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LE FORT FRACTURES: CONTEMPORARY DIAGNOSIS, CLASSIFICATION, AND SURGICAL MANAGEMENT — A NARRATIVE REVIEW

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Abstract. Le Fort fractures are high-energy midfacial injuries whose classic three-level description increasingly fails to capture modern fracture morphology. This narrative review synthesised PubMed-indexed literature published between 2021 and 2026 on the epidemiology, diagnosis, surgical management and outcomes of Le Fort fractures. Contemporary computed tomography series show that ideal, symmetrical Le Fort lines occur in fewer than one in ten patients, while mixed, unilateral and incomplete patterns predominate, and concomitant orbital or zygomatic fractures accompany roughly a quarter to a third of operated cases. Occlusion-driven open reduction and internal fixation of the facial buttresses remains the standard, with selective rather than routine intermaxillary fixation. Short-term complication rates after surgery are low, whereas mortality in Le Fort III injuries is driven by skull base, cranial vault and cervical vascular injury. Virtual surgical planning, navigation and structured CT reporting are improving precision. Individualised, CT-based and multidisciplinary care should replace treatment guided by the pattern label alone.
Keywords: Le Fort fracture; midface; maxillofacial trauma; computed tomography; internal fixation; intermaxillary fixation; virtual surgical planning; panfacial fracture.

Introduction

The midface is a lattice of thin bony plates reinforced by vertical and horizontal buttresses that absorb masticatory load and protect the orbit, nasal cavity and skull base. When high-energy force exceeds this capacity, the maxilla separates from the cranial base along planes of weakness first described by René Le Fort in 1901. Le Fort fractures account for approximately one fifth of facial fractures and arise predominantly from road traffic collisions, falls and assaults [1, 2]. National surgical registries confirm that men of working age are most frequently affected, with Le Fort I being the commonest subtype and Le Fort III the least common but most lethal [3, 4].

Despite its enduring clinical value, the Le Fort classification was derived from cadaveric experiments rather than from modern high-velocity trauma. Recent computed tomography (CT) studies demonstrate that pure bilateral patterns are rare and that most fractures combine different levels on each side or remain incomplete [5, 6]. Moreover, Le Fort injuries seldom occur in isolation: national claims data show frequent co-existence with zygomatic and orbital floor fractures [7], and severe injuries may extend into panfacial patterns that challenge conventional sequencing [8, 9]. Associated intracranial, cervical spine and ophthalmic injuries further influence the priority and timing of treatment [1, 10].

Management has evolved from prolonged intermaxillary fixation (IMF) and wire suspension toward early open reduction and internal fixation (ORIF) with titanium miniplates, guided by occlusion-based reduction [11, 12]. Digital technologies, including virtual surgical planning (VSP), three-dimensional (3D) printing and intraoperative navigation, are now entering acute trauma care [13]. At the same time, multidisciplinary groups are proposing standardised CT reporting frameworks to reduce miscommunication between radiologists and surgeons [14]. Given the rapid

accumulation of evidence, an updated synthesis is warranted. The aim of this review was to summarise current evidence on fracture patterns, diagnostic imaging, surgical strategies and outcomes of Le Fort fractures, and to identify priorities for clinical practice and research.

Methods

A narrative review was conducted following the Scale for the Assessment of Narrative Review Articles (SANRA) quality criteria. PubMed/MEDLINE was searched in September 2026 using the terms “Le Fort” combined with “fracture”, “midface fracture”, “panfacial fracture”, “maxillary fracture”, “intermaxillary fixation” and “virtual surgical planning”. The search was restricted to English-language articles published from January 2021 to September 2026.

Original clinical studies, registry analyses, randomised trials, systematic reviews with or without meta-analysis and authoritative clinical reviews addressing traumatic Le Fort fractures were eligible. Studies focusing exclusively on elective Le Fort osteotomy for dentofacial deformity, case reports without outcome data and non-peer-reviewed material were excluded. After title and abstract screening, study design, sample size, fracture pattern, intervention and principal outcomes were extracted into a structured matrix. Because designs and outcome measures were heterogeneous, findings were synthesised qualitatively under four themes: epidemiology and fracture morphology, diagnosis, surgical management, and outcomes and complications. In total, 24 publications were included in the final synthesis.

