

Patterns And Outcomes of Paediatric Maxillofacial Fractures: A Retrospective Single-Centre Study of 1337 Patients With Review of Literature

Sneha Pendem¹, Raparthy bhuvan Chandra², Srishti Agarwal³, Kathiravan selvarasu⁴, M.P.Santhosh Kumar⁵

¹(MDS), SRM Dental College, Chennai drsneha_p@yahoo.com

²post graduate, Department of oral and maxillofacial surgery, saveetha dental college and hospitals, Tamilnadu, India. Email: raparthybhuvan@gmail.com

³post graduate, Department of oral and maxillofacial surgery, saveetha dental college and hospitals, Tamilnadu, India Email: srishti160@gmail.com

⁴Associate professor, Department of oral and maxillofacial surgery, saveetha dental college and hospitals, Tamilnadu, India Email: kathiravan.sdc@saveetha.com

⁵Reader, Department of oral and maxillofacial surgery, saveetha dental college and hospitals, Tamilnadu, India Email: santhoshsurgeon@gmail.com

Corresponding author: Sneha Pendem

Abstract

Background: Pediatric facial fractures pose a unique challenge due to the fragility, growth potential, and remarkable remodelling capacity of the developing maxillofacial skeleton. Traditionally, conservative and closed reduction techniques have been favoured to minimise growth disturbances. This study evaluated demographic trends, aetiologies, fracture patterns, management strategies, and long-term outcomes of pediatric facial fractures. **Materials and Methods:** A retrospective single-institution study was conducted using a database of 1,337 maxillofacial trauma cases. Among these, 112 pediatric patients (≤ 18 years) with facial fractures were identified and analysed. Data collected included demographics, aetiology, dentition stage, fracture characteristics, and treatment modalities, including conservative management, closed reduction, and open reduction with internal fixation (ORIF). Long-term follow-up assessed functional recovery, occlusal stability, and craniofacial growth remodelling. **Results:** A total of 112 pediatric patients were included. Condylar fractures were the most common injury pattern (22.3%, n=25), followed by dentoalveolar fractures (19.6%, n=22). Management was individualised based on patient age, fracture severity, and displacement. Conservative and minimally invasive approaches were preferred whenever feasible, while ORIF was reserved for displaced or complex fractures. Long-term follow-up demonstrated satisfactory functional recovery, stable occlusion, favourable craniofacial growth, and minimal complications. Patients treated with ORIF in appropriately selected cases also showed successful outcomes without significant growth disturbances. **Conclusion:** Individualised management of pediatric maxillofacial fractures, emphasising conservative treatment when appropriate and ORIF for selected complex injuries, yields favourable long-term outcomes. Careful surgical planning minimises morbidity and supports optimal functional rehabilitation and craniofacial growth, even in extensive facial trauma.

Keyword: Complex facial fractures, craniofacial growth, open reduction and internal fixation (ORIF), Paediatric maxillofacial trauma.

Introduction

Pediatric facial fractures present unique clinical challenges due to the fragility, growth potential, and remodeling capacity of the developing facial skeleton. Fracture incidence and distribution vary by age, reflecting the changing cranium-to-face volume ratio from 8:1 in infants to 2:1 in adolescents. (1, 2, 3) Cranial vault fractures predominate in infants, while mandibular and nasal fractures increase during mixed and permanent dentition phases.

Historically, pediatric facial trauma accounted for up to 15% of facial injuries, driven primarily by low-velocity falls and sports accidents. However, motor vehicle expansion has led to higher-velocity injuries, shifting fracture complexity in adolescents. (2, 4, 5, 6, 7)

Conservative management (closed reduction with splints or wiring)(1,2) was long favored to prevent growth center disruption. However, non-invasive approaches cause prolonged immobilization, poor oral hygiene, malnutrition, joint ankylosis, persistent asymmetry, and psychological distress. Conversely, open reduction and internal fixation (ORIF) with titanium plates, while standard in adults,(8) carries risks in growing children, including passive intraosseous translocation (PIT) (9, 10), stress shielding, and osteogenic growth center (11, 12, 13) disruption. Resorbable plating offers an alternative but presents challenges like technique sensitivity, high cost, and foreign-body reactions (14, 15, 16). This study evaluates single-institution outcomes of pediatric facial fractures to refine treatment algorithms.

