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Introduction

Hip fracture is a severe and common injury that occurs predominantly in the elderly [1-5]. It is the leading cause of morbidity and mortality in this population [6-10]. The incidence of intertrochanteric fractures of the femur is race- and sex-dependent, and varies across countries. In the United States, the annual incidence rate of such fractures is approximately 63 per 100,000 in elderly females and 34 per 100,000 in elderly males [11]. As the population ages, the number of hip fractures tends to increase. In 2040, an estimated 512,000 hip fractures will occur in the U.S. population alone, at a cost of USD 16 billion [6]. These fractures have a long-term impact on the quality of life of patients and their carers. One-year mortality rates are high, ranging from 14% to 47% across studies [1]. The functional outcomes of patients with intertrochanteric fractures can be surprisingly poor, and many become limited to ambulation within the home and dependent on carers for the activities of daily living [11].

The dynamic hip screw (DHS) fixation device is widely used for the surgical treatment of intertrochanteric fractures [12,13]. This device is considered to be the gold standard for management of these fractures in the elderly [14]. In 1996, AO/ASIF developed the proximal femoral nail (PFN) as an intramedullary fixation device for pertrochanteric, intertrochanteric, and subtrochanteric fractures of the femur [15]. The PFN is a minimally-invasive implant and a good treatment option for fractures of the proximal end of the femur, particularly when closed reduction is possible [15]. Whether

KEYWORDS

Intertrochanteric fractures
Intramedullary nail
Sliding compression hip screw
Functional outcome

ABSTRACT

Introduction: Intertrochanteric fractures of the femur are prevalent in the elderly, and leave patients with functional restrictions after surgical treatment. The aim of this study was to compare the functional recovery at 1-year follow-up of elderly patients with intertrochanteric fractures treated surgically with the dynamic hip screw (DHS) or proximal femoral nail (PFN) fixation techniques.

Material and methods: This prospective, randomised, blinded trial included patients aged over 65 years with intertrochanteric fractures classified as AO group 31.A1 or 31.A2. The patients were allocated into one of two treatment groups: one treated with DHS and the other with PFN. Data on functional recovery were obtained using the Functional Recovery Score developed by Zuckerman for elderly patients with hip fracture. Variables were described as means and standard deviations, and the non-parametric Kolmogorov–Smirnov test was used to verify the normality of data distribution. Non-normally distributed variables were compared using the non-parametric Friedman and Mann-Whitney U tests. Data processing and analysis were carried out in SPSS 10.0. Results were deemed significant at the 5% level (p ≤ 0.05).

Results: There were no significant between-group differences in age (p=0.152), sex (p=0.363), or American Society of Anaesthesiologists (ASA) score (p=0.579). Functional recovery scores in the DHS group at 3 and 6 months after surgery were significantly reduced from preoperative baseline scores (p=0.007) compared with in the PFN group. However, there were no statistically significant differences between the two groups in functional recovery scores at baseline (p=0.346) or at 3 months (p=0.880), 6 months (p=0.699), and 12 months (p=0.468) after surgery. There was no between-group difference in mortality (p=0.140).

Conclusion: At 1-year follow-up, functional recovery scores were similar in elderly patients treated with the DHS and PFN techniques. However, DHS-treated patients exhibited significant loss of function in the first 6 months after surgery, which did not occur in the PFN-treated group.

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Functional recovery of elderly patients with surgically-treated intertrochanteric fractures: preliminary results of a randomised trial comparing the dynamic hip screw and proximal femoral nail techniques

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intramedullary nailing with the PFN has any advantage over the DHS in intertrochanteric fractures remains controversial [16]. However, in many patients, and particularly in the elderly, functional recovery is more important than implant selection.

The purpose of this study was to compare the functional recovery achieved with the DHS and PFN devices in elderly patients with surgically-treated intertrochanteric fractures.

