RESEARCH PAPER

Prospective Analysis of Periprosthetic Femur Fractures Around Well-Fixed Stems: Surgical and Functional Outcomes Following Cable-Plate Fixation

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ABSTRACT

Background: Periprosthetic femoral fractures around a stable femoral stem remain demanding injuries, particularly in older patients with osteoporotic bone and limited physiological reserve. Evidence on prospective outcomes after cable-plate fixation is still relatively sparse.

Objectives: To evaluate radiological union, healing time, functional recovery, and factors associated with incomplete healing after cable-plate fixation for Vancouver B1 and C periprosthetic femur fractures.

Materials and Methods: This prospective observational study included 30 patients treated over 9 months for Vancouver B1 or C periprosthetic femur fractures around well-fixed stems. All fractures were managed through a lateral approach using cable-plate constructs. Functional outcome was assessed with the Harris Hip Score (HHS), and radiographic healing was followed until union or persistence of nonunion. Descriptive statistics were generated for baseline and outcome variables. Preoperative and 9-month HHS values were compared using a paired t-test. Categorical associations with union status were assessed using Fisher's exact test.

Results: Mean age was 70.9 ± 6.8 years, and men and women were represented equally. Vancouver B1 fractures accounted for 22 cases (73.3%), while 8 (26.7%) were type C. Union was achieved in 21 patients (70.0%), delayed union in 6 (20.0%), and nonunion in 3 (10.0%). Among the 21 patients with timely union, mean time to union was 13.7 ± 1.4 weeks. Mean HHS improved from 44.8 ± 2.3 preoperatively to 75.9 ± 7.4 at 9 months, with a mean gain of 31.1 points (95% CI 28.2 to 34.1; $p<0.001$). Union was more frequent when plate-stem overlap was at least 6 cm (88.2% vs 46.2%, $p=0.020$).

Conclusion: Cable-plate fixation provided satisfactory healing and clinically meaningful functional improvement in selected Vancouver B1 and C fractures with stable stems. Healing problems clustered in fractures with adverse mechanical or biological features, especially shorter plate overlap, transverse distal fracture patterns, and osteoporosis. Careful implant planning and sound overlap across the stem appear central to success.

Keywords: Periprosthetic femur fracture; Vancouver classification; cable-plate fixation; fracture union; Harris Hip Score; hip arthroplasty

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INTRODUCTION

Periprosthetic femoral fractures have become an increasingly visible part of contemporary arthroplasty practice as the number of primary and revision hip replacements continues to rise.[1] Registry-based work from Sweden showed that these fractures are not only clinically serious but also epidemiologically relevant in an ageing arthroplasty population.[2] Their frequency has continued to climb in more recent large cohort analyses, reflecting both expanding arthroplasty volume and the longer survival of elderly patients with implants in situ.[3]

Treatment planning is inseparable from classification. The Vancouver system remains the most widely used framework because it links fracture location, stem stability, and bone stock to practical management pathways.[4] Its reliability has been validated in postoperative femoral periprosthetic fractures, which is one reason it still anchors most decision-making algorithms in daily practice.[5] When the stem is well fixed, particularly in Vancouver B1 and type C injuries, open reduction and internal fixation is generally preferred over revision arthroplasty.[6]

Even then, these fractures are rarely straightforward. The proximal fragment is often short, screw purchase can be compromised by the presence of the stem, and many patients bring biologically fragile bone to the operating room. Functional assessment after fixation also matters, because radiographic union alone does not fully describe recovery in elderly patients trying to regain mobility, pain control, and day-to-day independence. The Harris Hip Score remains one of the most widely used tools for this purpose in hip surgery outcomes research.[7]

Cable-plate constructs offer a practical solution in this setting. They allow circumferential proximal fixation around a well-fixed stem, preserve the possibility of distal screw fixation, and can reduce the need for extensive implant revision in carefully selected patients. Still, prospective clinical data remain limited, especially for mixed Vancouver B1 and C cohorts managed with a standardized cable-plate strategy. The present study was undertaken to examine radiological union, time to healing, functional recovery, and the pattern of complications after cable-plate fixation in periprosthetic femur fractures around stable stems.

MATERIALS AND METHODS

Study design and setting: A prospective observational study was conducted at AIMS, Bellur over a 9-month period.

Study population: A total of 30 patients with periprosthetic femur fractures around well-fixed femoral stems were included.

Inclusion criteria: Patients with Vancouver B1 or Vancouver C periprosthetic femur fractures and a well-fixed femoral stem were eligible for inclusion.