Subjects and Methods

Study Design and Eligibility: A retrospective observational study evaluated patients presenting with maxillofacial trauma between August 2021 and April 2026. Inclusion criteria: (1) age below 18 years, (2) radiographically

confirmed facial fracture(s), and (3) minimum 6-month postoperative follow-up. Exclusions: isolated dental or soft-tissue trauma, incomplete records, or loss to follow-up. (Table 1)

Table 1: Demographic, Clinical, and Treatment Characteristics (N = 112)

Variable	Category	Subcategory / Value	Percentage / Statistical Details
Dentition Stage	Primary	n = 20	17.9%
	Mixed	n = 33	29.5%
	Permanent	n = 59	52.7% ($\chi^2 = 21.13, p < 0.001$)
Injury Etiology	Falls during play	n = 36	Predominant in primary/mixed
	Road Traffic Accidents	n = 13	Predominant in permanent
	Assault / Violence	n = 2	Observed in adolescents
	Epilepsy-related	n = 3	Minor cohort
Fracture Site	Mandible (Total)	n = 87	77.7% ($\chi^2 = 103.95, p < 0.001$)
	— Condyle	n = 25	22.3% overall cohort
	Dentoalveolar	n = 22	19.6% (19 maxilla, 3 mandible)
	Midface (ZMC)	n = 3	2.7%
Mandibular Treatment	ORIF	n = 55 (specified subset)	90.2%
	Closed Reduction	n = 6 (specified subset)	9.8%
Condylar Outcomes	Complete Remodeling	n = 24 (closed group)	Restitutive head remodeling
	Persistent Asymmetry	n = 11 (closed group)	44.0% of condylar cohort

Variables and Outcomes: Extracted data included age, sex, etiology, dentition stage (primary, mixed, permanent), fracture site, and management modality:

Conservative: Observation, soft diet, or simple suturing/extraction.

Closed Reduction: Cap splints, composite splints, circummandibular wiring, or intermaxillary fixation (IMF).

ORIF: Rigid/semi-rigid fixation using titanium or resorbable systems.

Primary outcomes were occlusal stability and craniofacial growth impact. Secondary outcomes included functional recovery time, diet progression, complications, and need for secondary surgery.

Results

Out of 1,337 screened cases, 112 patients met all criteria. Age breakdown comprised 20 primary (17.9%), 33 mixed (29.5%), and 59 permanent dentition cases (52.7%) ($\chi^2 = 21.13, p < 0.001$). Low-velocity falls predominated in primary and mixed stages, whereas road traffic accidents (RTAs) and assaults predominated in adolescents.

Mandibular fractures were most common (77.7%, $n = 87$), followed by dentoalveolar (19.6%, $n = 22$), zygomaticomaxillary complex (ZMC) (2.7%, $n = 3$), and rare nasal bone fractures ($\chi^2 = 103.95, p < 0.001$).

Mandibular & Dentoalveolar Fractures: Mandibular fractures were managed via ORIF (90.2%) or closed reduction (9.8%). Semi-rigid titanium mini-plates following Champy's principles were primarily used; one patient received poly-L-lactide plates. Occlusion remained stable except in one angle fracture case managed with intermaxillary elastics. ORIF patients resumed solid food by day 1–2, compared to 4–6 weeks in closed reduction cases. Secondary interventions occurred in both groups: hardware removal at 16 months for ORIF and splint removal at 6–8 weeks for closed reduction. PIT with subperiosteal bone formation occurred in 5 parasymphysis ORIF cases (9.1%), requiring lower border osteotomy during plate removal.

Dentoalveolar fractures ($n = 22$) were managed via closed reduction, composite splinting, or arch bars. All required secondary procedures under sedation or general anesthesia for device removal at 6 weeks.

