Garden I femoral neck fractures in patients 65 years old and older: Is conservative functional treatment a viable option?

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Accepted: 17 November 2009

KEYWORDS
Functional treatment/non-surgical treatment; Femoral neck fracture/hip fracture; Non-displaced fracture; Elderly subject

Summary

Introduction: Internal fixation is the preferred treatment of Garden I femoral neck fractures in the elderly. High re-operation rates have however been reported, and the results of arthroplasty performed following internal fixation failure are not as good as those of primary arthroplasty. This is why we are advocating functional treatment. Our hypothesis is that this treatment leads to fewer decubitus complications than strict orthopaedic treatment and no more mechanical complications than internal fixation in a selected population sample. Therefore, the objective of our prospective work was: (1) to assess the results of functional treatment of Garden I femoral neck fractures in elderly subjects, and (2) to investigate predictive factors of secondary displacement.

Patients and methods: All patients over age 65 years, admitted for a Garden I femoral neck fracture between January 2006 and May 2008, were included in this prospective study representing 56 cases (57 fractures) with an average age of 82 years. Functional treatment was performed, including early weight-bearing mobilisation, followed by radiographic evaluation at days 2, 7, 21 and 45, then at 3, 6 and 12 months. In the absence of displacement, discharge was planned at day 5 (Non-Displaced [ND] group). Otherwise, arthroplasty was performed (Displaced [D] group). Parker score and Harris Hip Score (HHS) were used for functional evaluation.
Introduction

Femoral neck fractures, as a consequence of osteoporosis, are becoming a real public health problem with ageing of the population in industrialized countries. These fractures are predicted to double by 2050 [1,2], reaching a worldwide incidence of over six million a year [3]. Though arthroplasty has proven superiority for displaced fractures [4,5] and osteosynthesis has become essential for non-displaced fractures in young subjects [6], the treatment of non-displaced or impacted fractures in the elderly remains without consensus. Historically, the treatment of Garden I femoral neck fractures [7] in the elderly pits orthopaedic treatment [8] against classic osteosynthesis using triple screwing or the compression plate and screw method [9–16]. Nonetheless, high rates of mechanical complications, mainly osteonecrosis and secondary displacement or pseudoarthrosis, have been observed in the literature with a frequency ranging from 24 to 50% [17,18]. In addition, in this context, arthroplasty results after osteosynthesis failure appear to be clearly not as good as first-line arthroplasty in terms of survival, complications and functional results [19,20], leading some authors to consider first-line arthroplasty for these fractures [21,22]. Functional treatment with early mobilisation and protected weight-bearing is another option, but seems to increase the risk of secondary displacement. This modality has already been the subject of a study by SOFCOT [15], but follow-up lasted only 3 months, and no predictive factor of secondary displacement was indicated. Our hypothesis is that functional treatment leads to fewer decubitus complications than orthopaedic treatment and a rate of mechanical complications comparable to that of osteosynthesis. The purpose of our prospective study was therefore:

- to evaluate the results of managing Garden I femoral neck fractures in subjects over age 65 years with a minimum 1-year follow-up;

Results: The observed displacement rate was 33.3% (19 patients) within an average period of 10 days. In the ND group, one case of osteonecrosis was observed and treated by arthroplasty. The average Parker score was 6.9 and the HHS 82 in the ND group, and 7 and 85, respectively, in the D group. None of the factors studied (age, gender, side, fracture type, inclination angle, degree of outward displacement, sagittal displacement, general status) was statistically predictive of final displacement.

Discussion: The medical complication rate was only 7% in our series, which seems to be lower than that resulting from orthopaedic treatment. The observed secondary displacement rate seemed to be higher than the rate found in the literature on surgical treatment (5.4 to 20%), but the osteonecrosis rate appeared to be lower (11 to 25%). In addition, surgical treatment was the purveyor of specific complications in over 10% of cases.

Conclusions: The present prospective study with minimum 1-year follow-up shows that functional treatment results in fewer decubitus complications than orthopaedic treatment and a rate of revision surgery comparable to internal fixation since 70% of included patients could have been successfully treated without surgical intervention. However, the investigation of a larger cohort would be necessary to identify predictive factors for the treatment’s failure.

Level of evidence: Level III prospective non-comparative cohort study.