Exclusion criteria: Fractures around loosened stems, pathological fractures, and patients with polytrauma were excluded.

Surgical technique: All patients underwent fixation through a lateral approach to the femur. Fracture reduction was performed under direct visualization, followed by stabilization using a cable-plate construct. Proximal fixation was achieved with cerclage cables because the stem limited screw placement proximally. Distal fixation was obtained with plate fixation according to fracture morphology and available bone stock. Particular emphasis was placed on adequate plate overlap across the femoral stem to reduce stress concentration at the stem–plate junction.

Postoperative protocol and follow-up: Mobilization was initiated as tolerated. Weight-bearing was individualized according to fixation stability and bone quality. Patients were reviewed serially, and the principal follow-up endpoint for functional assessment was 9 months after surgery.

Outcome measures: The primary radiological outcome was fracture union. Delayed union and nonunion were also recorded. Functional recovery was assessed using the Harris Hip Score (HHS) preoperatively and at 9 months. Complications were documented from the clinical record.

Statistical analysis: Data were compiled and analyzed using standard descriptive statistics. Continuous variables are presented as mean ± standard deviation or median with interquartile range, as appropriate. Categorical variables are summarized as frequencies and percentages. Preoperative and 9-month HHS values were compared using a paired t-test. Associations between selected categorical variables and final healing status were explored using Fisher's exact test. A two-sided p value <0.05 was considered statistically significant.

RESULTS

A total of 30 patients were analyzed. The mean age of the cohort was 70.9 ± 6.8 years, with equal representation of men and women. Vancouver B1 fractures were more frequent than type C injuries, accounting for 22 cases (73.3%) compared with 8 (26.7%), as detailed in Table 1. All fractures were managed through a lateral approach, and plate–stem overlap measured 6 cm (interquartile range, 4–6 cm).

Radiological healing was achieved in most patients. Union occurred in 21 of 30 patients (70.0%), delayed union in 6 (20.0%), and nonunion in 3 (10.0%). This distribution is illustrated in Figure 2 and summarized numerically in Table 2. Among the 21 patients with timely union, the mean time to union was 13.7 ± 1.4 weeks. In the 6 delayed-union cases that ultimately healed, mean time to union was 20.7 ± 1.5 weeks. Considering all 27 patients who eventually achieved union, the overall mean healing time was 15.2 ±
3.3 weeks.

Functional recovery improved across the cohort. Mean preoperative HHS rose from 44.8 ± 2.3 to 75.9 ±
7.4 at 9 months, corresponding to a mean improvement of 31.1 points (95% CI 28.2 to 34.1). The paired comparison was statistically significant ($t=21.82$, $p<0.001$). Figure 1 depicts this shift in mean hip function, while Table 2 shows that the largest gain was observed among patients who went on to union.

Healing patterns were not evenly distributed across technical and biological subgroups. Patients with plate–stem overlap of at least 6 cm showed a higher union rate than those with shorter overlap (88.2% vs 46.2%), and this association reached statistical significance (p=0.020), as shown in Table 3. The stacked distribution in Figure 3 similarly shows a progressive reduction in delayed union and nonunion as overlap increased. Vancouver type was not significantly associated with final healing status in this cohort (p=0.374), although type C fractures numerically had a high union proportion. Figure 4 shows the underlying fracture-type distribution.

Complication clustering followed a recognizable pattern. All patients with uncomplicated records proceeded to union, whereas delayed union and nonunion were confined to cases with adverse features such as transverse distal fracture morphology, osteoporosis, or severe osteoporosis with displacement. This relationship is presented in Table 3. Nonunion cases also demonstrated the lowest postoperative HHS values, underscoring the clinical cost of failed biological healing.

Table 1. Baseline demographic, fracture, and construct characteristics (n=30).

Variable	Value
Age, mean ± SD (years)	70.9 ± 6.8
Sex, male	15 (50.0%)
Sex, female	15 (50.0%)
Side, right	19 (63.3%)
Side, left	11 (36.7%)
Vancouver type B1	22 (73.3%)
Vancouver type C	8 (26.7%)
Surgical approach, lateral	30 (100%)
Plate–stem overlap, median (IQR), cm	6 (4–6)
Plate–stem overlap ≥6 cm	17 (56.7%)
Plate–stem overlap <6 cm	13 (43.3%)

Values are presented as number (percentage) unless otherwise specified. IQR, interquartile range.

