Locking plate fixation of distal femoral fractures is a challenging technique: a retrospective review

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Summary

Distal femoral fractures have typically a bimodal occurrence: in young people due to a high-energy trauma and in older people related to a low-energy trauma. These fractures are associated to a very high morbidity and mortality in elderly. Distal femoral fractures might be treated with plates, intramedullary nails, external fixations, and prosthesis. However, difficulties in fracture healing and the rate of complications are important clinical issues. The purpose of this retrospective review was to present our experience in treatment of distal femoral fracture in a sample of older people in order to evaluate the technical pitfalls and strategies used to face up the fractures unsuccessfully treated with locking plates. We included people aged more than 65 years, with a diagnosis of distal femoral fracture, treated with locking plates. We considered ‘unsuccessfully treated’ the cases with healing problems or hardware failures. Of the 12 patients (9 females and 3 males; mean aged 68.75 ± 3.31 years) included, we observed 3 ‘unsuccessfully cases’, 2 due to nonunions and 1 due to an early hardware failure, all treated using a condylar blade plate with a bone graft. One patient obtained a complete fracture healing after 1 year and in the other cases there was a nonunion. We observed as most common technical pitfalls: inadequate plate lengthening, fracture bridging, and number of locking screws. The use of locking plates is an emerging technique to treat these fractures but it seems more challenging than expected. In literature there is a lack of evidences about the surgical management of distal femoral fractures that is still an important challenge for the orthopaedic surgeon that has to publish their clinical data for scientific and educational purposes.

Materials and methods

We performed a retrospective review of distal femoral fractures treated surgically in the period between 2011 and 2014. We included people aged more than 65 years, with a diagnosis of distal femoral fracture, treated with locking plates. All fractures were classified according to the AO/OTA Classification of Fractures and Dislocations (previously known as the Müller/AO Classification). We considered ‘unsuccessfully treated’ the cases with healing problems (i.e. non-healing, malunion) or hardware failures. An implant removal for any other reasons (i.e. intolerance) was not considered as an unsuccessfully case. A X-ray evaluation was performed among the unsuccessful cases and we assessed eventual technical pitfalls. Ethical approval was not required for this study, according to Italian law, because it involved routine clinical follow up and X-ray evaluations. Written informed consents were obtained from all patients that Authorized the surgical treatment and allowed to collect and publish their clinical data for scientific and educational purposes.

Results

We included 12 patients, mean aged 68.75 ± 3.31 years: 9...
females and 3 males. Demographic data, fracture patterns and surgical outcomes of the sample are summarized in Table 1.

The fracture types most observed were the 33A.3 (25.00%) and 33C.2 (25.00%). We observed 3 ‘unsuccessfully cases’ (patients 1, 3 and 6): 2 cases due to nonunions and 1 due to an early hardware failure. All these ‘unsuccessfully cases’ were treated using a condylar blade plate with a bone graft. We obtained a complete fracture healing after 12 months in one patient (Figure 1), whereas it was observed a nonunion in the two other cases whereby knee mega-prosthesis were used (Figures 2 and 3). Inadequate plate lengthening, fracture bridging and number of locking screws are the most common technical pitfalls observed.

### Table 1 - Fracture patterns and outcomes of our population.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>Fracture</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>66</td>
<td>F</td>
<td>33A.1</td>
<td>Nonunion</td>
</tr>
<tr>
<td>2</td>
<td>69</td>
<td>M</td>
<td>33C.2</td>
<td>Healed</td>
</tr>
<tr>
<td>3</td>
<td>69</td>
<td>F</td>
<td>33A.1</td>
<td>Nonunion</td>
</tr>
<tr>
<td>4</td>
<td>75</td>
<td>F</td>
<td>33A.3</td>
<td>Healed</td>
</tr>
<tr>
<td>5</td>
<td>68</td>
<td>F</td>
<td>33C.2</td>
<td>Healed</td>
</tr>
<tr>
<td>6</td>
<td>66</td>
<td>F</td>
<td>33C.1</td>
<td>Hardware failure</td>
</tr>
<tr>
<td>7</td>
<td>65</td>
<td>F</td>
<td>33C.3</td>
<td>Healed</td>
</tr>
<tr>
<td>8</td>
<td>67</td>
<td>F</td>
<td>33A.3</td>
<td>Healed</td>
</tr>
<tr>
<td>9</td>
<td>70</td>
<td>M</td>
<td>33A.2</td>
<td>Healed</td>
</tr>
<tr>
<td>10</td>
<td>65</td>
<td>M</td>
<td>33A.3</td>
<td>Healed</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>F</td>
<td>33C.3</td>
<td>Healed</td>
</tr>
<tr>
<td>12</td>
<td>74</td>
<td>F</td>
<td>33C.2</td>
<td>Healed</td>
</tr>
</tbody>
</table>

Figure 1 - X-ray evaluation of patient 3 showing: a) a 1.2 distal femoral fracture; b) reduction and synthesis using a locking plate; c) nonunion and plate breakage at 12 months after surgery; d) new synthesis using blade plate and graft; e) bone healing 12 months after second surgical intervention.

