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IN BRIEF

Classifications In Brief: The Tscherne Classification of Soft Tissue Injury

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History

Soft tissue injuries are an intrinsic component of any fracture. Treatment of these soft tissue injuries is challenging, but is an integral element of fracture care. The initial evaluation of a patient with orthopaedic trauma must include a detailed assessment of the soft tissue envelope. The timing and method of fracture fixation are directly influenced by the degree of trauma to the overlying soft tissues and have been shown to have a direct effect on postoperative function [5, 8, 13, 14, 17].

Various classification systems have been proposed to help communicate, classify, and guide treatment of soft tissue injuries occurring in the setting of fractures. These include the Tscherne classification for open and closed fractures [36], Gustilo and Anderson classification for open fractures [15, 16], Hannover fracture scale [35], and the AO soft tissue grading system [31].

Developed by Harald Tscherne and Hans-Jörg Oestern in 1982 at the Hannover Medical School (Hanover, Germany), the Tscherne classification for closed and open fractures [36] has become a frequently referenced system for defining soft tissue injuries. They based their classification on the apparent kinetic energy imparted on soft tissue in fracture trauma and the physiologic consequence of this trauma on the overlying soft tissue envelope.

Purpose

In general, classification systems serve as communication tools in the research and clinical settings. An ideal classification offers a method to predict prognosis and dictate clinical management. With the advent of the Tscherne classification system, greater emphasis was placed on the contribution of associated soft tissue injury in fracture management. A previous study showed its ability to serve as a concise and reliable communication tool in a research capacity [37]. In a similar fashion, the Tscherne system serves as an effective guide for predicting treatment and prognosis [6, 7, 9, 12, 22, 30, 38]. This has important implications in fracture care, where factors such as polytrauma and severe soft tissue injury may preclude primary definitive fixation. As such, a validated classification system that stratifies soft tissue injuries as they relate to bony trauma allows for a more comprehensive approach to fracture care.

Description

As outlined in the original publication by Tscherne and Oestern [36], their classification system differentiates between two main fracture subgroups of the appendicular skeleton: open (O) and closed (C) injuries. Four grades of injury are included in each subgroup, which increase in

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severity concordant with their numeric value. The classification system for closed fractures is based on the physiologic concept that the energy imparted to the bone (and the resultant fracture pattern) directly correlates with the energy transferred to the surrounding soft tissues. The severity of the resultant soft tissue injury increases with higher-energy fracture patterns from values of C0 to C3 (Table 1). A similar classification scheme was delineated for open fractures, describing a spectrum of soft tissue injuries. Open injuries were further classified based on the nature of the associated injuries and the degree of contamination. This subgroup increases in severity with associated numerical identification from O1 to O4 (Table 2).

No specific guidelines currently exist that dictate fracture management based exclusively on the Tscherne grade of soft tissue injury. Nevertheless, some authors have identified the relationship between increasing soft tissue injury severity and decreased postoperative clinical and functional outcomes [6, 28]. Based on the best-available current evidence and the physiologic rationale described by Oestern and Tscherne [27], primary fixation of closed Grades 0 to 1 and open Grades 1 to 2 injuries is reasonable [6, 12, 38]. Attempts at early definitive fixation of high-energy injuries have been shown to result in an increased rate of complications, including skin slough and deep infection [7, 9, 22, 30]. Conversely, staged fracture care (provisional external fixation followed by definitive internal fixation) has been shown to result in favorable functional outcomes with decreased rates of soft tissue complications [10, 18, 29, 34].

Validation

The original article by Tscherne and Oestern [36] provided a physiologic rationale and validation for their classification based on the cellular cascade of inflammation, proliferation, and repair, which occurs in the fracture setting. Although no clinical validation was performed to support their classification, they referenced the radiographic study by Allgöwer [1], correlating the degree of radiologic deformity with the extent of soft tissue trauma to support their argument. They furthermore pointed to the experimental study performed by Schweiberer et al. [33], which suggested that an angular deformity of bone greater than 30° is associated with decreased diaphyseal vascularity. Numerous studies have since evaluated these physiologic relationships in a clinical setting [5, 6, 9, 10, 28, 34, 38].

