European Journal of Orthopaedic Surgery & Traumatology (2019) 29:1069–1072
https://doi.org/10.1007/s00590-019-02393-8

ORIGINAL ARTICLE • HIP & KNEE - FRACTURES

Reliability of the commonly used classification systems for interprosthetic fractures

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Received: 23 June 2018 / Accepted: 4 February 2019 / Published online: 18 March 2019

Abstract

Objectives An interprosthetic fracture occurs between a hip and knee arthroplasty. There is currently no universally agreed classification. The aim of this study was to determine the interobserver and intraobserver reliability of the most commonly used interprosthetic fracture classifications.

Methods Nineteen interprosthetic fractures were classified by four reviewers for inter- and intraobserver reliability. The most commonly used interprosthetic fracture classifications were the Soenen classification, Platzer classification, and Pires classification. Cohen's kappa coefficient was calculated.

Results A moderate interobserver reliability was found for all the classification systems. The Platzer classification had a kappa value of 0.586, the Pires classification 0.499, and Soenen classification 0.489. The intraobserver error was 0.767 for the Platzer classification (substantial agreement), 0.636 for the Pires classification (substantial agreement), and 0.318 for the Soenen classification (fair agreement).

Conclusions This study has demonstrated moderate interobserver reliability and substantial intraobserver reliability for both the Platzer and Pires classifications. This paper would recommend the use of either classification for interprosthetic fractures.

Keywords Interprosthetic fracture · Platzer classification · Pires classification · Interobserver error · Intraobserver error

Introduction

There are increasing numbers of lower limb arthroplasties being undertaken [1]. This increases the risk of these patients sustaining an interprosthetic fracture. These occur between a total knee replacement and a femoral stem of either a hemiarthroplasty or total hip replacement [2–4].

There is currently no universally agreed treatment algorithm or classification system for interprosthetic fractures [5, 6]. Several have been suggested. These were initially based on modifications of classifications used for periprosthetic fractures such as the Vancouver classification [5, 7, 8]. More recently, separate classifications have been proposed [9]. Despite this, there is still currently no universally accepted classification and few studies have assessed the reliability of these classifications systems [5, 6].

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The primary aim of this study was to determine the interobserver and intraobserver reliability of the most commonly used interprosthetic fracture classifications. The secondary outcome was to determine whether these classifications could reliably guide treatment for these fractures.

Materials and methods

Patients were identified from a hospital database of all periprosthetic fractures that presented to a single institution between 2008 and 2015. All interprosthetic fractures were identified between a femoral stem of a total hip replacement, hemiarthroplasty or revision femoral stem, and a total knee or revision knee replacement.

All radiographs were reviewed, and patients were included if they had pre-operative radiographs showing the entire femur in 2 planes. Radiographs were excluded if they were of poor quality and did not show the entire femur.

All images were sent to three Consultant Orthopaedic Surgeons and a Specialty Registrar. They classified all fractures and then undertook this again at least 4 weeks

following initial review of the images. The second part of the study asked the surgeons the surgical treatment they would recommend based on the classification in a patient that was medically fit for a surgical procedure. This was used to determine the use of these classifications at predicting surgical treatment.

The most commonly used interprosthetic fracture classifications were determined following a literature search. These were the Fink classification, Soenen classification, Platzer classification, and Pires classification [7–10].

The Fink classification system was developed from the Vancouver classification for periprosthetic hip fractures. It differentiates interprosthetic fractures between a stemmed prosthesis of the hip and surface replacement prosthesis of the knee joint (type IA) and those that occur between two stemmed prostheses (hip and knee) (type IB). The type IA fractures are further classified according to the status of the implants: stable implants as type IA1 and loose implants as type IA2 [7].

Soenen et al. [7] proposed a classification based on the Vancouver and the Societe Francaise de Chirugie Orthopaediuque et Traumtologique classifications. These both divide the fracture into A above, B at the level, and C below the implant. Soenen proposed a type D fracture which corresponds to an interprosthetic femoral fracture between a standard or revision THR and a revision TKR wherever the fracture site [8].

Platzer et al. [10] devised a new classification based on the Vancouver classification for periprosthetic hip fractures. Platzer et al.'s classification was based on the location of the fracture and its adjacency to the prosthesis. A type 1 fracture is not adjacent to a prosthesis, type 2 is adjacent to one prosthesis, and type 3 adjacent to both prostheses. These are subdivided into A, B, and C: type A when both implants are stable, and C both unstable. B is divided into type B1 with a loose hip component and B2 with a loose knee component (Fig. 1) [10].

Pires et al. proposed a new classification in 2014. It is one of the first to not be closely related to the previous classifications on periprosthetic fractures. The classification is based on the fracture site in relation to the prosthesis, interprosthetic bone fragment viability, and prostheses stability. A type I fracture is surrounding the hip, type II is surrounding the knee, and type III is an interprosthetic fracture with femoral extension stem. These are then sub-classified dependent on stem stability and bone viability (Fig. 2) [9]

Statistical analysis

Cohen's kappa coefficient (κ value) was used to determine intraobserver and interobserver error. It can range from a score of −1 to +1: +1 being perfect agreement and 0 representing the amount of agreement that can be expected from random chance. The Landis and Koch criteria were used to interpret the κ value. A value of 0.00–0.20 indicates slight agreement, 0.21–0.40 fair agreement, 0.41–0.60 moderate agreement, 0.61–0.80 substantial agreement, and 0.81–1.00 almost perfect agreement [11]

Where there were more than two observers for comparison, the raw data are published in tabular form, and for conclusions the mean of the κ value was taken.