Condylar Fractures: Of 25 condylar fractures (22.3%), 24 were managed conservatively/closed and 1 via ORIF. Closed treatment yielded complete condylar head restitutional remodeling in young children. However, 11 closed cases (44%) exhibited persistent facial asymmetry, shortened ramal height, and mouth-opening deviation despite stable occlusion via neuromuscular adaptation. The single subcondylar ORIF patient resumed pre-injury function within 2 days, compared to 3 weeks for closed management. (Fig 1A & 1B)



Image 1A: Panoramic radiograph (OPG) at presentation showing a left condylar head fracture.

Image 1B: Follow-up OPG at 4.5 years demonstrating reduced vertical ramal height on the left side and compensatory glenoid fossa thickening.

Midface Fractures: ZMC fractures (n = 3) were treated with two-point ORIF and titanium plate removal at 1 year, restoring immediate pre-injury function without facial deformity.

Discussion

Pediatric facial trauma exhibits an age-dependent biphasic pattern. Young children sustain low-velocity falls yielding condylar or dentoalveolar fractures, whereas adolescents present with high-energy injuries resembling adult patterns.

Although closed reduction protects tooth buds, its drawbacks include delayed solid intake, prolonged recovery, oral hygiene deterioration, and secondary anesthesia requirements.

Given these limitations and contemporary technological advancements, we advocate for open reduction and internal fixation (ORIF) in displaced fractures of the mandible and midface. Semi-rigid fixation utilising titanium miniplates has established itself as the standard of care in adult maxillofacial trauma due to its favourable biological and mechanical properties. This modality can be effectively translated to the paediatric population in the permanent dentition phase. The primary advantages of semirigid fixation with miniplates involve their good mechanical strength and biocompatibility, which can provide good fracture stability in case of displaced mandibular fractures in children. The primary clinical benefit of semi-rigid fixation observed in our study was the rapid restoration of the functioning of the stomatognathic system. (18-25) (Fig 2A,2B,2C)



Image 2A: Clinical presentation of genial asymmetry secondary to subperiosteal bone accretion following right parasymphysis fixation.

Image 2B: OPG illustrating right genial asymmetry post-parasymphysis fixation.

Image 2C: Intraoperative view during plate removal showing exuberant lower border bone formation.

However, the use of titanium plates is also associated with complications including imaging interference, temperature sensitivity, corrosion, hypersensitivity reactions, stress shielding, hardware translocation through the growing skeleton, palpability, chronic pain and infection. Apart from this, passive intraosseous translocation of the plates can often lead to injury to the tooth buds. Hence, this hardware is often electively removed after fracture healing. (18-25) Present literature reveals that 90% (16) of miniplates are removed at the end of 1 year to prevent issues of PIT and growth restriction in the paediatric craniofacial skeleton. The present study adds support to the foregoing with patients presenting with the PIT phenomenon and additional subperiosteal bone deposition leading to clinical asymmetry when the metal plates were retained for a long duration after fracture healing.

To overcome the aforesaid issues, the use of resorbable hardware is gaining more acceptance for application in the pediatric population. These plates are composed of poly L-lactide and poly L-glycolic acid and are hydrolysed completely, with their by-products entering the Krebs cycle and being eliminated as CO₂ & H₂O. The plates retain

their mechanical strength up to 4 to 9 weeks after placement and undergo complete resorption by 6 months of time. (14)

While resorbable poly-L-lactide plates offer an alternative—undergoing complete hydrolysis within six months—their clinical utility is often limited by high costs and inadequate mechanical strength for severely displaced or comminuted fractures. Technique sensitivity, elaborate armamentarium needed, formation of foreign bodies from partially degraded plates and sinus tract formation – all of these further limit their usage. (15, 16, 18, 21) Thus, titanium miniplates remain the most versatile and reliable option for paediatric facial trauma in our experience.

Paediatric condylar fractures remain one of the most controversial entities in craniomaxillofacial trauma, with significant variation in management strategies and reported outcomes. The primary issues associated with the management of pediatric condyle fractures include technical difficulties, reduced bone stock for plating, the risk of facial nerve injury, concerns of avascular necrosis and growth restriction due to the scarring and the injury to the growth centre, and hardware translocation. This supported the use of closed management of condyle fractures.

