Use of the LISS for Distal Femur and Proximal Tibia Fractures: Current Practices and Ongoing Research

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INTRODUCTION

The surgical treatment of distal femur and proximal tibia fractures has presented significant challenges, particularly in elderly osteoporotic patients. Varus and valgus malalignment, implant failure, joint stiffness, infection, non-union and technical difficulty have all been associated with previous treatment techniques[1]. The LISS (Less Invasive Stabilization System, Synthes USA, Paoli, PA) was developed to address these issues for a subset of periarticular fractures about the knee[2]. We have begun to utilize this system at our institutions and are beginning to evaluate its efficacy for this class of difficult fractures.

BACKGROUND

LISS plates differ significantly from more traditional plating systems that have been used for these fractures. The fundamental difference is that all of the screws in a LISS plate are "locking" screws. The threaded screw head locks into the plate and can only be inserted at one angle. The angle between the plate and screw is therefore fixed in space, allowing each individual screw to function as a mini blade plate. The LISS can be thought of as analogous to an external fixator that is beneath the skin.

Since each screw in the LISS is fixed to the plate, there is no need for the plate to touch the bone, thus reducing the disruption to the bone's blood supply by decreasing the plate's footprint. Additionally, the plate can be inserted with a percutaneous technique, minimizing the disruption to the fracture's soft tissue envelope[3]. Furthermore, the plate's locking screw construct, like other locking plates, changes the failure mechanics of the plate. It is theorized that unlike traditional plates --which can fail one screw at a time-- the locked nature of the LISS plate screws requires that the plate fail by all of the screws pulling out together. This failure mode provides added structural support that is thought to be particularly important in osteoporotic bone [4,5].

INDICATIONS

The LISS plate has been used at our institution for four clinical situations:

1. Proximal Tibia Fractures (AO Types A2,3 and C1,2,3)
2. Distal Femur Fractures (AO Types A1,2,3 and C1,2,3)
3. Non-unions and delayed-unions of the above fractures.
4. Periprosthetic fractures of the distal femur associated with TKR or hip arthroplasty.

AO Type A fractures in this study group are periarticular fractures that do not cross the articular surface[6]. Type C fractures are "complete" articular fractures that involve the articular surface and also have a fracture line that completely separates the articular surface from the diaphysis.

When feasible, the plate is inserted using a percutaneous technique[7]. If the reduction cannot be achieved adequately with the percutaneous approach, a more traditional extensile approach can be used. An external guide allows all of the screws to be placed percutaneously, without need for fluoroscopic guidance. The screws are self-tapping, self-drilling, and typically unicortical, further facilitating the ease of application of the system.

METHODS

The LISS began use at the Massachusetts General (MGH) and Brigham and Women's (BWH) hospitals in July of 2001 by the Harvard Orthopaedic Trauma team under the direction of Drs. Mark Vrahas and Malcolm Smith. In addition to its use on the trauma service, the system has also been used on the arthroplasty services for treating periprosthetic fractures.

The current study, with IRB approval, has tracked all of the cases where the LISS plate was used from July 2001 until September of 2002. The cases were found by utilizing Ortho DUDE, the trauma database developed by the Harvard Combined Orthopaedic Residency Program,[8] and by reviewing all of the operative notes for CPT codes from fractures appropriate for the LISS. Analysis has involved review of operative notes, computer records, and radiographs.

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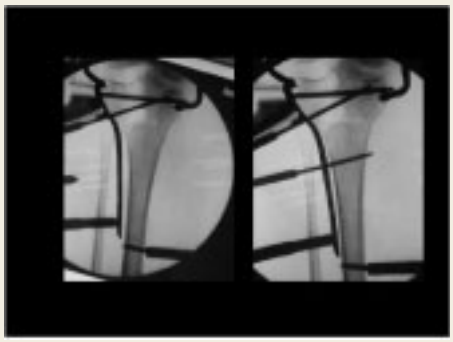

Figure 1. Intraoperative radiograph during percutaneous insertion of a LISS plate for a proximal tibia fracture.

Figure 2. Intraoperative radiograph of fracture from figure 1 after application of the LISS. Note that the plate is not touching the surface of the bone, which is thought to be advantageous for the bone's blood supply and healing. There is therefore no need to contour the plate. Further note that the distal screws are unicortical.

Figure 3. Postoperative radiograph of a distal femur fracture with proximal extension, after application of the LISS. Again note that the plate is not in contact with the diaphysis to minimize disruption to the bone's blood supply. The plate was inserted percutaneously.

