Injury, Int. J. Care Injured 47 (2016) 1162–1169

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Review

What's new in the management of complex tibial plateau fractures?

Zinon T. Kokkalis, Ilias D. Iliopoulos, Constantinos Pantazis, Elias Panagiotopoulos *

University of Patras, School of Medicine, University Hospital of Patras, Department of Orthopaedics, Papanikolaou 1, 26504 Rio-Patras, Greece

ARTICLE INFO

Keywords:
Tibial plateau fracture
Augmentation
Minimal invasive technique
Locking plates

ABSTRACT

The management of complex tibial plateau fractures is ever evolving. The severity of the injury to the surrounding soft tissues influences the timing and the method of fixation. Minimal invasive techniques continue to dominate our philosophy of reduction and reconstruction whereas augmentation of depressed intra-articular fragments remains an accepted strategy to maintain reduction and prevent secondary collapse. Locking plates, conventional plates and fine wire fixators all have been used successfully with satisfactory outcomes. In this article we report on the latest advances made in the management of these complex injuries.

Contents

Introduction . . . 1162
Definition and classification . . . 1163
Incidence and presentation . . . 1163
Treatment options and clinical results . . . 1163
Temporary external fixation . . . 1163
Open reduction and internal fixation (ORIF) – evidence for approach . . . 1164
Arthroscopically-assisted reduction and internal fixation (ARIF) . . . 1165
External fixators . . . 1165
ORIF vs. Ex-Fx . . . 1166
Latest data and innovative techniques . . . 1166
Recommendations – conclusion . . . 1166
Conflict of interest statement . . . 1166
References . . . 1167

Introduction

Complex bicondylar fractures of the tibial plateau remain a challenge to even the most experienced surgeons. The anatomy of the tibial plateau, combined with high energy trauma, produce complicated injury patterns with involvement of metaphyseal and articular comminution and frequently with loss of integrity of the soft-tissue envelope. The severity of soft tissue injury and the degree of bone comminution reflects the energy transmitted to the bone and incline to unfortunate prognosis [1,2].

In these severe cases the goal of treatment is the recovery of the articular surface and the reduction of the anatomic alignment of the lower extremity. However, what is crucial in deciding the time and modus of the surgical intervention is the status of local soft tissues.

Modern operating techniques focus on the maintenance of the integrity and vascularity of the injured soft tissue and it seems that biologic approach of these intrarticular fractures achieves to lessen their morbidity [3,4].

We discuss current treatment options and results reported in the literature, in an attempt to shed some light in the demanding procedure of complex tibial plateau fractures management.

* Corresponding author at: Orthopaedic Department, Patras University Hospital, 26504, Rio, Patras, Greece. Tel.: +30 2613603555; fax: +30 2610994657.
E-mail addresses: drkokkalis@gmail.com (Z.T. Kokkalis), ecpanagi@med.upatras.gr (E. Panagiotopoulos).

http://dx.doi.org/10.1016/j.injury.2016.03.001
0020–1383/

Definition and classification

Schatzker et al. in 1979, classified tibial plateau fractures into six groups, each representing similar injury mechanism and fracture pattern, resulting in similar management difficulties [5]. Complex fractures, most of the authors regard as AO type C or Schatzker type V and VI, can be defined as intra-articular lesions, involving osseous compromise of more than one distinct anatomical areas of the proximal tibia, with a variable degree of comminution and soft-tissue damage. Type V fractures are bicondylar, occurring as a result of an axial thrust in knee extension, with varying degrees of metaphyseal comminution and usually no depression of the articular surface [6]. Type VI fractures are characterised by meta-diaphyseal extension of the fracture line separating metaphysis from diaphysis presented with various degrees of articular and metaphyseal comminution [6].

However, both Schatzker and AO classification, as AP radiograph-based systems, somewhat fail to adequately identify and describe posterior shearing fracture patterns, which subsequently leads to poor clinical relevance with a negative impact on treatment plan [7,8]. Incidence and distinct clinical characteristics of these high-energy related fractures have been gaining attention over the last years, due to their highlighted poor compliance to conventional treatment methods and surgical approach [9–12].

With his recent research, Luo et al. introduced the "Three Column" Classification, based on CT axial view and 3D reconstruction as a supplement to the Schatzker classification, dividing the tibial plateau in three columns each defined according to anatomic location and corresponding surgical approach achieving high therapeutic correlation [7,13].