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Patients and methods

Patients

A prospective monocentric cohort study, aiming to assess the functional treatment of impacted femoral neck fractures in elderly subjects, was conducted over a continuous 30-month period.

The inclusion criteria were:

- Garden I femoral neck fracture [7];
- recent injury (< 24 hours);
- age 65 years or over;
- follow-up longer than 12 months.

The exclusion criteria were:

- age under 65 years;
- pathological fracture;
- a history of fracture in the studied hip.

The variables assessed included age, sex, general state (ASA score [23], chronic diseases, dementia if MMS < 24), functional state (Parker score [24], Harris Hip Score (HHS) [25]) and the side injured. Initial X-rays were analyzed by two different observers, including a senior department surgeon, noting (1) fracture type; (2) subcapital or transcervical location; (3) inclination angle of the fracture line based on Pauwels classification [26]; (4) valgisation degree (Fig. 1); and (5) inclination angle on lateral X-rays (Fig. 2).

Therapeutic method

Unique, original functional treatment was administered to patients admitted to emergency with an impacted femoral
On anterior hip X-ray, the valgisation angle (AV) is formed by the intersection of two straight lines passing through bone fracture sections in the femoral neck (A) and head (B). This angle measures fracture impaction in the anterior plane.

Figure 1  On anterior hip X-ray, the valgisation angle (AV) is formed by the intersection of two straight lines passing through bone fracture sections in the femoral neck (A) and head (B). This angle measures fracture impaction in the anterior plane.

Figure 2  On virtual lateral surgical hip X-ray, the sagittal inclination angle (IS) is formed by the intersection of a straight line (A) passing through the axis of the neck and a straight line (B) parallel to the cephalic bone span going through the centre of the head (C). This angle measures head impaction in the sagittal plane and its possible retro- or anteversion.

Figure 3  Results of functional treatment. A. Anterior at day 0. B. Lateral at day 0. C. Follow-up at day 7. D. Follow-up at 1 year.

neck fracture (Fig. 3). After an initial 48-hour period of bed rest during which patients received analgesics without any additional immobilisation device (traction, splints, etc.), this treatment included a full mobilisation test supported by a pair of crutches or a walker under strict guidance by a physiotherapist, followed with routine anterior and lateral X-rays. In the absence of fracture displacement, a second test was performed under similar conditions within less than 48 hours. The onset of decubitus complications (bedsores, venous thrombosis, respiratory and urinary complications) during hospitalisation was recorded for each patient.

Depending on whether or not secondary displacement had occurred during one of two mobilisation tests or after initial hospitalisation, the patients were assigned to the displaced group (D group) or the non-displaced group (ND group), respectively. Based on functional demand and osteoarthritic status, we performed hemi-arthroplasty or total hip arthroplasty in D group patients. Each patient was prescribed rehabilitation care with assistance to resume walking and preventive anticoagulant treatment with low-molecular-weight heparin for a period of 2 months. Length of hospitalisation, the need for and duration of a second hospitalisation as well as discharge destination (home or convalescence and/or rehabilitation centre) were recorded.

Assessment method

Follow-up X-rays were all analyzed by two different observers, including a senior department surgeon, who reported secondary displacement defined as any displacement in varus, allowing the classification of fractures as Garden III or IV. Potential valgus impaction was neither considered as secondary displacement nor as a factor of surgical indication. All patients were seen during a consultation to ensure radioclinical follow-up at 1, 3 and 6 weeks, 3, 6 and 12 months, to monitor consolidation as well as possible onset of secondary displacement, pseudoarthrosis or osteonecrosis of the femoral head.
Table 1  Data on patient series.

<table>
<thead>
<tr>
<th></th>
<th>ND Group</th>
<th>D Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture (n)</td>
<td>40</td>
<td>17</td>
<td>57</td>
</tr>
<tr>
<td>M/W</td>
<td>3/37</td>
<td>4/13</td>
<td>7/50</td>
</tr>
<tr>
<td>Average age (years)</td>
<td>81.8 ± 9.2</td>
<td>85 ± 6.1</td>
<td>82.8 ± 8.5</td>
</tr>
<tr>
<td>Side (right/left)</td>
<td>22/18</td>
<td>7/10</td>
<td>29/28</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-cervical</td>
<td>34</td>
<td>14</td>
<td>48</td>
</tr>
<tr>
<td>Transcervical</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Pauwels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>16</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>II</td>
<td>21</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>III</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Valgisation angle (°)</td>
<td>21.5</td>
<td>19.1</td>
<td>21</td>
</tr>
<tr>
<td>Sagittal inclination (°)</td>
<td>5.75</td>
<td>6.1</td>
<td>6</td>
</tr>
<tr>
<td>Length of hospitalisation (days)</td>
<td>8 ± 4</td>
<td>15 ± 8</td>
<td>10 ± 6</td>
</tr>
</tbody>
</table>

ND: non-displaced; D: displaced.