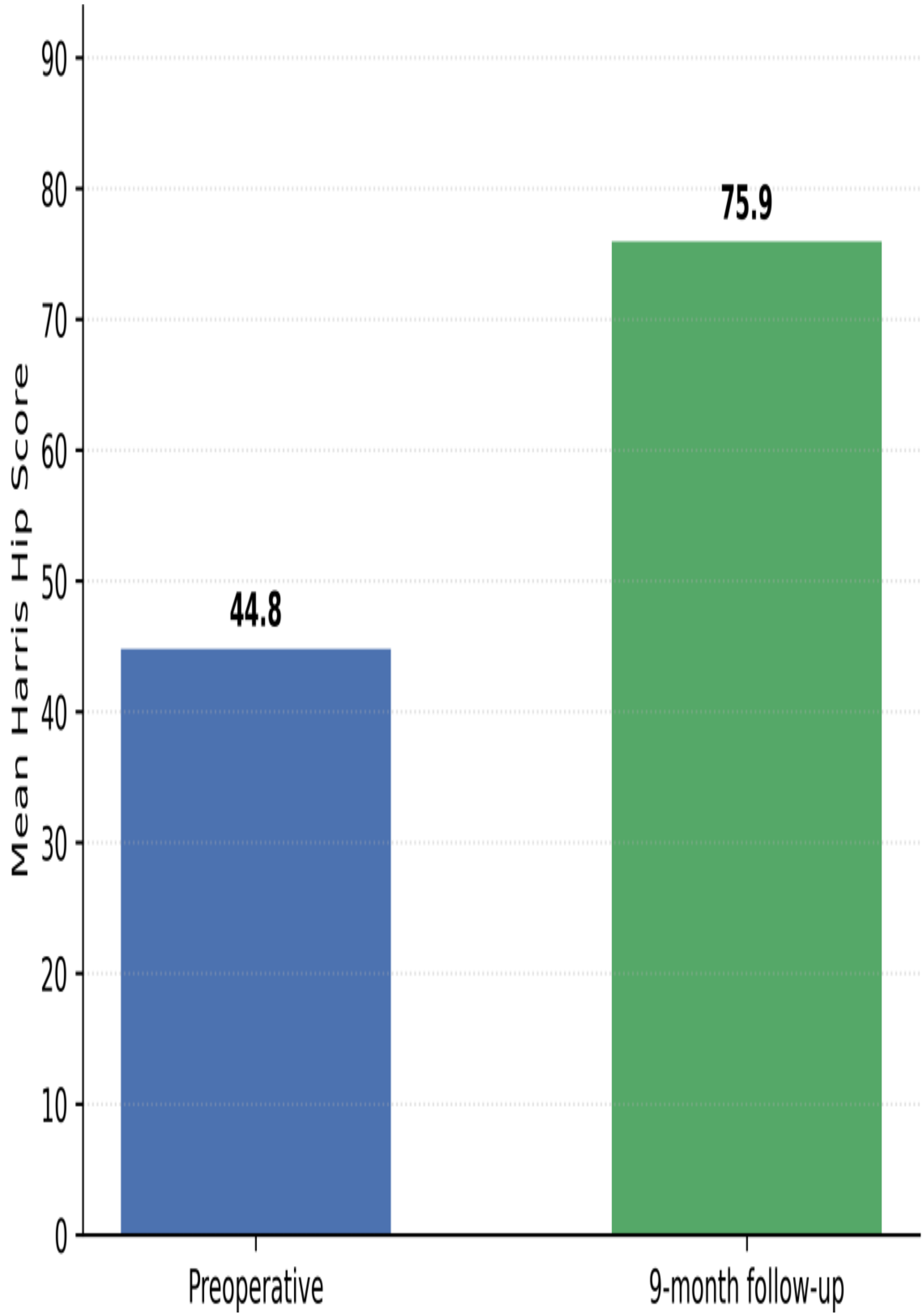

Figure 1. Mean Harris Hip Score before surgery and at 9 months after cable-plate fixation.
Mean values are shown above each bar. The figure illustrates the cohort-level functional gain over follow-up.

