Injury, Int. J. Care Injured 48 (2017) 1388–1392

Contents lists available at ScienceDirect

Injury

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

# Validation of a new classification system for interprosthetic femoral fractures

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ARTICLE INFO

*Article history:*
Received 9 December 2016
Received in revised form 31 March 2017
Accepted 11 April 2017

*Keywords:*
Fractures
Interprosthetic fractures
Periprosthetic fractures
Knee prosthesis
Hip prosthesis
Osteoporotic fractures
Femur fractures
Fragility fractures

ABSTRACT

Interprosthetic femoral fracture (IFF) incidence is gradually increasing as the population is progressively ageing. However, treatment remains challenging due to several contributing factors, such as poor bone quality, patient comorbidities, small interprosthetic fragment, and prostheses instability. An effective and specific classification system is essential to optimize treatment management, therefore diminishing complication rates. This study aims to validate a previously described classification system for interprosthetic femoral fractures.



## Introduction

Incidence of interprosthetic femoral fracture is 1.25% of patients who undergo hip and knee replacements. Despite undeniable improvement with fracture fixation techniques and replacements, mortality and surgery revision rates have reached 50% [1].

Some authors have previously reported classification systems for periprosthetic and interprosthetic femoral fractures [2–4]. However, a specific, validated classification method that indicates a treatment algorithm is crucial to improve treatment outcomes.

This study aims to confirm the reliability of a new Classification System for IFF.

## Methods

The classification system proposed by the authors was presented in detail to five observers prior to evaluation. An orthopedic trauma surgeon, a knee surgeon, and a hip surgeon, all fellowship-trained, as well as two senior residents in orthopedics and traumatology voluntarily participated in the study.

Twenty-three radiographs of interprosthetic femoral fractures in anteroposterior and lateral views were randomly selected from the personal archives of the authors. Fractures were classified twice, with 30 days between each assessment, using the Pires Classification System [1]. During the second assessment, the radiographs were evaluated in a different order to prevent bias based on previous assessment. No time limit was given for fracture classification. Sample size calculation was performed based on previous studies and according to statistical parameters. Kappa Index stratified by Landis and Koch evaluated inter-observer reproducibility. Statistical significance was established at $P < 0.05$.

Pires et al., classification system for interprosthetic femoral fractures is based on fracture site, interprosthetic bone fragment viability, and prostheses stability. Figs. 1–3 show the proposed classification system [1] and Figs. 4–7 show our treatment algorithm.

The study was approved by the Institutional Ethics Committee and performed according to the standards of the Declaration of Helsinki.

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http://dx.doi.org/10.1016/j.injury.2017.04.008
0020-1383/

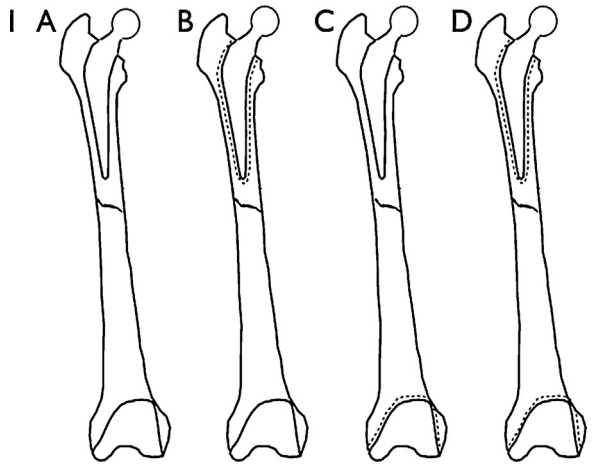


**Fig. 1.** Interprosthetic fracture surrounding hip.
IA: Stable prostheses.
IB: Unstable hip prosthesis; stable knee prosthesis.
IC: Stable hip prosthesis; unstable knee prosthesis.
ID: Unstable hip and knee prostheses.

## Results

Kappa index showed moderate concordance on the first evaluation between residents one and two ($K = 0.048$; $P = 0.000$). Fair agreement was found on the second evaluation between residents one and two ($K = 0.370$; $P = 0.000$). Among fellowship-trained surgeons (trauma, knee, and hip), all inter-observer evaluations showed moderate agreement ($P = 0.000$). Inter-observer reliability among fellowship-trained surgeons and residents showed moderate agreement either in first or second evaluations ($P = 0.000$). However, it is noteworthy that inter-observer reliability of first evaluation between resident one and knee surgeon showed substantial agreement ($K = 0.628$; $P = 0.000$).

Table 1 shows inter-observer reproducibility.