Statistical methods

The patients’ sociodemographic characteristics (age > 80 years, sex), clinical characteristics (side fractured, dementia, existence of two or more co-morbidities, ASA score) and radiographic characteristics (location on neck, Pauwells score, valgisation > 15° and > 20°, sagittal inclination angle) as well as complications during hospitalisation were compared between the D and ND groups. In this univariate analysis, we used the Chi-square test, and replaced it, if necessary, by Fisher’s exact probability test to compare proportions, and Student’s t-test was replaced by the Mann-Whitney test when the distribution was not normal, to compare averages of the two groups. Multivariate analysis was conducted with a logistic regression model to identify factors independently associated with secondary displacement. Variables independently introduced into the model included those identified by univariate analysis with a value of \( p < 0.20 \). Associations were estimated with odds ratios and 95% confidence intervals.

The threshold of statistical significance was set at 5%. Statistical analyses were conducted with statistical treatment software (SPSS version 15.0).

Results

Descriptive results

Of the 357 cases admitted to our hospital emergency for cervical femoral neck fractures during the study period, 56 patients with 57 valgus-impacted fractures (15.7%) meeting the inclusion criteria were treated according to the study protocol (Table 1), including seven men and 49 women, with one female patient who was injured on both sides during two separate events that occurred several months apart. Average age of the series was 82.8 ± 8.5 years (65 to 99 years old). The right side was injured in 29 cases, and the left, in 28 cases. Twelve patients did not present with co-morbidity factors and 11 patients had dementia. Based on ASA classification [23], 12 patients were in Class I, 24 in Class II, 20 in Class III, and one in Class IV. Average follow-up was 20 ± 8 months (12 to 28 months). One patient was excluded from the statistical analysis of research into the predictive factors of secondary displacement due to another fall on the hip 2 months after the first injury, causing a basivertical fracture in the same hip, which was treated by the compression plate and screw method; 10 patients were lost to follow-up, and eight patients were already dead at the time of follow-up.

Radiographic analysis found nine transcervical and 48 subcapital fractures. Inclination angle of the fracture was Pauwels I (< 30°) in 19 cases, Pauwells II (30–50°) in 28 cases, and Pauwels III (> 50°) in 10 cases. Average valgisation was \( 21 ± 10.7° \) (5° to 40°) and average sagittal inclination was \( 6 ± 7° \) (0° to 25°).

During initial hospitalisation, we found only three complications (5.2%): two cases of bronchial congestion and one case of trophic problems related to bed rest. Deep venous thrombosis was diagnosed during convalescence and received ambulatory treatment, for an overall complication rate of 7%. Twenty-five patients (44.6%) were able to return home or to their former lifestyles, and 30 patients needed to be placed in a convalescent home.

Nineteen patients (33.3%) presented with secondary displacement, for an average of 10.1 ± 4.9 days (1 to 30 days); 10 patients during their initial hospitalisation; for an average of 6.3 ± 4 days (1 to 15 days), seven patients were admitted for a second hospitalisation, for an average of 11.8 ± 3.9 days (8 to 17 days), and two patients showed secondary displacement during follow-up at 1 month. Average duration of hospitalisation was 10 ± 6 days (4 to 30 days) for the entire cohort, 8 ± 4 days (4 to 21 days) for the ND group and 15 ± 8 days (8 to 30 days) for the D group. Arthroplasty was performed in 17 patients (three total arthroplasties and 14 hemi-arthroplasties), and two patients refused any kind of procedure. In the ND group, radioclinical follow-up identified only one aseptic osteonecrosis of the femoral head at 12 months, which required total arthroplasty.