Materials and methods

Patients

The study population comprised patients aged over 65 years with intertrochanteric fracture of the femur, classified as 31.A1 or 31.A2 under the AO system, who were treated at Hospital Independência (Porto Alegre, Brazil) from October 2007. Patients were excluded from the study if any of the following criteria were met: compound femoral fracture, aged under 65 years, history of previous femoral fracture, contraindications to surgery, non-ambulatory before the presenting injury, or presence of any other traumatic fractures. Two patients were excluded from the study for refusing to provide informed consent.

Data collection

Data collection took place at the study hospital starting November 2007. The Functional Recovery Score questionnaire proposed by Zuckerman et al. [17] was administered to measure functional recovery on inclusion and at 3, 6, and 12 months post-operatively. Patients were also assessed for pre-operative physical condition (American Society of Anaesthesiologists [ASA] status). The Zuckerman questionnaire comprises 11 items and yields a score of 0 to 44; higher scores denote better functional capacity. The type of fixation device (DHS or PFN) was chosen at random. Briefly, the departmental secretary, who had access to a box containing 20 envelopes - 10 containing the words “dynamic hip screw” and 10 containing the words “proximal femoral nail” - was contacted by telephone. After random selection, the chosen envelope was returned to the box. The selection procedure was carried out in the operating suite.

Functional Recovery Scores were obtained by a staff physical therapist blinded to treatment allocation, who calculated the initial score on patient admission and administered the instrument again, by telephone, at 3, 6, and 12 months after surgery.

Statistical analysis

Statistical analyses consisted of tables, charts, descriptive statistics (means and standard deviations), and a series of statistical tests.

The non-parametric Kolmogorov–Smirnov test was used to evaluate variables for normality. This goodness-of-fit test assesses the degree of agreement between the distribution of a set of sample values and a certain theoretical distribution - in this case, the normal distribution [18]. The assumption of normality was violated for some of the measurements of interest. For this reason, and due to the variability in some variables, non-parametric tests were selected for further analyses; the Friedman test for pairwise comparison of Functional Recovery Scores (at baseline, 3, 6, and 12 months) and the Mann–Whitney U test (independent samples) for comparison between device types.

Data processing and analysis were carried out in the SPSS 10.0 software environment. Results were deemed significant at the 5% level (p≤0.05).

Results

The study population profile is shown in Table 1. The DHS and PFN groups were similar, as shown in Tables 2 and 3 (p=0.363 for sex, p=0.579 for ASA status, and p=0.152 for age). The study population was predominantly female (25 of 31 patients). Most of the fractures were due to low-energy trauma; 29 of 31 fractures were due to falls from a standing height. Approximately 95% of patients in the DHS group and 83% in the PFN group were classified as ASA status II or III. No patient was classified as ASA I.

Table 4 presents a within-group comparison of Functional Recovery Scores at baseline (pre-operatively) and 3, 6, and 12 months after surgery. In the DHS group, there was great data variability, which meant that the mean was a poor measure of central tendency for the behaviour of this variable. The median was used instead as this is not affected by outliers.

Table 4 shows the progression of Zuckerman Functional Recovery Scores over 1 year. As shown in this table, the non-parametric Friedman test revealed a significant difference in these values in the DHS group alone. In patients who received DHS devices, Functional Recovery Scores at 3 and 6 months post-operatively were significantly lower than pre-operative values. There were no significant differences in Functional Recovery Scores at 12 months.

Figures 1 and 2 show the progression of median Functional Recovery Scores in the DHS and PFN groups, respectively.

Table 5 compares Functional Recovery Scores in the two study groups. In the DHS group, median scores were lower at 3 and 6 months post-operatively compared with pre-operative values, and were still lower, but starting to improve at 12 months. In contrast, median scores in the PFN group were lower at 3 months post-operatively compared with pre-operative values, but started to improve as early as 6 months after surgery. Nevertheless, the non-parametric Mann–Whitney U test showed no significant differences between the DHS and PFN groups in these comparisons.