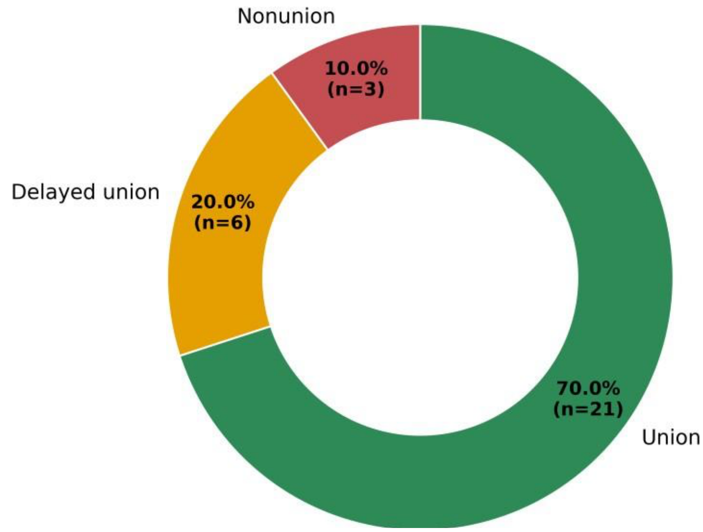

Figure 2. Distribution of final radiological outcomes after cable-plate fixation.

The donut chart presents the proportions of union, delayed union, and nonunion in the full cohort.

Table 2. Radiological and functional outcomes according to final healing status.

Outcome category	n (%)	Time to union, mean ± SD (weeks)	Pre-op HHS, mean ± SD	Post-op HHS at 9 months, mean ± SD	Mean HHS change
Union	21 (70.0%)	13.7 ± 1.4	45.0 ± 2.6	80.0 ± 1.9	35.1
Delayed Union	6 (20.0%)	20.7 ± 1.5	43.8 ± 1.5	70.3 ± 2.4	26.5
Nonunion	3 (10.0%)	Not achieved	45.7 ± 0.6	58.3 ± 1.2	12.7

Time to union was calculated only for cases in which radiographic union was eventually achieved.

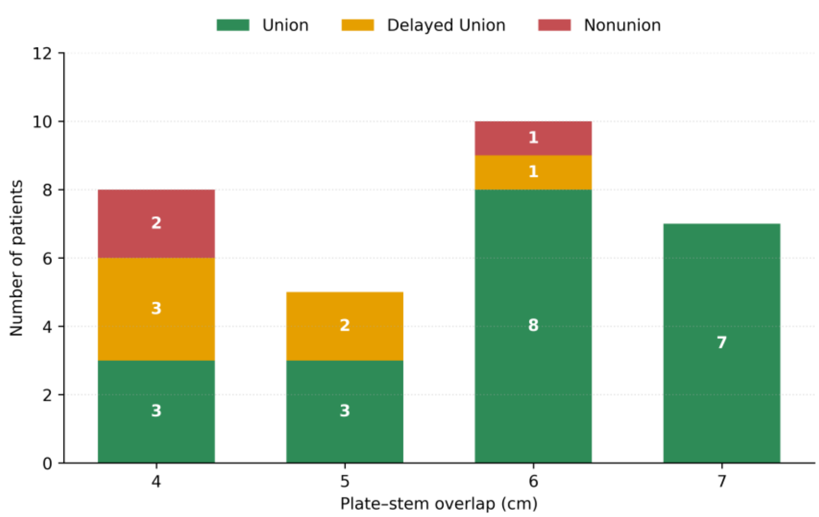

Figure 3. Healing outcome according to plate–stem overlap.

Segment labels indicate the number of patients in each overlap category. Shorter overlap was associated with a greater burden of delayed union and nonunion.

Table 3. Selected factors associated with final healing status.

Factor	Union, n/N (%)	Delayed union or nonunion, n/N (%)	Reference group union, n/N (%)	P value
Vancouver type C	7/8 (87.5%)	1/8 (12.5%)	14/22 (63.6%)	0.374
Plate–stem overlap ≥6 cm	15/17 (88.2%)	2/17 (11.8%)	6/13 (46.2%)	0.020
Complication/risk-pattern present	0/9 (0.0%)	9/9 (100.0%)	21/21 (100.0%)	<0.001

P values were obtained using Fisher's exact test after collapsing delayed union and nonunion into a single incomplete-healing group.

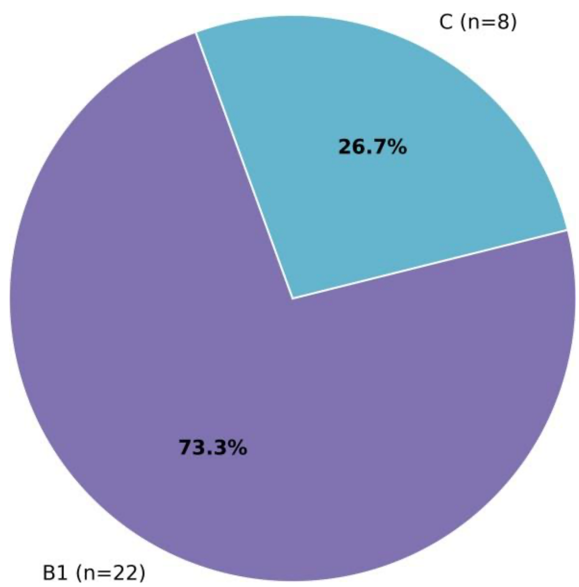

Figure 4. Vancouver fracture-type distribution in the study cohort.