Analytical results

At follow-up, the average Parker score was 7 and the HHS was 85 points in the D group, and 6.9 and 82 points,
respectively, in the ND group. No mechanical or infectious complications were noted in the D group at follow-up. Only one significant difference ($p = 0.03$) was found between the two groups concerning average age, with higher age in the D group (85 vs 81.8 in the ND group). However, analysis of age over or under 80 years, mentioned by some authors [21,22] as a predictive factor, did not show a significant difference ($p = 0.108$). Despite the distribution of male patients in the two groups, statistical analysis did not discern any significant difference ($p = 0.206$). Univariate analyses (Table 2) did not indicate any significant difference between the D and ND groups with respect to other demographic factors (side, dementia, co-morbidity) or radiographic factors (location, Pauwels classification, initial valgisation over 15$^\circ$, initial valgisation over 20$^\circ$, initial sagittal inclination). Multivariate logistic regression analyses were conducted on the demographic and radiographic data but no significant differences were ascertained. None of these factors was considered to be predictive.

### Discussion

Classic treatments of Garden I femoral neck fractures in the elderly include bed rest with or without traction until consolidation is achieved, so-called “functional” treatments and osteosynthesis by triple screwing or the compression plate and screw method. We suggest functional treatment of Garden I femoral neck fractures, including early mobilisation with immediate resumption of weight-bearing to avoid surgical intervention while limiting decubitus complications.

Factors limiting our study were the small number of cases and differences in the number of subjects in the two groups. The lack of power limited the statistical analysis. The second factor limiting our study was the absence of osteoporosis assessment. The only radiographic assessment tool for osteoporosis found in the literature was the Singh index [27], but recent studies have shown no correlation between the degree of osteoporosis and this index [28–30]. As a result, we did not investigate this factor.

The objective functional results of various treatments are rarely assessed and often the measuring tools used cannot be compared [31–35]. The average Parker score [24] at follow-up in the ND group of our study was 6.9 and the HHS [25] was 82 points. The SOFCOT series [15] obtained an average Parker score of 5.5 in functionally-treated patients at 3 months versus 5 in patients with osteosynthesis, which did not seem to improve the results. Nikolopoulos et al. [36] recorded HHS > 80 in 82.6% of patients after internal fixation. In a study of non-displaced fracture treatment in patients over age 60 years, Yih-Shiunn et al. [16] reported average HHS of 84.2 ± 5.2 for DHS and 82.6 ± 5.1 for osteosynthesis with cannulated screws. In a recent series involving 224 patients who had completed a self-evaluation questionnaire over 3 years after internal fixation, Rogmark et al. [37] perceived 40% with average to severe pain in walking and 25% pain at rest, which led 4% of them to undergo surgical material removal. The heterogeneity of these measuring systems makes it difficult to compare different types of treatment.

The displacement rate in our series was 33.3%, which appears comparable to the data in the literature. At the 2008 SOFCOT symposium, Simon et al. [15] reported a 28% displacement rate for similar treatment in terms of weight-bearing and early resumption of weight-bearing. Raaymakers and Marti [22,38,39] observed displacement rates of 14 to 31% with treatment similar to that in our study, upon resumption of weight-bearing delayed by 1 week. Verheyen et al. [26] noted a 46% displacement rate in a retrospective series involving 105 patients aged 17 to 97 years, after implementing partial weight-bearing, without a significant difference between subgroups whose average age was about 70 years. However, as Handoll and Parker [40] point out, it is difficult to identify an exact trend in the displacement rates of non-surgical treatments due to the large variety of protocols found in the literature. With a rate of 16 to 41% [13,35], prolonged bed rest with or without traction—which theoretically has the advantage of delaying surgery—does not consistently reduce the risk of secondary displacement, while remaining a purveyor of decubitus complications and cognitive deterioration [8,13,41]. These high rates of decubitus complications have led numerous authors to regard osteosynthesis as a first-line treatment for postponing early weight-bearing to reduce secondary displacements [9–11,13,14]. In a prospective series comparing 247 patients, Cserhati et al. [41] discerned 16% of general complications with bed rest versus 3% for osteosynthesis. In comparison to our study, prolonged bed rest did not seem to offer benefits in terms of consolidation or reduction of secondary displacements. We noted only 7% of decubitus complications in our series, which was comparable to the results of the SOFCOT series [15] that reported 4% of complications for the same protocol. We hypothesize that mobilisation within 48 hours and authorisation of early weight-bearing are certainly responsible for these low rates of decubitus complications. In their retrospective, comparative series, Jain et al. [42] had already shown a significant decrease of mortality rates (2.5 times lower) than functional treatment with early mobilisation or prolonged bed rest, the mortality rate for early verticalisation approaching that of surgical treatment by internal fixation.