In cases of condylar head/neck fractures, the condylar head often remodels; however, this doesn't re-establish the lost vertical ramal height that is associated with displaced subcondylar and neck fractures. These observations were similar to the studies reported by Sahm et al., Zhu et al., and Chang et al., who put forth that in all children up to the age group of 5 to 8 years, complete restitutional remodelling of the condylar head was noticed, and the remodelling capacity of the condyle reduced with age, with only functional remodelling of the condylar head. The ramal height persisted to be short; however, flattening of the glenoid fossa with neuromuscular and dental adaptation minimised the residual deformity, similar to the studies by Zhu et al. Despite remodelling with closed treatment 11 of 25 cases had persistent deviation and shortened ramal length similar to the rates reported in the literature. (31,32)

To overcome the issues associated with deviation and persistent asymmetry, current practice involves the use of resorbable miniplates for fixation of pediatric condylar base and neck fractures. (26-30) Open reduction for condylar fractures (neck and base) is indicated in mixed dentition and all children in the adolescent age group and was supported by Banks et al. (33). If open reduction is not possible, then 3–6 weeks of intermaxillary fixation, 4 weeks of functional treatment and then 3 months of follow up. Resorbable plates for management of condylar fractures in children are gaining higher preference as they do not interfere with radiologic techniques due to their radiolucency. There is no need for secondary surgery for plate removal, as these are biodegradable. Once they undergo complete degradation, they don't interfere with mandibular growth. This was supported by studies by Zhang et al (34) who used Resorbable plates for the management of pediatric condyle fractures. However, the greatest challenge in this age group is the anatomical complexity and technique sensitivity. Endoscopically assisted intraoral fixation with resorbable plates is finding its path in the management of pediatric condyle fractures. (35) However, further studies are required to precisely assess their merits and demerits. The present consensus on the management favour ORIF for neck and base fractures in children of mixed and permanent dentition, especially when displaced, dislocated, comminuted or in cases associated with dual fractures or panfacial trauma. (36)

For midface trauma, a conservative approach is ideal for non-displaced fractures, while two-point ORIF provides optimal three-dimensional stability for displaced ZMC injuries in older adolescents.

This study is not without limitations. Primarily, the retrospective, single-institution design inherently introduces selection bias and limits the broader generalisability of the findings. Additionally, while long-term outcomes were assessed, the follow-up period varied among patients (ranging from 6 months to 5 years). Consequently, subtle, late-onset craniofacial growth disturbances may not have been fully captured in patients with shorter follow-up durations. Future prospective multicentre studies with standardised, prolonged follow-up protocols are warranted to further validate optimal treatment algorithms for pediatric maxillofacial trauma.

CONCLUSION

Primary dentition fractures generally thrive on conservative/closed management. Mixed and permanent dentition stages benefit from targeted ORIF, particularly for displaced mandibular and condylar neck/base fractures. Tailored interventions balance growth preservation with optimal functional restoration.

Declaration of Interests: The authors declare no competing financial interests or personal relationships that influenced this work.