In their retrospective review of 38 patients with Lisfranc fracture-dislocations treated by open reduction and internal fixation, Demirkale et al. [6] reported that the severity of soft tissue injury and anatomic fracture reduction were important prognostic factors for functional outcomes. Through multiple linear regression analysis of the Foot and Ankle Disability Index (FADI) [23] and American Foot and Ankle Society score (AOFAS) [19], Demirkale et al. [6] showed a significant decrease in scores at Tscherne Grades 2 and 3 compared with Grade 1. Similarly, reduction quality (as assessed radiographically after internal fixation) was correlated to final outcome scores and shown to be significantly higher for anatomic reduction compared with acceptable or unsatisfactory reductions.

Table 1. Tscherne classification for closed fractures

Grade	Energy	Typical fracture pattern	Typical soft tissue damage
C0	Low	Spiral	None to minimal
C1	Mild to moderate	Rotational ankle fracture-dislocations	Superficial abrasion/contusion
C2	High	Transverse segmental complex	Deep abrasions; impending compartment syndrome
C3	High	Complex	Extensive skin contusion; myonecrosis; degloving; vascular injury; compartment syndrome

Table 2. Tscherne classification for open fractures

Grade	Typical fracture patterns/injuries	Typical soft tissue damage
O1	Fractures resulting from indirect trauma (eg, AO A1-2)	Skin laceration; none to minimal
O2	Fractures resulting from direct trauma (eg, AO A3; B, C)	Skin laceration; circumferential contusions; moderate contamination
O3	Comminuted fractures; farming injuries; high-velocity gunshot wounds	Extensive; major vascular and/or nerve damage; compartment syndrome
O4	Subtotal and complete amputations	Extensive; major vascular and/or nerve damage

Dillin and Slabaugh [9] emphasized the clinical consequences of high-grade trauma on fracture care in their review of 11 patients who underwent attempted primary internal fixation of high-energy closed and open tibial plafond fractures. In their study, more than 50% of patients had osteomyelitis develop after primary internal fixation.

In comparison, a staged protocol (spanning external fixation followed by delayed open reduction and internal fixation) for treating fractures associated with a more tenuous blood supply and/or less-robust soft tissue envelope, has resulted in better outcomes. Egol et al. [10] reported an overall 5% incidence of infection or wound problems in their series of 53 patients with high-energy tibial plateau fractures. Patterson and Cole [29] reported 77% good results and no soft tissue complications or infections in their series of 21 patients with high-grade pilon fractures. Sirkin et al. [34] reported similar findings in their series of 56 patients with closed and open pilon fractures.

Reproducibility of the Tscherne classification generally has been moderate to high. Valderrama-Molina et al. [37] examined the intra- and interobserver reliability of the Tscherne classification as it applied to closed tibial plateau and pilon fractures. Based on results from 15 evaluators reviewing 20 fractures, they reported an intraobserver agreement of kappa 0.81 (95% CI, 0.79–0.83) and an interobserver agreement of kappa 0.65 (95% CI, 0.55–0.73). Intra- and interobserver reliability were comparatively lower at the time of initial trauma evaluation compared with 24, 48, and 72 hours after admission, suggesting that the evolution of soft tissue injury may play a role in the reliability of the classification at initial presentation. Although limited in sample size, the findings suggest that the Tscherne classification may serve as a potentially reliable way for standardizing and classifying fractures.

The Tscherne classification was found to have better utility than some other trauma classifications in terms of anticipating prognosis after injury. Gaston et al. [13] compared multiple fracture classification systems (AO, Gustilo, Tscherne, and Winquist-Hansen) of tibial diaphyseal fractures and showed that the Tscherne classification was better able to predict time to restoration of function as determined by time to return to prolonged walking and running, return to walking on difficult ground, jumping, climbing ladders, and normal sporting activities. Although Gaston et al. [13] questioned the utility of classification systems as a means for predicting outcomes after fracture, they showed that the Tscherne system was more predictive of functional outcomes compared with other systems. Demirkale et al. [6] showed a similar relationship in their retrospective analysis of 38 patients who underwent open reduction and internal fixation of Lisfranc fracture dislocations.