Results

Epidemiology and fracture morphology

The included studies originated from North America, Europe, Asia and Latin America and comprised retrospective cohorts, national database analyses, one long-term multicentre randomised trial, systematic reviews and clinical reviews. In a national surgical database, Le Fort fractures represented 130 of 3,293 facial fractures (about 4%), with a male-to-female ratio of 4.9:1 and a predominance of patients aged 18–65 years. Of these 130 cases, 70 (54%) were Le Fort I, 41 (32%) Le Fort II and 19 (15%) Le Fort III.

In the largest CT-based analysis of 513 patients, isolated Le Fort lines were present in 40.3% of cases, yet ideal bilateral symmetrical lines occurred in only 9%. Combined Le Fort I and II lines were observed in 23%, Le Fort II and III in 10.4%, Le Fort I and III in 6%, and all three levels in 20%. In a claims database of 244,751 patients, 28% of Le Fort I and 32% of Le Fort II repairs were accompanied by a zygomatic fracture, while 22–30% of Le Fort repairs involved a concomitant orbital floor fracture. During the COVID-19 pandemic, midface fracture volume in one German centre fell from 88 to 57 cases, with a shift from violence and sport toward domestic falls and delayed admission.

Diagnosis

Multidetector CT with multiplanar and 3D reconstruction was regarded as the diagnostic standard in all included studies. A 13-member multispecialty Delphi panel reached more than 75% agreement that CT reports should describe Le Fort, zygomaticomaxillary and naso-orbito-ethmoid patterns using clinically familiar groupings, although routine structured templates did not achieve consensus. Ophthalmic involvement was common: across 7,998 patients with facial fractures, 3,693 had ocular complications, most often subconjunctival haemorrhage.

Surgical management

Occlusion-guided ORIF of the nasomaxillary, zygomaticomaxillary and pterygomaxillary buttresses was the dominant strategy. Table 1 compares the principal management approaches identified. In a series of 100 operated midface fractures, postoperative malocclusion occurred in 8%, and IMF was used mainly in more complex cases. In a cohort of 106 patients, the need for

postoperative IMF was significantly associated with fracture pattern and with surgical delay ($p < 0.001$). When passive maxillary reduction was impossible, an acute Le Fort I osteotomy restored stable occlusion in 21 of 22 patients, with one nonunion. For Le Fort III injuries, an ordered surgical sequence normalised orbital volume, with no significant postoperative difference between the injured and contralateral eyes ($p = 0.35$).

Table 1. Comparison of contemporary management approaches for Le Fort fractures

Approach	Main indication	Evidence base (design, size)	Key reported outcome
Occlusion-guided ORIF with buttress miniplates	Displaced Le Fort I–III fractures with dentate maxilla	Registry and cohort studies (n = 43–562)	30-day complications 2.5–5.4%; occlusal disorder linked to condylar fracture
Selective intermaxillary fixation	Complex, multi-buttress or delayed fractures	Retrospective cohorts (n = 100; n = 106)	Malocclusion 8%; IMF need linked to fracture pattern and delay
Acute Le Fort I osteotomy	Asymmetric or incomplete fractures without passive reduction	Retrospective series (n = 22)	Stable occlusion in 21/22; one nonunion
Ordered sequencing with orbital reconstruction	Le Fort III and panfacial fractures	Case series (n = 15); meta-analysis (14 studies, 1,238 patients)	Orbital volume normalised; bottom-up sequence most common (57.1%)
Digital workflow (VSP, 3D printing, navigation)	Comminuted, panfacial or ballistic fractures	Systematic review (5 studies, 82 patients)	Operative time −124.8 min with navigation; maxillary error 0.88 mm
Titanium vs biodegradable osteosynthesis	Fracture and osteotomy fixation	Multicentre RCT, ≥15-year follow-up (n = 230)	Symptomatic removal 17.4% vs 29.5%

Abbreviations: ORIF, open reduction and internal fixation; IMF, intermaxillary fixation; VSP, virtual surgical planning; 3D, three-dimensional; RCT, randomised controlled trial.

In panfacial fractures, the bottom-up sequence was used in 57.1% of studies, and a major fragment strategy was proposed when conventional sequencing fails. A systematic review of digital workflows in acute panfacial trauma found that navigation reduced mean operative time by 124.8 minutes and that fully integrated VSP achieved a maxillary reduction error of 0.88 ± 0.52 mm.