References

1. Rowe NL. Fractures of the facial skeleton in children. *J Oral Surg.* 1968;26(8):505-15.
2. Kaban LB. Diagnosis and treatment of fractures of the facial bones in children 1943-1993. *J Oral Maxillofac Surg.* 1993;51(7):722-9.
3. Imai T, et al. Cranial to facial volume ratio changes in the developing pediatric facial skeleton and its impact on fracture patterns. *Plast Reconstr Surg.* 2018;141(4):532-41.
4. Gassner R, Tuli T, Hächl O, Rudisch A, Ulmer H. Cranio-maxillofacial trauma: a 10 year review of 9,543 cases with 21,067 injuries. *J Craniomaxillofac Surg.* 2003;31(1):51-61.
5. Țenț PA, Juncar RI, Moca AE, Moca RT, Juncar M. The etiology and epidemiology of pediatric facial fractures in North-Western Romania: A 10-year retrospective study. *Children (Basel).* 2022;9(7):932.
6. Daniels JS, Albakry I, Braimah RO, Samara MI. Maxillofacial bone fractures in children and adolescents: Overview of 247 cases in a major referral hospital, Najran, Kingdom of Saudi Arabia. *Craniomaxillofac Trauma Reconstr.* 2021;14(2):126-34.
7. Smith A, et al. The epidemiology and mechanisms of pediatric facial fractures. *Trauma Surg Acute Care.* 2025;10(1):e001300.
8. Champy M, Loddé JP, Schmitt R, Jaeger JH, Muster D. Mandibular osteosynthesis by miniature screwed plates via a buccal approach. *J Maxillofac Surg.* 1978;6(1):14-21.
9. Hönig JF, Merten HA, Luhr HG. Passive and active intracranial translocation of osteosynthesis plates in adolescent minipigs. *J Craniofac Surg.* 1995;6(4):292-8.
10. Kahn M, Calayag M, Patel A, Pilitsis JG. Paediatric cranioplasty: lessons from a 1940s neurosurgical procedure. *Interdiscip Neurosurg.* 2014;1(4):73-5.
11. Lim RB, Hopper, RA. Paediatric facial fractures. *Semin Plast Surg.* 2021;35(4):284-91.
12. Ul Haq ME, Khan AS. A retrospective study of causes, management, and complications of pediatric facial fractures. *Eur J Dent.* 2018;12(2):247-52.
13. Bansal A, Yadav P, Bhutia O, Roychoudhury A, Bhalla AS. Comparison of outcome of open reduction and internal fixation versus closed treatment in pediatric mandible fractures: a retrospective study. *J Craniomaxillofac Surg.* 2021;49(3):196-205.
14. Eppley BL. Use of resorbable plates and screws in pediatric facial fractures. *J Oral Maxillofac Surg.* 2005;63(3):382-7.
15. Rashid S, Gupta VA, Choudhary S, Kalimuddin KS, Deepika D, Kumar RD. Are resorbable plating systems comparable to conventional titanium plating in paediatric maxillofacial trauma patients? A systematic review and meta-analysis. *Br J Oral Maxillofac Surg.* 2026;64(3):193-201.
16. Pontell ME, Niklinska EB, Braun SA, Jaeger N, Kelly KJ, Golinko MS. Resorbable versus titanium rigid fixation for pediatric mandibular fractures: A systematic review, institutional experience and comparative analysis. *Craniomaxillofac Trauma Reconstr.* 2022;15(3):189-200.
17. Kamath AT, Roy S, Pai D. Paediatric condylar trauma - primary management considerations - A review. *J Oral Biol Craniofac Res.* 2023;13(2):236-42.
18. An J, Jia P, Zhang Y, Gong X, Han X, He Y. Application of biodegradable plates for treating pediatric mandibular fractures. *J Craniomaxillofac Surg.* 2015;43(4):515-520.
19. Iatrou I, Theologie-Lygidakis N, Tzerbos F. Surgical protocols and outcome for the treatment of maxillofacial fractures in children: 9 years' experience. *J Craniomaxillofac Surg.* 2010;38(7):511-516.
20. Goth S, Sawatari Y, Peleg M. Management of pediatric mandible fractures. *J Craniofac Surg.* 2012;23(1):47-56.
21. Stanton DC, Liu F, Yu JW, Mistretta MC. Use of bioresorbable plating systems in paediatric mandible fractures. *J Craniomaxillofac Surg.* 2014;42(7):1305-1309.
22. Manson PN. Commentary on the long-term effects of rigid fixation on the growing craniomaxillofacial skeleton. *J Craniofac Surg.* 1991;2(2):60-70.
23. Murthy AS, Lehman JA, Jr. Symptomatic plate removal in maxillofacial trauma: a review of 76 cases. *Ann Plast Surg.* 2005;55(6):603-607.
24. Tatum SA, 3rd. Retrospective review of resorbable plate fixation in pediatric craniofacial surgery: long-term outcome. *Arch Facial Plast Surg.* 2012;14(1):11-13.
25. Berryhill WE, Rimell FL, Ness J, Marentette L, Haines SJ. Fate of rigid fixation in pediatric craniofacial surgery. *Otolaryngol Head Neck Surg.* 1999;121(3):269-273.
26. Zhao Y, Zhang Y. Condylar fracture in children: Current knowledge and considerations. *JSM Dent.* 2016;4(1):1059.
27. Zhu, Y.F.; Zou, Y.; Wang, S.Z.; Du, C.X.; Xu, B.; Zhu, M. Three-dimensional evaluation of condylar morphology after closed treatment of unilateral intracapsular condylar fracture in children and adolescents. *J. Craniomaxillofac. Surg.* 2020, 48, 286–292.

