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Surgical strategies in polytraumatized patients with femoral shaft fractures – Comparing a German and an Australian level I trauma centre

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ABSTRACT

Background: Femoral shaft fractures are one of the most common injuries in multiple trauma patients. Due to their prognostic relevance, there is an ongoing controversial discussion as to the optimal treatment strategy in terms of Damage Control Orthopaedics (DCO) and Early Total Care (ETC). We aimed to describe the differences in fracture management and clinical outcome of multiple trauma patients with concomitant femoral shaft fractures treated at a German and an Australian level I trauma centre using the same inclusion criteria.

Methods: Polytraumatized patients (ISS $\geq$ 16) with a femoral shaft fracture aged $\geq$ 16 years treated at a German and an Australian trauma centre between 2003 and 2007 were included. According to ETC and DCO management principles, we evaluated demographic parameters as well as posttraumatic complications and clinical outcome.

Results: Seventy-three patients were treated at the German and 134 patients at the Australian trauma centre. DCO was performed in case of increased injury severity in both hospitals. Prolonged mechanical ventilation time, and length of ICU and hospital stay were demonstrated in DCO treatment regardless of the trauma centre. No differences concerning posttraumatic complications and survival were found between both centres. Survival of patients after DCO was similar to those managed using ETC despite a greater severity of injury and lower probability of survival. There was no difference in the incidence of ARDS. DCO was, however, associated with a greatly increased length of time on mechanical ventilation and length of stay in the ICU.

Conclusion: We found no differences concerning patient demographics or clinical outcomes in terms of incidence of ARDS, MODS, or mortality. As such, we propose that comparability between German and Australian trauma populations is justified. Despite a higher ISS in the DCO group, there were no differences in posttraumatic complications and survival depending on ETC or DCO treatment. Further research is required to confirm whether this is the case with other countries, too.

Introduction

Femoral shaft fractures are one of the most common concomitant injuries in multiple trauma patients.[15,25] Due to their prognostic relevance, there is an ongoing controversial discussion as to the optimal timing of definitive femoral shaft intramedullary nailing (IMN) in these multitrauma patients.[10,20,37,38] As operative procedures are potentially hazardous for the patient in terms of a so-called "second hit", temporary or definitive fracture stabilization could be performed following the principles of Early Total Care (ETC, involving primary IMN within 24 h of injury) or Damage Control Orthopaedics (DCO, involving primary external fixation or traction within the first 24 h of injury followed by delayed IMN some days later).[16,29,33] Based on the "two-hit-theory", posttraumatic complications such as the Acute Respiratory Distress Syndrome (ARDS) and Multi Organ Dysfunction Syndrome (MODS) are

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caused by an excessive release of pro- and anti-inflammatory mediators at the time of operative treatment.[16,21,33] Intramedullary nailing is thought to have a greater influence on the second hit phenomenon than external fixation.[12,24] The longer operation time, higher blood loss and effect of reaming and nail insertion is likely to add to the systemic distress caused by the initial trauma.[32] Therefore, an increased susceptibility to these complications has been described after ETC fracture management, especially in multiple trauma patients with accompanying severe head and thoracic injuries.[22,29,34,37] However, some authors, especially from outside Germany, still prefer the ETC procedure in order to reduce the risk of posttraumatic complications (e.g. infection, pain, pulmonary morbidity).[8,20,38] Further, the use of primary external fixation in DCO is disadvantaged by the need for additional planned operations, prolonged mechanical ventilation and ICU length of stay, the potential for increased infection rates and increased costs.

Previous investigations comparing ETC and DCO have been performed in different countries with divergent trauma care systems.[9,20,22] Accordingly, comparability of current study results seems to be limited due to the marked demographic and geographical discrepancies as well as differences in preclinical and clinical treatment standards.[9,20,22] In lieu of a randomized trial, we present a comparison between two Level I trauma centres from different countries exhibiting different pre-hospital and in-hospital management guidelines. Consequently, the present study aimed to describe the differences in fracture management and clinical outcome of multiple trauma patients with concomitant femoral shaft fractures treated at a German and an Australian Level I trauma centre using the same inclusion criteria.