RESULTS

During the first 15 months of its use we identified 94 cases where the LISS was used at the MGH and BWH. These cases have undergone preliminary analysis. Thirty-nine percent of cases were for femur fractures and 61% for tibia fractures. Twelve of the femur fractures (32%) were associated with either a total knee or hip arthroplasty. The average age for the periprosthetic fractures was 82 years. The average age of the patients was 56 years old (range of 20 to 93). The most common injury mechanisms were a fall from standing (45%) and motor vehicle collisions (21%).

The initial operative experiences have yielded encouraging results. Anecdotally, patients have appeared to tolerate weight bearing more quickly than with prior techniques, although this requires further research to verify. Longer term analysis of clinical and radiographic union rates, complications, and outcomes is ongoing at the time of this writing. There are few reports in the literature detailing outcomes with this technique, and we hope that our study will add significantly to our knowledge of this surgical technique.

CONCLUSIONS:

Periarticular fractures at the knee present difficulties, particularly in the osteopenic patient or the patient with a preexisting prosthesis. The LISS has been proposed as a tool with significant promise for improving the care of these fractures. Our initial experiences with the first 94 patients at our institutions have been encouraging, and these patients form a data pool to begin more rigorous evaluation of the merits of this technology. The initial experience with LISS appears to be fueling its use, as at least 50 more cases have been performed in the 5 months after the study period.

Our newly developed database, Ortho DUDE, is assisting in the trauma service's ability to better analyze outcomes, and this project is one of many that are likely to emerge in the future as the trauma database facilitates outcomes studies.

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References

1. **Schatzker J:** Fractures of the distal femur revisited. Clin Orthop 1998; 347:43.56.
2. **Frigg R, Appenzeller A, Christensen R, Frenk A, Gilbert S, Schavan R:** The development of the distal femur Less Invasive Stabilization System (LISS). Injury 2001; 32 Suppl 3:SC24-31.
3. **Borrelli J, Prickett W, Song E, Becker D, Ricci W.** Extraosseous Blood Supply of the Tibia and the Effects of Different Plating Techniques: A Human Cadaveric Study. J Ortho Trauma 2002; 16 (10) 691-5.
4. **Marti A, Fankhauser C, Frenk A, Cordey J, Gasser B:** Biomechanical evaluation of the less invasive stabilization system for the internal fixation of distal femur fractures. J Orthop Trauma. 2001; 15:482-7.
5. **Bon MR, Egol KA, Koval KJ, Kummer FJ, Su ET, et al.** Comparison of the LISS and a Retrograde-Inserted Supracondylar Intramedullary Nail for Fixation of a Periprosthetic Distal Femur Fracture Proximal to a Total Knee Artroplasty J Arthrop 2002; 17 (7): 876-81.
6. **Muller ME, Nazarian S, Koch P, Schatzker J:** The comprehensive classification of fractures of long bones. Berlin: Springer-Verlag, 1990, pp 171-179.
7. **Schandelmaier P, Krettek C, Miclau T:** Stabilization of distal femoral fractures using the LISS. Techniques in Orthopaedics 1999; 14: 230-246.
8. **Morrison S, Vrahas, M.** Ortho DUDE. Orthopaedic Journal at Harvard Medical School 2002; 4: 109-11.
9. **Chandelmaier P, Partenheimer A, Koenemann B, Grun OA, Krettek C:** Distal femoral fractures and LISS stabilization. Injury 2001; 32 Suppl 3:SC55-63.
10. **Kregor PJ, Stannard J, Zlowodzki M, Cole PA, Alonso J:** Distal femoral fracture fixation utilizing the Less Invasive Stabilization System (L.I.S.S.): the technique and early results. Injury 2001; 32 Suppl 3:SC32-47.
11. **Kregor PJ, Hughes JL, Cole PA:** Fixation of distal femoral fractures above total knee arthroplasty utilizing the Less Invasive Stabilization System (L.I.S.S.). Injury 2001; 32 Suppl 3:SC64-75.
12. **Schutz M, Muller M, Krettek C, Hontzsch D, Regazzoni P, Ganz R, Haas N.** Minimally invasive frature stabilization of distal femoral fractures with the LISS: a prospective multicenter study. Distal femoral fractures and LISS stabilization. Injury 2001; 32 Suppl 3:SC 48-54.