Discussion

Distal femoral fractures are some of the most common non-proximal femoral fractures (3). They often represent an important clinical issue because of difficulty in surgical treatment and worse outcomes in older people. Moreover, the proximity to the knee joint negatively influences the restoring of knee Range Of Motion (ROM) and knee function (6). Kammerlander et al. (4) in 2012 evaluated 43 distal femoral fractures in older people (mean aged 80.0 ± 9.3), observing a mean survival time of 434 days, and only 18% of them were able to walk without aids. Recently, Smith et al. (5) evaluated a population of older people, reporting a mortality at 30 days at 6 months, and at 12 months, respectively of 7, 16, and 18%; only the 46% of the participants was able to walk independently. The Authors comparing these results with those of proximal femoral fractures, supported the hypothesis of a substantial similarity between these two populations; therefore, they suggested that it was more appropriate using the same pathway for both types of femoral fractures.

Locking plates are the fixation method most used for distal femoral fractures, considering that the stability of conventional screw-plate systems depends on bone quality, whereas intramedullary retrograde nailing makes necessary an arthrotomy also in the extra-articular fractures. Moreover it might be associated to nail protrusion and knee pain and stiffness (7). Locking plates present multiple points of fixation even in case of low bone quality; the screws, once locked to the plate, do not pull the fragments towards the implant. They act on the internal fixator principle in order to bridge metaphyseal comminution (8). However, Schmal et al. have recently underlined biomechanical and clinical differences between external and internal fixators, affirming that external fixators have a better control of stiffness over a broad range (9). Moreover, locking plates are able to cause less disruption of the soft tissues, osseus blood supply, and periosteum. Fragomen et al., considering the anatomical shape of this device, encouraged the use of Minimally Invasive Plate Osteosynthesis (MIPO) technique, preserving thus soft tissues and periosteum vascularization (10). These proprieties make the locking plates a good option for the treatment of distal femoral fractures in osteoporotic older people. However, it is still debated in literature the use of locking plates for distal femoral fractures, because of healing problems and eventual complications.

A recent review reported that among 23 articles there was a rate of healing complications from 0 to 32% after using locking plates, in particular nonunion rate ranged from 0% to 19%, delayed unions ranged from 0 to 15%, implant failures ranged from 0 to 20%. The Authors affirmed that “in current
practice, a locked plate implant combined with a minimally invasive insertion technique does not guarantee successful fracture repair in all cases” (11). In our opinion, these healing issues are more likely due to an inadequate implantation of locking plates, making necessary improving the technique or identifying new ones. In a recent retrospective review, Ricci et al. studying 326 patients with 335 distal femur fractures treated with lateral locked plates identified that open fractures, diabetes, smoking, increased body mass index, and shorter plate length were risk factors for failure of locking plate fixation (12). The Authors observed that the worst results were obtained when the plate length was less than 9 holes and recommended the use of longer constructs with at least 8 holes proximal to the fracture in a plate of at least 9 holes in overall length. Therefore, it is mandatory for the surgeon to choose a plate with an adequate length to allow the modulation of fixation stiffness and the interfragmentary movement that improve fracture healing. In our series in 2 out of 3 ‘unsuccessfully’ cases we used plates with a length less than 9 holes. Heyland et al., in a biomechanical study, demonstrated that the working length of a locking plate construct in a comminuted fracture at the distal femur is the most important factor to influence the interfragmentary movement at the fracture gap. The working length of a locking plate is defined by the distance between the inner screw at each side of fracture gap and it is influenced not only by plate length but also by locking screws placement (13). However, location and number of locking screws are commonly chosen by surgeon experience than scientific evidences. Hoffman et al. suggested the use of at least three bi-cortical screws at each side of the fracture (14). The locking screw placement in case of a very unstable fracture should be closer to the fracture gap; on the contrary, it should be positioned further away in order to have a more elastic system (15).

We observed an inadequate plate working length in all our 3 ‘unsuccessfully’ cases: one related to an inappropriate plate length; the second case due to an inappropriate screw placement; the third one related to both situations.

Recently, the far cortical technology has been introduced in order to improve system elasticity, with promising results in terms of fracture healing and reduction of complications (16, 17).

In our series we did not evaluate the influence of MIPO technique, although it seems that the respect of soft tissues could improve locking plates outcome (14, 18, 19).

In all the ‘unsuccessfully cases’ we used condylar blade plates with a bone graft. Although their limited use, blade-plates still represent a valuable option for the treatment of
distal femoral fractures. In fact, two recent case-control studies comparing blade-plates with locking plates reported similar results and less complications using 95° angled blade plates (20, 21). In our series, two of the three cases treated with condylar blade plates did not heal. We consider that these bad results could be due to an inadequate medial pillar reconstruction and a poor bone quality. These cases underwent a total knee replacement. According to Haidukewych et al. (22) TKR is a demanding salvage technique for distal femoral fractures with several early complications and poor functional results. In our series we did not observe any early complications, but a reduction in knee range of motion. A recent Cochrane systematic review underlined the importance of lack of important clinical studies that might guide the orthopaedic surgeon in treating adequately the distal femoral fractures (23).

Conclusion

Distal femoral fractures are a challenge for the orthopaedic surgeon considering the difficulties in fracture healing, poor outcomes, and the high rate of complications, although the development of new surgical techniques. In our opinion the use of locking plates is an emerging technique to treat this kind of fractures but it seems more challenging than expected. The orthopaedic surgeon should be able to use all the fixation devices available in order to face up the possible issues that can occur in the surgical management of distal femoral fractures.

References