Between-group comparison of mortality rates showed that more deaths occurred in the DHS group than in the PFN group, see Table 6. However, the chi-square test revealed no significant association between type of fixation device and occurrence of death during the study period (χ²=2.178; p=0.140) (Figure 3).

Table 1 Sample profile

<table>
<thead>
<tr>
<th>Variable</th>
<th>DHS</th>
<th>PFN</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75 years or younger</td>
<td>8</td>
<td>42.1</td>
<td>2</td>
</tr>
<tr>
<td>76 to 80 years</td>
<td>6</td>
<td>31.6</td>
<td>5</td>
</tr>
<tr>
<td>81 years or older</td>
<td>5</td>
<td>26.3</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100.0</td>
<td>12</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5</td>
<td>26.3</td>
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</tr>
<tr>
<td>Female</td>
<td>14</td>
<td>73.7</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100.0</td>
<td>12</td>
</tr>
<tr>
<td>Mechanism of injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Struck by car</td>
<td>1</td>
<td>5.3</td>
<td>0</td>
</tr>
<tr>
<td>Struck by motorcycle</td>
<td>0</td>
<td>0.0</td>
<td>1</td>
</tr>
<tr>
<td>Fall from standing</td>
<td>18</td>
<td>94.7</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100.0</td>
<td>12</td>
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<tr>
<td>ASA</td>
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<td></td>
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</tr>
<tr>
<td>II</td>
<td>9</td>
<td>47.4</td>
<td>5</td>
</tr>
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<td>9</td>
<td>47.4</td>
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<tr>
<td>Total</td>
<td>19</td>
<td>100.0</td>
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</tbody>
</table>

DHS = dynamic hip screw, PFN = proximal femoral nail.
The primary objective of this study was to ascertain whether there are differences in functional recovery of elderly patients after treatment of intertrochanteric fractures with two distinct, well-established fixation techniques. The intramedullary PFN tolerates greater static loads and much greater cyclic loading than the DHS device. Consequently, the fracture consolidates with PFN treatment even in the absence of primary restoration of medial support, as the implant temporarily compensates the function of the medial column [19]. Other studies have shown that the DHS is a reliable method for stabilisation of intertrochanteric fractures [16]: it is technically simple, allows weight-bearing as early as the first post-operative day, is associated with low complication rates, and provides good outcomes across a broad spectrum of indications [20].

The present study was a prospective, randomised, blinded clinical trial. The small sample size may have introduced bias, but it was still possible to detect statistically significant differences. The patient population in this study had a particularly high female-to-male ratio (8:2), as reported elsewhere [1,15-17,19-31]. Overall, 93% of intertrochanteric fractures were due to low-energy trauma (fall from standing height). This is consistent with previous studies that have demonstrated the high prevalence of these mechanisms of injury, predominantly falls at home [21,22].

As noted above, the two study groups were similar in terms of age, sex, and ASA status.

The reasons why one method may produce outcomes superior to another can depend on several factors. Small changes in implant shape can make a difference [32]. The DHS device is considered the gold standard, as studies have demonstrated its superiority in relation to other extramedullary fixation devices [33]. On the other hand, the use of intramedullary implants is growing in popularity in the U.S., but morbidity and mortality rates have remained unchanged [34,35].

As shown in Table 6, despite the higher mortality rate observed in the DHS group - in contrast to the studies of Dujardin et al. [22], in which between-group mortality rates were similar, and Saarenpää et al. [23], in which mortality at 4 and 12 months was lower in the DHS group - the percentage of patients who

![Fig. 1. Comparison of median Functional Recovery Scores at baseline (pre-operative), 3, 6, and 12 months in the DHS group.](image)
did not die was essentially the same in both groups, which made this finding non-significant ($\chi^2=2.178; \ p=0.140$). The 12-month mortality rate was 32.3%. This exceeds the rates observed in some studies, which have reported 20%9 and 14.5% [21] mortality, but is within the range reported by Holt et al. [1] (14–47%).