Results

There were 19 interprosthetic femoral fractures included

The Fink classification was initially to be included in the study, but all the authors could not classify 10 of the 19 fractures on this classification system and were therefore excluded from the analysis.

A moderate interobserver reliability was found for all the classification systems. The Platzer classification had a kappa value of 0.586, the Pires classification 0.499, and Soenen classification 0.489.

Fig. 1 Platzer classification

Classification	Fracture adjacency to the prosthesis		
	Type I (no adjacency)	Type II (adjacency to one prosthesis)	Type III (adjacency to both prostheses)
Stability of the prosthesis Sub-type A (both stable)	√	√	√
Sub-type B (one stable, one loose B1 (loose hip component)	X	√	√
B2 (loose knee component)	X	√	√
Sub-type C (both loose)	x		√

Fig. 2 Pires classification

I. 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

II. 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

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
- 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

Table 1 Kappa coefficient for interobserver error

Classification	A versus B	A versus C	A versus D	B versus C	B versus D	C versus D	Mean
Soenen	0.744	0.286	0.593	0.236	0.823	0.251	0.489
Pires	0.502	0.369	0.410	0.506	0.507	0.698	0.499
Platzer	0.369	0.468	0.780	0.622	0.602	0.675	0.586

The intraobserver error was 0.767 for the Platzer classification (substantial agreement), 0.636 for the Pires classification (substantial agreement), and 0.318 for the Soenen classification (fair agreement) (Table 1).

The treatment that the participants recommended based on there classification is shown in Table 2.

Table 2 Surgical treatment recommended by authors of each individual fracture dependent on classification

Classification	ORIF percentage	Revision hip percentage	Distal femoral replacement (percentage)
Soenen B	81.3	6.3	12.5
Soenen C	92.9	0	7.1
Soenen D	78.6	0	21.4
Platzer 1A	100	0	0
Platzer 1B2	100	0	0
Platzer 2A	100	0	0
Platzer 2B1	0	0	100
Platzer 2B2	16.7	0	83.3
Platzer 3A	100	0	0
Platzer 3B1	66.7	33.3	0
Platzer 3B2	0	0	100
Pires 1A	100	0	0
Pires 1B	25	75	0
Pires 2A	100	0	0
Pires 2B	0	0	100
Pires 2C	33.3	0	66.7
Pires 3A	100	0	0
Pires 3B	100	0	0
Pires 3D	0	0	100

Discussion

There are over 1.5 million primary hip and knee replacements recorded in the NJR as of 2016 [1]. Therefore, the risk of patients sustaining an interprosthetic fracture will increase in future [2–4]. Despite the increasing incidence, there is limited research into the management and outcomes. This has therefore meant it is difficult to currently draw conclusions about there management and long-term outcomes. There is not currently a universally agreed classification system. Several classification systems have been proposed and can be found in the literature [6].

Classification systems for interprosthetic fractures were initially based on the Vancouver classification and the Societe Francaise de Chirugie Orthopaediuque et Traumtologique classifications for periprosthetic fractures [6]. These classifications systems have become more complex over time with a greater number of variations suggested.

This study aimed to assess the interobserver and intraobserver reliability of the most commonly used classifications. This study demonstrated a moderate interobserver reliability for all the classifications and a substantial intraobserver reliability for the Platzer and Pires classifications. The Pires and Platzer classifications have many similarities. The Platzer assesses the adjacency of the fracture to the prosthesis and then sub classifies this based on implant stability [10]. The Pires classification divides the fracture based on fracture position, relative to the implants, and then subdivides these based on implant stability and bone viability [9]. Both studies had moderate interobserver reliability, and the participants agreed in the choice of surgery for these patients in the majority of cases, demonstrating that these are useful at guiding treatment. A previous study by Pires found moderate interobserver reliability for there classification [12]. This was also demonstrated in this study.

All these classification systems have proposed algorithms for the treatment of these fractures. These all essentially suggest that if the implant is loose, then it should be revised, and if the implant is stable, then plate osteosynthesis should be performed [5, 12].

Designing a classification system for interprosthetic fractures is difficult, as it encompasses a wide variety of fractures, and the ideal classification system for these fractures should comment on both the fracture location, and its impact on the surrounding implant. The Pires and Platzer classifications systems both comment on these and provide a moderate reliability.

A concern with these classifications is the complexity of them. As classification systems get more complex, there reliability goes down [13]. This though does not seem to be the case in these classifications, as despite the large number of variables, they are relatively simple to use.

There are limitations to this study, and they include a small number of fractures, and that these did not incorporate all the potential divisions of each classification. These fractures were taken from a case series at a single centre, so do demonstrate a realistic spectrum of fractures that a surgeon may encounter. A further limitation is that only 4 participants undertook the study, but with 3 consultant arthroplasty surgeons, and a specialty registrar which gives a good representation of professionals who will be managing these fractures.

Interprosthetic fractures provide many challenges, and there incidence is only going to increase in future. At present from the current literature, it is difficult to draw strong conclusions on there management and outcomes. By recommending the use of either the Platzer or Pires classification system, this will enable future papers to be more easily compared to make valid conclusions on there management and outcomes.

Conclusions

This study has demonstrated moderate interobserver reliability and substantial intraobserver reliability for both the Platzer and Pires classifications. This paper would recommend the use of either classification for interprosthetic fractures.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

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