Type B1 fractures formed the majority of the series, while type C fractures accounted for just over one-quarter of cases.

DISCUSSION

The present series suggests that cable-plate fixation can provide dependable fracture stabilization and meaningful functional recovery in periprosthetic femur fractures occurring around a stable stem. That overall direction is consistent with broader reviews of postoperative periprosthetic femoral fracture management, which continue to support internal fixation rather than stem revision for well-fixed Vancouver B1 and type C injuries.[8] An updated review of periprosthetic hip fracture management has similarly underscored the evolving complexity of these cases and the need for thoughtful construct selection in routine practice.[9] More recent summaries have continued to emphasize the rising volume and technical demands of this problem.[10]

Our union profile compares reasonably with the published literature on cable-assisted fixation. In a systematic review of Vancouver B1 fractures, Dehghan et al. noted that construct choice influences nonunion risk and that fixation strategies using cable-plate or compression-based constructs may perform more favorably than locking plates alone in selected cases.[11] Chakrabarti et al. later highlighted a particularly problematic subgroup: transverse or short-oblique fractures near the stem tip, where fixation failure and nonunion were more likely after internal fixation alone.[12] That observation resonates closely with the current cohort, where incomplete healing clustered in transverse distal patterns and in patients with osteoporosis or marked displacement.

The practical importance of implant spanning also appears again in our findings. Froberg et al. reported that successful fixation of Vancouver B1 and C fractures depends not only on plate strength but on sufficiently spanning the prosthesis to avoid stress-rising zones.[13] In the present study, union was significantly more frequent when plate overlap measured at least 6 cm, which supports the same mechanical principle from a prospective clinical perspective. This point matters because cable-plate constructs are sometimes judged only by whether union eventually occurs. Here, the pattern suggests that how the construct is planned may be just as important as the choice of construct itself.

Recent cable-plate case series have been broadly encouraging, although their populations and follow-up horizons differ. Şen et al. found reliable union in a mixed Vancouver B1 and C cohort managed with a hybrid locking plate/cable strategy.[14] Our results sit in the same general range for healing time and functional improvement, but they also reinforce a point that tends to get diluted in smaller retrospective series: when biology is poor and overlap is modest, cable-plate fixation becomes less forgiving.

The functional findings deserve attention. HHS improved substantially by 9 months, and the average gain exceeded 30 points. That does not imply complete restoration of preinjury status, especially in an elderly cohort, but it does indicate clinically relevant recovery in pain and ambulation. Because the HHS remains a standard outcome instrument in hip reconstruction studies, it provides a useful bridge between radiological success and the patient's lived experience after surgery.[7] The weaker postoperative scores in delayed union and nonunion patients also remind us that radiographic delay is not a sterile endpoint. It is usually accompanied by slower mobilization, persistent dependence, and less confident limb use.

This study has limitations. The cohort was modest in size and drawn from a single center, which narrows precision and limits broad generalization. The follow-up framework was prospective, but the recorded clinical variables were clinically pragmatic rather than exhaustive, so variables such as comorbidity burden, implant brand, cementation pattern, and bone mineral density were not available for multivariable modeling. In addition, the complication field captured dominant adverse healing patterns rather than a uniform complication taxonomy, which means those data are best interpreted descriptively. Even so, the study retains practical value. It reflects the sort of real-world decisions surgeons make when a stable stem, compromised proximal bone, and a difficult fracture line converge in the same patient.

Taken together, the findings support cable-plate fixation as a sound option for selected Vancouver B1 and C fractures when the stem is stable. Most notably, they suggest that success depends less on the label of the implant and more on disciplined execution: accurate classification, biological respect for the fracture zone, and sufficient plate overlap across the stem.

CONCLUSION

Cable-plate fixation yielded satisfactory radiological healing and substantial 9-month functional improvement in this prospective series of Vancouver B1 and C periprosthetic femur fractures around well-fixed stems. Incomplete healing was uncommon but clustered in cases with unfavorable mechanics or compromised bone biology. Adequate plate–stem overlap emerged as an especially important technical factor. For carefully selected patients, cable-plate fixation remains a credible limb-preserving strategy when meticulous planning and stable fixation can be achieved.

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Conflict of Interest: None declared.

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