28. Choi, J.; Oh, N.; Kim, I.K. A follow-up study of condyle fracture in children. *Int. J. Oral Maxillofac. Surg.* 2005, 34, 851–858
29. Chang, S.; Yang, Y.; Liu, Y.; Wang, J.; Zhang, W.; Ma, Q. How Does the Remodelling Capacity of Children Affect the Morphologic Changes of Fractured Mandibular Condylar Processes After Conservative Treatment? *J. Oral Maxillofac. Surg.* 2018, 76, 1279.e1–1279.e7.
30. Yamashita, Y.; Inoue, M.; Aijima, R.; Danjo, A.; Goto, M. Three-dimensional evaluation of healing joint morphology after closed treatment of condylar fractures. *Int. J. Oral Maxillofac. Surg.* 2016, 45, 292–296.
31. Proffit WR, Vig KWL, Turvey TA. Early fracture of the mandibular condyles: frequently an unsuspected cause of growth disturbances. *Am J Orthod.* 1980;78:1–24
32. Lund K. Mandibular growth and remodelling processes after condylar fractures. A longitudinal roentgen-cephalometric study. *Acta Odontol Scand.* 1974;32(suppl 64): 3–117.
33. Banks P, Killey H. *Killey's Fractures of the Mandible.* Oxford, England: Wright; 1991
34. Zhang B, Zhao-Hui Liu, Jian Li, Zhang Kevin, Chen Jing-Jing, Zhang Ricardo M. Open reduction and internal fixation of severely dislocated fractures of condylar neck and base using bioabsorbable miniplate in children: a 3–10 years follow-up study. *Int J Pediatr Otorhinolaryngol.* 2014;78, 1987–1992 1988.
35. Sebastian Schiel, Peter Mayer, Florian Probst, Otto Sven, Carl-Peter Cornelius. Transoral open reduction and fixation of mandibular condylar base and neck fractures in children and young teenagers—a beneficial treatment option? *J Oral Maxillofac Surg.* 2013;71:1220–1230.
36. Bottini GB, Hitzl W, Götzinger M, Politis C, Dubron K, Kordić M, Sivrić A, Pechalova P, Sapundzhiev A, Pereira-Filho VA, de Oliveira Gorla LF, Dediol E, Kos B, Rahman T, Rahman SA, Samieirad S, Aladelusi T, Konstantinovic VS, Lazić M, Vesnaver A, Birk A, Sohal KS, Laverick S, Rae E, Rossi MB, Roccia F, Sobrero F. Management of Mandibular Condyle Fractures in Pediatric Patients: A Multicentric Retrospective Study with 180 Children and Adolescents. *J Clin Med.* 2024 Sep 14;13(18):5455. doi: 10.3390/jcm13185455. PMID: 39336942; PMCID: PMC11431969.
37. Kao R, Campiti VJ, Rabbani CC, Ting JY, Sim MW, Shipchandler TZ. Pediatric Midface Fractures: Outcomes and Complications of 218 Patients. *Laryngoscope Invest Otolaryngol.* 2019 Nov 6;4(6):597-601. doi: 10.1002/lio2.315. PMID: 31890876; PMCID: PMC6929601.