General intra-observer Kappa index was 0.016, showing poor agreement. However, this finding should be interpreted with caution since no statistical significance was found ($P = 0.697$).

## Discussions

Periprosthetic fractures occur 2.5% around the knee, and 2% around the hip. Interprosthetic femoral fractures incidence is reported in 1.25% of patients who undergo hip and knee replacements. However, with the increasing number of elderly patients requiring joint replacements, the IFF number is gradually rising [1,5–9].

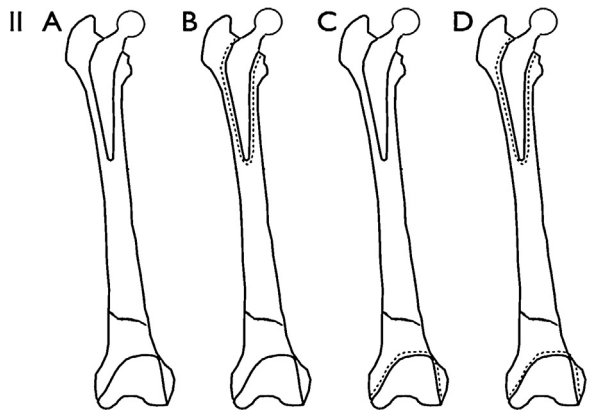


**Fig. 2.** I Interprosthetic fracture surrounding knee.
IIA: Stable prostheses.
IIB: Unstable hip prosthesis; stable knee prosthesis.
IIC: Stable hip prosthesis; unstable knee prosthesis.
IID: Unstable hip and knee prostheses.

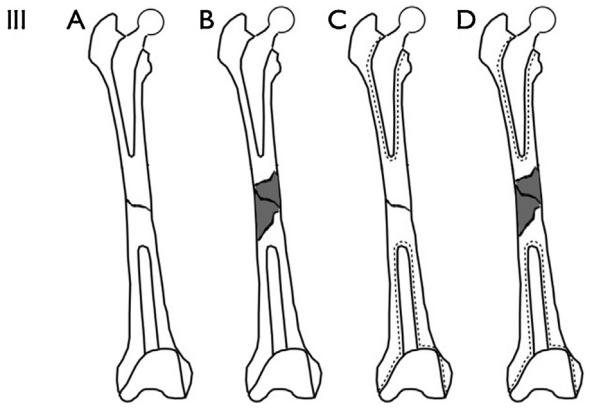


**Fig. 3.** III Interprosthetic fracture with femoral extension stem.
IIIA: Stable prostheses with viable bone between the prostheses.
IIIB: Stable prostheses with unviable fragment due to lack of bone interval between prostheses ends. A convention for bone fragment viability was defined as at least 5 cm with cement and prosthesis components absence in the fracture site.
IIIC: Unstable prostheses (hip, knee, or both) with viable bone between the prostheses.
IIID: Unstable prostheses (hip, knee, or both) with unviable fragment due to lack of bone interval between prostheses ends.

Several classifications have been described for periprosthetic fractures around the knee and hip. However, a few studies have been specifically addressed for classification and management of interprosthetic femoral fractures [10–19].

Soenen et al. [4] proposed an additional grade in the Vancouver and Societé Française de Chirurgie Ortopédique et Traumatologique (SoFCOT) classifications. The complement in the original classifications specifically addresses the challenging interprosthetic fracture around total knee prosthesis with diaphyseal extension stem. Two main reasons contribute to the high complication rates related to this fracture pattern: presence of cement in the medullary canal, compromising blood supply; and the small bone interval between prostheses, which presents a hazard for stable fracture fixation.

Platzer et al. [14] described a classification system for IFF based on the fracture site and prosthesis vicinity: Type I, no adjacency; Type II, adjacent to one prosthesis, and Type III, adjacent to both prostheses.

Pires et al. [1] presented a case series of IFF patients and described a specific and complete classification system. A treatment algorithm rooted in this classification was also demonstrated. The main advantage of the proposed classification system is the addition of the most challenging interprosthetic femoral fracture pattern: the interprosthetic fracture with knee revision stem. Type III was subdivided into four subtypes, according to the viability of the remaining interprosthetic bone fragment and prostheses stability. At least 5 cm with no cement or prosthetic components in the fracture site was defined as allowing bone fragment viability.

An adequate fracture classification system presents acceptable reproducibility as well as indicates treatment and prognosis. This study showed moderate inter-observer agreement for the proposed classification system. Therefore, one can conclude that our classification system, whose treatment algorithm has recently been published, fulfils all requirements for its application in clinical practice.

Scolaro and Schwarzkopf, in a review article about interprosthetic femoral fractures, emphasized that the present classification