Outcomes and complications

In an analysis of 562 patients, the 30-day complication rate after Le Fort repair was 2.49%, and corticosteroid use independently predicted severe complications (odds ratio 13.73). Another registry reported in-hospital complications in 5.4% and reoperation in 2.3% of cases. In a series of 43 Le Fort I fractures, occlusal disorder occurred in six patients and was significantly associated with concomitant condylar fracture ($p = 0.044$). The pooled fracture-related infection rate was

lowest in the midface (0.9%) compared with the mandible (8.9%). Molar bite force after rigid fixation increased from about 94 N at one week to 280 N at four weeks. After a median follow-up of 16.3 years in a randomised trial, symptomatic plate removal was required in 17.4% of titanium and 29.5% of biodegradable osteosynthesis cases. Among 559 patients with isolated Le Fort III fractures, in-hospital mortality was 2.68%, and skull base fracture, subarachnoid haemorrhage and cervical vessel injury were significant mortality risk factors.

Discussion

This review confirms that the contemporary Le Fort fracture is less a fixed anatomical category than a spectrum of mixed, asymmetrical and incomplete midfacial disruptions. The finding that only 9% of CT-analysed fractures follow the ideal description [5] agrees with clinical observations that pure patterns are rare [6] and with current reviews advocating individualised reconstruction [2, 15]. High-velocity road traffic mechanisms probably explain much of this heterogeneity [1, 5]. The Le Fort nomenclature therefore remains useful for communication, as endorsed by the recent Delphi consensus [14], but surgical planning should be based on the displacement of individual buttresses rather than on the label alone.

The high frequency of concomitant zygomatic and orbital fractures [7] and ocular injuries [10] supports routine ophthalmic assessment and whole-face CT review before surgery. In Le Fort III injuries, mortality appears to be driven less by the facial fracture itself than by skull base, cranial vault and cervical vascular trauma [4], reinforcing trauma life-support principles in which airway control and neurological stabilisation precede definitive fixation [1]. Changing injury circumstances, such as those observed during the COVID-19 pandemic, also show that trauma services must adapt to shifting aetiology and delayed presentation [16].

Restoring premorbid occlusion remains the cornerstone of treatment. Concomitant condylar fracture was the main risk factor for occlusal disorder after Le Fort I repair [11], emphasising that the mandible serves as the template for maxillary position. The shift toward selective IMF is supported by low malocclusion rates in centres that reserve it for complex cases [12], while surgical delay increases the likelihood that IMF will be needed [17]. When the maxilla cannot be reduced passively, an acute Le Fort I osteotomy provides a reproducible solution [6]. In Le Fort III and panfacial injuries, the choice between bottom-up and top-down sequencing appears less important than technique and experience [9], and the major fragment theory offers a pragmatic alternative when landmarks are lost [8]. Ordered reconstruction of the orbit within the sequence helps prevent enophthalmos [18], and single-stage protocols have produced satisfactory occlusion in high-volume centres [19].

The short-term safety of surgical repair is reassuring, with national complication rates below 6% [3, 20] and a notably low infection rate in the midface compared with the mandible [21]. Functional recovery, measured by bite force, progresses rapidly within the first month after rigid fixation [22]. Long-term randomised data show that titanium remains reliable, although about 5% of patients require plate removal more than five years after surgery [23]. Digital workflows promise greater precision and shorter operations, but the evidence in acute settings is still small and of low certainty [13]. In children, growth considerations and the rarity of midface fractures justify a more conservative approach, with longitudinal follow-up of facial growth [24].

This review has limitations. It is narrative rather than systematic, was limited to a single database and English-language articles, and relied predominantly on retrospective studies with heterogeneous definitions of fracture type and outcome. Registry data capture only 30-day outcomes and may under-report late malocclusion or aesthetic deformity. Future research should prioritise prospective multicentre cohorts using standardised CT-based classification, validated

patient-reported outcome measures and cost analyses of digital planning, particularly in low-resource settings where high-energy road trauma is most common.

Conclusion

Le Fort fractures remain a defining challenge of maxillofacial surgery, yet the textbook three-level pattern now describes only a minority of patients. Modern injuries are mixed, asymmetric and frequently accompanied by orbital, zygomatic, intracranial and cervical trauma. Successful treatment rests on three pillars: early life-saving stabilisation, detailed CT-based analysis of every buttress, and occlusion-driven anatomical fixation with selective use of intermaxillary fixation and acute osteotomy. Complication rates after contemporary surgery are low, but mortality in Le Fort III injuries reflects associated skull base and vascular damage. Digital planning, navigation and structured reporting are poised to make reconstruction more precise and reproducible. Integrating these tools into multidisciplinary trauma pathways offers the best opportunity to restore both function and facial identity.

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