Others have underscored the applicability of the Tscherne system to fracture care and infection. In the study by Ovaska et al. [28], the Tscherne grade was an independent risk factor that increased the odds of deep infection in the operative treatment of ankle fractures (odds ratio [OR], 2.6; 95% CI, 1.3–5.3; $p = 0.006$). Almeida Matos et al. [2] described a similar relationship as it pertained to the treatment of open tibia fractures. In their study, Tscherne Grades 3 and 4 injuries were the most important independent risk factor for infection (OR, 8.07; 95% CI, 2.4–47.1; $p < 0.00$).

Limitations

As mentioned earlier, the Tscherne classification has been shown to be a valuable tool in clinical decision-making. Like most classification systems, however, several limitations exist. Gaston et al. [13] showed that the Tscherne classification system performs better than others in predicting functional outcomes after tibial shaft fractures, although all systems in that study were found to be of overall poor reliability. They also highlighted the potential difficulty of applying the Tscherne classification to closed fractures, where the extent of deep trauma may not be as readily apparent at the initial clinical assessment.

Table 3. Strengths and weaknesses of the Tscherne classification system

Strengths	Weaknesses
Accounts for closed and open fractures	Accurate classification may be difficult with closed injuries
Useful for initial triage of traumatized patient (anticipation of outcomes and optimizing management)	Does not account for location of soft tissue trauma
Moderate to high reproducibility	Does not consider host factors
Better able to predict functional outcomes than other similar classification systems	Accurate classification can be affected by timing of initial trauma evaluation
Useful for predicting risk of infection based on soft tissue trauma severity	Does not offer treatment guidelines based on extent of soft tissue trauma
	Not as useful for trauma to the axial skeleton

In a similar fashion, the location of soft tissue injury, and patient host factors, can influence prognosis in fracture care, both of which are not accounted for in the Tscherne system. This is evident in the study by Folk et al. [11], wherein diabetes, smoking, and open fracture were shown to be independent and significant risk factors for wound complications after surgical stabilization of calcaneus fractures. Other authors also have emphasized the effects of peripheral neuropathy, medications, and noncompliance on prognosis in fracture treatment [4, 24, 26].

As reported by Valderrama-Molina et al. [37], the accuracy of grading in the Tscherne system is largely influenced by the time at which patients are evaluated. Namely, the amount of elapsed time after injury will affect the assigned Tscherne grade, and (if the grading is done too early) potentially lead to underestimation of the true nature of soft tissue injury severity. This limitation emphasizes the underlying complexity of soft tissue injuries in orthopaedic trauma, suggesting that the external trauma often may not reflect the true extent of injury [36]. Physiologic changes that occur at the microvascular and cellular levels will define the zone of injury and, if not recognized, may propagate to adjacent tissue, potentially affecting patient prognosis and outcomes [21, 25, 32]. The level of sophistication necessary to fully encapsulate the complexity of this physiologic cascade is unlikely to be well defined by a single classification system.

As is the case with most historical classification systems, the Tscherne classification does not offer therapeutic recommendations for fracture treatment in patients with polytrauma. Kobbe et al. [20] offered a potential approach to complex fracture management, recognizing the importance of degree of soft tissue damage and overall injury severity as critical determinants of treatment. They stratified fracture care based on low-risk, moderate-risk, and high-risk complex extremity fractures, and provided a treatment guide based on local injury severity.

Conclusions/Uses

The implications of soft tissue trauma in the treatment of closed and open fractures are well recognized. The Tscherne classification serves as a valuable clinical tool to categorize and predict the extent of soft tissue injury associated with fracture trauma based on fracture pattern and energy involved. Such categorization can assist with anticipating outcomes and optimizing treatment. Primary definitive fixation has been shown to be appropriate for lower-grade open and closed injuries, whereas staged treatment is more appropriate for higher-grade injuries. Because the Tscherne classification is based largely on clinical examination, the system serves as a useful tool in the initial triage and evaluation of patients in the acute setting. The classification also serves as a systematic method to communicate the degree of soft tissue injury clinically and in a research capacity.

As reported by Gaston et al. [13] and Bernstein et al. [3], no classification system will likely ever be all-encompassing while still remaining useful and understandable to the individual practitioner. Like other systems, the Tscherne classification exhibits strengths and weaknesses that contribute to and limit its effectiveness, respectively (Table 3). Despite this, the Tscherne classification system remains a useful tool to help evaluate the degree of soft tissue injury based on fracture pattern and energy and guide clinicians toward subsequent management.

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