Materials and methods

The present report is a retrospective study of two level I trauma centres following the guidelines of the revised UN declaration of Helsinki in 1975 and its latest amendment in 1996 (42nd general meeting). Data were raised by chart review.

Inclusion and exclusion criteria

Polytraumatized patients (Injury Severity Score [ISS] $\geq$ 16 points) with a concomitant femoral shaft fracture aged $\geq$ 16 years and primarily admitted to the level I trauma centres in Germany and Australia between January 1st 2003 and December 31st 2007 were included in the present study. Plate or screw osteosynthesis of femoral fracture led to exclusion. Patients who were deceased before admission to the intensive care unit (ICU) were excluded as well.

Injury severity and injury pattern

The injury severity was classified according to the Injury Severity Score (ISS),[2] based on the Abbreviated Injury Scale (AIS).[14]

Clinical parameters and outcome evaluation

Demographic and clinical data including duration of ventilation, intensive care unit admission, and overall length of hospital stay were abstracted from patients' chart review. Laboratory, haemodynamic and respiratory parameters were documented. The results of clinical examination and blood chemistry were recorded up to fourteen days after hospital admission. Transfusion requirements including packed red blood cells (PRBC), fresh frozen plasma (FFP) and platelets (PLT) was measured within the first twenty-four hours after hospital admission. The survival prognosis of trauma patients was described using the established Trauma and Injury Severity Score (TRISS)[7]:

$$\text{TRISS survival} = \frac{1}{1 + e^{-X}}$$

$$X_{\text{blunt trauma}} = -0.4499 + 0.8085 \times \text{RTS} - 0.0835 \times \text{ISS} - 1.7430 \times (\text{age} \geq 55\,\text{years})$$

$$X_{\text{penetrating trauma}} = -2.5355 + 0.9934 \times \text{RTS} - 0.0651 \times \text{ISS} - 1.1360 \times (\text{age} \geq 55\,\text{years})$$

Posttraumatic complications during hospital treatment focused explicitly on MODS and ARDS. Common posttraumatic complications after surgery like infection, non-union, or venous thromboembolism were not evaluated by this study. MODS was defined according to the score described by Marshall et al.[17] A manifest MODS was considered if the score was greater than twelve points on two consecutive days or at least three days during the observation period.[11,17,39] The diagnosis of ARDS was made according to the criteria of the American-European Consensus Conference on ARDS.[3,4] Primary outcome was defined as mortality during clinical course.

Surgical strategy

ETC management was defined as definitive intramedullary treatment of femoral shaft fractures within the first 24 h after admission with nailing.[5] Following the DCO treatment, definitive osteosynthesis by nailing was performed after more than 24 h. Temporary fracture stabilization was performed by external fixation early after hospital admission within the first 24 h.[6,30,34]

Statistics

Incidences are presented with counts and percentages while continuous variables are presented as mean and standard deviation (SD) or median with interquartile range. Differences between the groups were evaluated with Student's *t*-test or Wilcoxon rank sum test for continuous data, while Fisher's exact test was used for categorical variables. A two sided p-value <0.05 was considered to be significant. The data were analysed using the Statistical Package for the Social Sciences (SPSS; version 20; IBM Inc., Somers, NY, USA). We determined sample size and power analysis using GraphPad StatMate version 2.00 for Windows (GraphPad Software; San Diego; CA; USA).

Results

In total, 207 multiple traumatized patients were included in this study. Seventy-three patients were treated at the German trauma centre while 134 patients were treated at the Australian trauma centre. Comparing the demographic parameters of both trauma centres, no differences were found concerning age, gender distribution or injury severity (Table 1).

ETC and DCO at the German trauma centre

Fracture management in terms of DCO was performed in 51 patients (70%) at the German trauma centre (Table 2). Analysing the injury pattern between ETC and DCO, patients undergoing DCO had suffered more severe traumatic brain injuries which lead to an increased overall injury severity and a significantly worse prediction of survival (DCO: 72.5 $\pm$ 30.7% vs. ETC: 92.0 $\pm$ 18.4%;