The potential advantages of intramedullary nailing over extramedullary devices for treatment of intertrochanteric fractures remain a matter of debate [36]. When a difference is found, it does not appear to be explained by the type of soft tissue injury, because a study has demonstrated that no significant difference exists between the injuries caused by extra- and intramedullary techniques [37]. Nevertheless, several studies have attempted to demonstrate differences in treatment, first comparing the DHS versus the Gamma Nail device [23–27] and, as in the present investigation, comparing DHS and PFN [21,28].

Saudan et al. [21] assessed social functioning and mobility scores at 3, 6, and 12 months after surgery with PFN or DHS. Although findings at intermediate months were not explained in the study text, at 1-year follow-up, the authors found no significant differences in terms of return to pre-fracture levels of ambulation and independence between the PFN-treated and DHS-treated groups. Thus, they concluded that intramedullary nails (such as the PFN) offer no advantage over extramedullary devices (such as the DHS) for the treatment of intertrochanteric fractures caused by low-energy trauma (AO types 31.A1 and 31.A2). Another study [28] compared functional recovery 1 year after trochanteric nail or DHS repair. Final assessment was conducted over the phone, and no between-group differences in recovery scores were found.

In a randomised, prospective study comparing intramedullary versus extramedullary fixation, Baumgaertner et al. [29] found no between-group differences in functional recovery rates.

Saarenpää et al. [23] compared functional outcomes with the DHS and Gamma Nail fixation systems in terms of parameters including ability to walk and ability to dress and undress both pre-operatively and 4 months after surgery. Although there were no between-group differences in the use of walking aids, in the DHS group, 4-month outcomes were significantly better than pre-injury levels compared with the Gamma Nail group.

In the current study, assessment of Zuckerman Functional Recovery Scores showed that patients in the DHS group experienced a significant reduction in scores from baseline at
3 and 6 months after surgery (p=0.007), whereas no such loss of function occurred in the PFN-treated group (p=0.097), unlike in the Saarenpää et al. study [23]. Nevertheless, there were no between-group differences in final scores. Little et al. [38] also found that intramedullary nailing enabled faster recovery of mobility.

Regarding functional recovery, Dujardin et al. [22] showed that hip strength and mobility progressed similarly in the first 3 months after surgery in patients treated with the DHS and in those treated with static nailing, but significant differences favouring the intramedullary nail group were apparent 6 months after surgery. This is consistent with the findings in the present study, where functional recovery was faster in PFN-treated patients in the first 6 months after surgery. However, the authors found no differences in walking ability or recovery of independence. Again, this is consistent with our findings, even though Dujardin et al. [22] followed patients for a shorter time (26 weeks) and used different scores.

The finding that functional recovery in the first 6 months after surgery is significantly poorer after DHS treatment is important, because it is widely known that elderly patients require faster recovery. Similar findings have been reported by Goulidakis et al. [39] and Calderón et al. [40]. Conversely, Escher et al. [41] found that patients treated with an extramedullary device fared subjectively better. Ultimately, however, both groups had similar functional recovery outcomes and no significant loss of function at 1-year follow-up. The importance of this finding in elderly patients is relative. There were more deaths in the DHS group, although the difference was not significant.

Taken together, these data indicate that despite similar final scores, the most important result is that patients treated with the PFN technique exhibited functional improvement as early as 6 months after surgery, unlike DHS-treated patients. In practice, this means that PFN treatment is associated with faster improvement in quality of life than the DHS technique.

Conclusion

At 1-year follow-up, there were no significant differences in functional recovery scores between PFN-treated and DHS-treated elderly patients with intertrochanteric fractures of the femur in this study. However, DHS-treated patients experienced significant loss of function in the first 6 months after surgery compared with no such loss of function in the PFN-treated group.

Conflict of Interest Statement

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Funding sources

None.

References