Incidence and presentation

Tibial plateau fractures account for 1–2% of all fractures and 8%of fractures in the elderly [14]. Albuquerque et al. in 2013 study of 239 tibial plateau fractures surgically treated in a level I trauma hospital, reported a 36% incidence of Schatzker V and VI type, associated with high-energy injury mechanism involving car/motorcycle accidents or high altitude falls [15]. They also demonstrated a male to female predominance of approximately 70–30%, with a mean occurrence age of 43.7 years.

These severe-trauma related injuries produce comminuted fractures with significant soft tissue damage, as well as disruption of primary and secondary knee stabilisers [16,17]. In a 2010 study, Stannard et al. reported an incidence of torn ligaments following tibial plateau fractures, as high as 85% and 79% in type V and VI respectively [17]. However, this type of injury is also becoming more and more prevalent in the elderly, as consequence of low energy falls and osteoporosis [18]. In such cases, soft tissue damage arises from the delicacy of the skin. The dissociation of the metaphyseal flare from the diaphyseal columns and the status of the soft tissue envelope, can typically represent the severity of the energy imparted to the bone [5,19,20].

Schatzker V and VI fractures have a notoriously high incidence of compartment syndrome that can reach 30.4% for type VI in some studies [21,22]. Compartment syndrome may develop several hours or more after the injury and post-operatively. Pallor, pulselessness, paresthesiae are late signs of compartment syndrome, but patients should be treated with fasciotomy prior to developing these [23].

Radiographic evaluation of these fractures involves four views: anteroposterior (AP), lateral, internal oblique and external oblique. It is useful a 10° craniocaudal angle in AP view in order to represent normal proximal tibia's posterior slope. Computed tomography (CT) is of great value for determining the location and magnitude of the joint depression, enabling greater precision of preoperative planning, while 3D reconstructions provide an estimation of metaphysical bone loss, of articular comminution and joint depression.

The importance of CT evaluation was best demonstrated through the identification of postero-medial and postero-lateral shear fractures as a distinct subtype of complex bicondylar tibial fracture prone to be missed by AP radiograph [13,24]. Higgins et al. in his 2007 comparison of lateral LCP fixation to dual plate fixation and Luo's three-column approach, highlighted the clinical importance of identifying these posterior coronal fracture patterns while Barei et al. in 2008 showed a postero-medial fracture component to exist in nearly one third of the bicondylar plateau fractures [11,13,25].

However, controversy exists in the literature, as to whether routine CT evaluation can provide greater concordance regarding Schatzker's classification and contribute towards changes in preoperative planning in comparison with plain radiographs [26–32]. Both Chan et al. in 1997 and Markhardt et al. in 2009, concluded that the addition of CT scan significantly increasesinterobserver and intraobserver agreement on treatment plan, while Te Stroet et al. in his 2011 study, disputed former evidence reporting no significant advantages over the use of CT scan and concluded against its' routine use [26,27,29]. In accordance with Stoet's results, latest research from de Lima Lopes et al. in 2014 reported no greater concordance regarding Schatzker classification and only moderate effect on Luo's three-column classification concluding that larger studies are needed to decide on routine use [7,33].

Similarly, the formerly suggested capability of an early MRI scan to identify ligamentous or meniscus lesions and affect concordance is questionable by latest research [17,18,34,35].

Treatment options and clinical results

All kinds of stabilisation, from non-operative treatment, to modern staged and combined management with temporary external fixators, prior to conventional or angular stable plating, fine-wire devices or even arthroscopically assisted procedures and nailing for selected cases have been recommended in the literature for complex tibial plateau fractures [5,36–42]. Adequate fixation and early motion are important for a good prognosis and satisfying postoperative functioning [43,44]. In the era before ORIF, Rasmussen back in 70s presented acceptable results with conservative treatment but recognised increased incidence of posttraumatic arthropathies and malunions, while non-operative management remained a supported option till several years later regarding complex injuries [36,37,45]. Targets of definitive treatment should be from one hand restoration of the articular surface and from the other hand the restoration of tibial length and alignment, by rebuilding metaphyseo-diaphyseal comminution. The basic principles for all articular fractures imply rigid fixation for the articular block and indirect reduction with relative stability for the metaphysic foundation of the knee joint [46].

However, what is crucial in deciding the time and modus of the intervention is the status of local soft-tissues which, along with patient's co-morbidities, lead the time of definitive fixation since early incisions through compromised skin could become disastrous.

Temporary external fixation

Casts, splints, traction, and braces are some options for initial damage control treatment for severe cases, nevertheless, the optimal temporising treatment is spanning external fixation [38,47,48]. Staged management with standardised protocol is evaluated by Egol, reporting low rate of wound infections (5%) and