patient-specific implants in maxillofacial reconstruction: a systematic review and meta-analysis of clinical outcomes and workflow efficiency. PMC. 2025. Available from: PMC12667220.
[28] Author(s). 3D printing and virtual surgical planning in oral and maxillofacial surgery. J Clin Med. 2022;11(9):2385.
[29] Author(s). Virtual 3D planning in maxillofacial surgery: the journey so far and the way ahead. PMC. 2024. Available from: PMC11279760.
[30] Author(s). Recurrence-related factors of temporomandibular joint ankylosis: a 10-year experience. J Oral Maxillofac Surg. 2019.
[31] Author(s). Current concepts in the pathogenesis of traumatic temporomandibular joint ankylosis. PMC. 2014. Available from: PMC4158390.
[32] Ahmed W, Fillmore WJ, et al. Treatment of temporomandibular joint ankylosis with total prosthetic joint reconstruction: a case series and scoping review of the literature. Front Oral Maxillofac Med. 2022.
[33] Author(s). A case of temporomandibular joint ankylosis with adenoid hypertrophy and associated airway challenges. PMC. 2024. Available from: PMC11089270.
[34] Author(s). An opportunity for diagonal development in global surgery: cleft lip and palate care in resource-limited settings. PMC. 2012. Available from: PMC3539333.
[35] Author(s). Inequitable access to timely cleft palate surgery in low- and middle-income countries. J Craniofac Surg / PubMed. 2016; PMID 26669785.
[36] Yao CA, Swanson J, Chanson D, et al. Barriers to reconstructive surgery in low- and middle-income countries: a cross-sectional study of 453 cleft lip and cleft palate patients in Vietnam. Plast Reconstr Surg. 2016;138(5):887e-895e.
[37] Author(s). Cleft lip and palate repair training to bridge the gap in low-income countries. J Craniofac Surg. 2022.