Interobserver and Intraobserver Reliability and Validity of the Vancouver Classification System of Periprosthetic Femoral Fractures After Hip Arthroplasty

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Abstract: The Vancouver classification system of periprosthetic fractures has been revalidated in this study, using the radiographs of 45 patients. Three consultants and 3 trainees reviewed the radiographs independently, on 2 separate occasions, at least 2 weeks apart. Interobserver and intraobserver agreement and validity were analyzed, using weighted κ statistics. The mean κ value for interobserver agreement was found to be 0.69 (0.63-0.72) for consultants and 0.61 (0.56-0.65) for the trainees, both representing substantial agreement. Intraobserver κ values ranged from 0.74 to 0.90, showing substantial agreement. Validity analysis of 37 type B cases revealed 81% agreement within B1, B2, and B3 subgroups with a κ value of 0.68 (substantial agreement). This study has reconfirmed the reliability and validity of the Vancouver classification while it also emphasizes the intraoperative assessment of implant stability. **Keywords:** arthroplasty, periprosthetic, fracture, Vancouver, reliability, validity.

The number of primary and revision total hip arthroplasties (THA) is steadily increasing with the increase in average life expectancy [1]. An increasing number of joint arthroplasties are being performed on young active patients as well as osteopenic elderly patients, raising the lifetime risk of aseptic loosening and requirement of revision surgery. Periprosthetic fracture is one of the most serious complications of THA, with a reported mortality of 11% [2] and an incidence reportedly as high as 0.9% for primary THA and 4.2% for revision THA [3].

The treatment of periprosthetic fractures is challenging for the orthopedic surgeon because of the many variables that need to be considered with each fracture, including fracture site and pattern, implant stability and the surrounding bone quality, coupled with the more general factors such as patient's age and functional demands. As the treatment is complex, frequently requiring referral to specialized centers, preoperative planning plays an important role, necessitating a reliable and valid classification system that can assist surgeons to formulate a treatment plan and check for available resources, as well as to communicate across different hospitals. Various classifications have been described [4-7], although thus far, no single system has been successful in addressing all these 3 vital factors, together.

The Vancouver classification was developed in 1995 [8] (Table 1). It covers not only the fracture site but also the stability of the femoral implant and the quality of surrounding bone stock, which are important factors in determining definitive treatment of these complex fractures. The Vancouver classification system categorizes periprosthetic fractures into 3 types, based on fracture location. Type A fractures are located in the proximal metaphysis without extending into the diaphysis. Type A is further subdivided into those involving the greater trochanter (A_G) and lesser trochanter (A_L). Fractures around the stem or just below it are defined as type B, whereas those well below the prosthesis tip are classified as type C. Type B fractures are further subdivided into B1 (prosthesis stable) (Fig. 1), B2 (loose prosthesis with adequate bone stock) (Fig. 2), and B3 (loose prosthesis with poor bone stock) (Fig. 3). The reliability and validity of this classification system have been assessed by the developers [9] and an independent researcher Rayan

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Table 1. Vancouver Classification [8] for Periprosthetic Fracture of Femur

Type	Subtype	Fracture Description
Type A		Fracture in proximal metaphysis
	A_G	Greater trochanter fracture
	A_L	Lesser trochanter fracture
Type B		Fracture around or just below the stem
	B_1	Stable implant
	B_2	Loose implant
	B_3	Loose implant with poor bone stock
Type C		Fracture well below the tip of the stem

et al [10]. The objective of this study is to independently reassess the interobserver and intraobserver reliability and validity of the Vancouver classification system, in our regional trauma center.

Materials and Methods

The records of all consecutive patients with periprosthetic fractures, after hip arthroplasty, admitted to our regional trauma center between 2004 and 2010, were analyzed, retrospectively. Only those patients with appropriate preoperative and postoperative radiographs showing the full extent of the fracture and prosthesis in 2 planes, as well as having documentation of intraoperative implant stability were included in the study.

Fig. 1. Vancouver type B1 periprosthetic fracture of left femur showing well-fixed stem.

Fig. 2. Vancouver type B2 periprosthetic fracture of femur. Implant is loose but there is adequate bone stock.

Forty-eight patients were potentially eligible for inclusion. Three were excluded because of incomplete data, leaving a cohort of 45 patients for the study, of which 19 were men and 26 were women, with a mean age of 76 (64-81) years.

The study was done in 2 stages. Stage 1 of the study involved the analysis of interobserver and intraobserver reliability of the Vancouver classification. Six observers were involved in this study, including 3 consultants and 3 trainee surgeons (registrar). All participants reviewed the Vancouver classification system before the study. Radiographs of all 45 patients were classified by all 6 participants independently, on 2 separate occasions, at least 2 weeks apart. Stage 2 of the study assessed the validity of the classification by comparing the subgroup classification of type B fractures with the intraoperative findings, as retrieved from the operative notes. The senior consultant's classification results were used for validation purpose and were compared with the intraoperative findings.

Statistical Analysis

Data were analyzed on Stata 11.1 using the weighted κ statistic to measure the agreement level, for 2 observers. For more than 2 observers in each group (3 consultants