The advantage of osteosynthesis would be to reduce secondary displacement rates while authorising early weight-bearing. Rates may vary between 5.4% [43] and 20% [17]. In addition, these techniques are associated with specific complications, such as infections at the operating site.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Univariate statistical analyses (Mann-Whitney test).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic data</strong></td>
<td></td>
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<tr>
<td>Age &gt; 80 years</td>
<td>$p = 0.108$</td>
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<td>Sex</td>
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</tr>
<tr>
<td>Side</td>
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</tr>
<tr>
<td>Dementia</td>
<td>$p = 0.153$</td>
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<td>$&gt; 2$ co-morbidities</td>
<td>$p = 0.099$</td>
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<tr>
<td>ASA</td>
<td>$p = 0.103$</td>
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<tr>
<td><strong>Radiographic data</strong></td>
<td></td>
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<tr>
<td>Location</td>
<td>$p = 0.341$</td>
</tr>
<tr>
<td>Pauwels classification</td>
<td>$p = 0.105$</td>
</tr>
<tr>
<td>Valgisation &gt; 20$^\circ$</td>
<td>$p = 1$</td>
</tr>
<tr>
<td>Valgisation &gt; 15$^\circ$</td>
<td>$p = 1$</td>
</tr>
<tr>
<td>Sagittal inclination</td>
<td>$p = 0.675$</td>
</tr>
</tbody>
</table>
(10% according to Rodriguez-Merchan [44]), the need for material ablation (4% according to Rogmark et al. [37]), and the risk of anaesthesia. Osteosynthesis also does not protect against aseptic osteonecrosis of the femoral head and the possibility of arthroplasty. We found only one case (2%) of osteonecrosis of the femoral head at 1 year in our series, which is lower than the overall data in the literature on non-surgical treatments. The SOFCOT series [15] did not have enough follow-up, and the osteonecrosis rate was not indicated, whereas Raaymakers [39] ascertained 11% of osteonecrosis in a 2-year follow-up of 319 functionally-treated patients. It would appear that these rates are higher with treatments by internal fixation, ranging from 11 to 25% [17,36,44]. Chen et al. [43] reported 67% of radiological signs of osteonecrosis at 1 year of surgical treatment, but only 11% justified secondary arthroplasty.

The second objective of this work was to be able to make a choice between functional treatment and first-line arthroplasty based on predictive criteria. However, we could not identify predictive clinical factors of secondary displacement on the basis of patient age, sex or general health (ASA score [23], co-morbidity or dementia), thereby matching the data in the literature. Heetved et al. [32] have already shown that physiological status cannot guide the therapy in case of displaced femoral neck fractures among the elderly. These criteria have been described as predictive by certain authors: Raaymakers and Marti [22] as well as Hui et al. [21] recommended first-line arthroplasty in women over 80 years old. More recent studies involving larger series [12,14] have revealed significant mortality with this option compared to classic treatments, thus not endorsing this first-line treatment [22,36]. Radiographic analysis has not disclosed a significant difference with respect to fracture location, its type according to Pauwels score, the degree of anterior valgisation or sagittal inclination of the femoral head, thereby corroborating the literature [22,35,45]. A study involving a larger population seems necessary to identify predictive factors.

Conclusions

This investigation shows that functional treatment with early mobilisation helps to successfully manage nearly 70% of patients without exposing them to the risks of surgical intervention. The secondary displacement rate is equal to that of prolonged bed rest, with a decubitus complication rate that is clearly lower. Osteosynthesis, the currently-recommended treatment, presents a non-negligible complication rate, without protecting against secondary arthroplasty. Given that arthroplasty performed after failure of functional treatment did not seem to evoke a high complication rate in our study and that, on the other hand, it was not possible to determine any predictive factors of its failure, we believe that, as described in this investigation, functional treatment remains a valid option for Garden I fractures among the elderly.

Conflict of interest statement

None.

References


