Acta orthop. scand. 52, 543–546, 1981

HAS THE McLAUGHLIN HIP IMPLANT ANY FUTURE?

J. Steen Jensen

Biomechanics Laboratory and Department of Orthopaedic Surgery T-2,
Gentofte Hospital, University of Copenhagen, Hellerup, Denmark

Modifications of the nail-plate junction of conventional McLaughlin implants were manufactured. An additional washer was introduced between the back of the nail and the plate extension or the contact area was extended by modifying the nail base. Mechanical testing of the strength of the two modifications was performed.
It is concluded that these modifications combined with replacement of the stiff nail by a sliding nail might provide a free angle device suitable for fracture fixation in trochanteric fractures.

Key words: biomechanics; femoral neck fractures, internal fixation; fracture fixation

Accepted 7.ii.81

In recent publications (Jensen 1980a, b) the weakness of the nail-plate junction of McLaughlin implants has been demonstrated and consequently a warning was given against the clinical application of the nail-plate implant. It has also been observed that the sliding screw-plate hip implant is the most suitable for the internal fixation of unstable trochanteric fractures (Jensen 1980c). This observation has been supported by clinical series (Jensen et al. 1980).

Considering the difficulties encountered in the operative procedure when applying a fixed angle device there may in the future be a need for a free angle device.

In collaboration with Howmedica Inc., Limerick, Ireland, two modifications have been made of the existing McLaughlin implant in order to improve the mechanical strength. In the present paper the results of mechanical testing of these modifications will be presented.

MODIFICATIONS

The contact area of the nail-plate junction of McLaughlin hip nail plates was enlarged by extending the base of the trifin nail and making it hemispherical with dimensions equal to the hemispherical curvature of the plate extension. In addition the flanges of the U-shaped plate were extended to the curved plate extension (Figure 1) and the serrations omitted. In the second modifi-

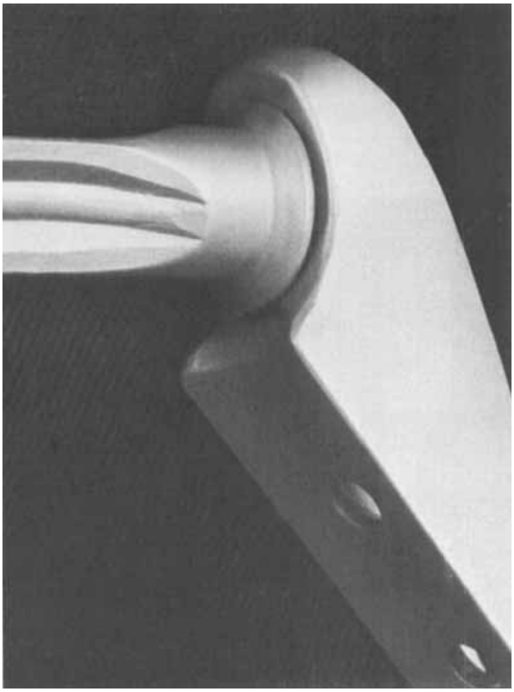

Figure 1. Nail base of the trifin nail enlarged.

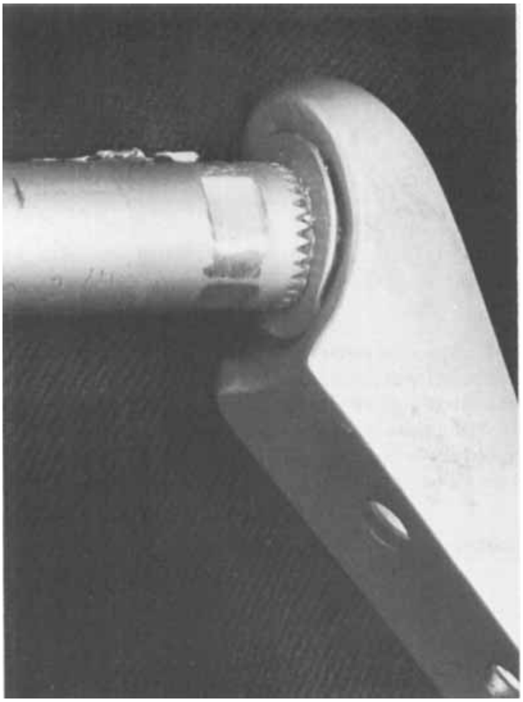

Figure 2. Additional washer introduced between the nail base and the plate extension.

cation the trifin nail was replaced by a conventional sliding nail (catalogue no. 6457-X) and the telescoping ability eliminated by gluing the inner nail to the outer cylinder by a slightly expanding 2-component polyurethane glue (Foss-Than 2 K 2350, Sadofoss, Denmark). A congruent surface between the nail base and the curved plate extension was made possible by introducing an additional washer (Figure 2). The modified parts were manufactured from Cobalt-Chromium-Molybdenum alloy by Howmedica Inc., Limerick, Ireland. The assembled implants are shown in Figure 3.

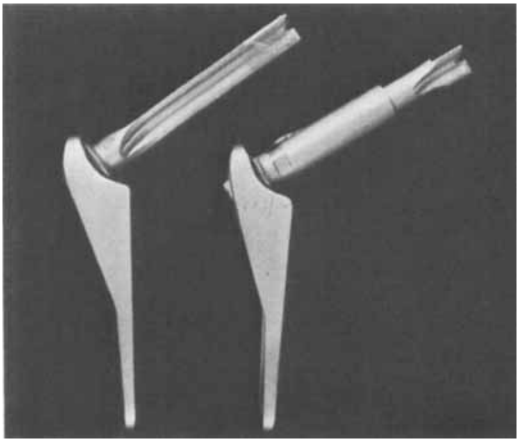

Figure 3. Assembled implants. McLaughlin implant with enlarged base and sliding nail mounted to McLaughlin plate with additional washer.

MECHANICAL TESTING

Mechanical testing of two implants of each type was performed according to the descriptions given in previous reports (Jensen 1980a, b, c). The nail-plate angle of 132° was applied and the moment arm kept at 41.1 mm about the intersection line between the back of the plate and the centre line of the nail.

RESULTS

The load-deflection diagrams for the original design of the 132° McLaughlin hip implant and those for the two types of modifications are demonstrated in Figure 4. The calculated mean curves differed very little from the curves obtained in the tests.

It can be seen that there were two yield points with the modified implants. In the original design three yield points were determined (Jensen 1980a), but there was no yield point caused by bending of the curved plate extension in the testing of the modified implants with the flanges added to the plate.

In Figure 5 the load-strain diagrams for the hip nails are demonstrated. The yield points in these graphs correspond to bending of the nail.

On the graphs in Figure 4 of the modified implants the lowest yield points thus equal bending of the nail, whereas the highest yield points are caused by permanent deformation of the nail-plate junction. In comparison the lowest yield point of 230 N in the original design was caused by loosening of the nail-plate junction due to deformation. This means that the modifications of the nail-plate junction presented here improve the mechanical strength by 5.2–5.4 times. The nail has now become the weakest part of the implant.

At the yield point for the nail-plate junction the nail base or the extra washer will deform

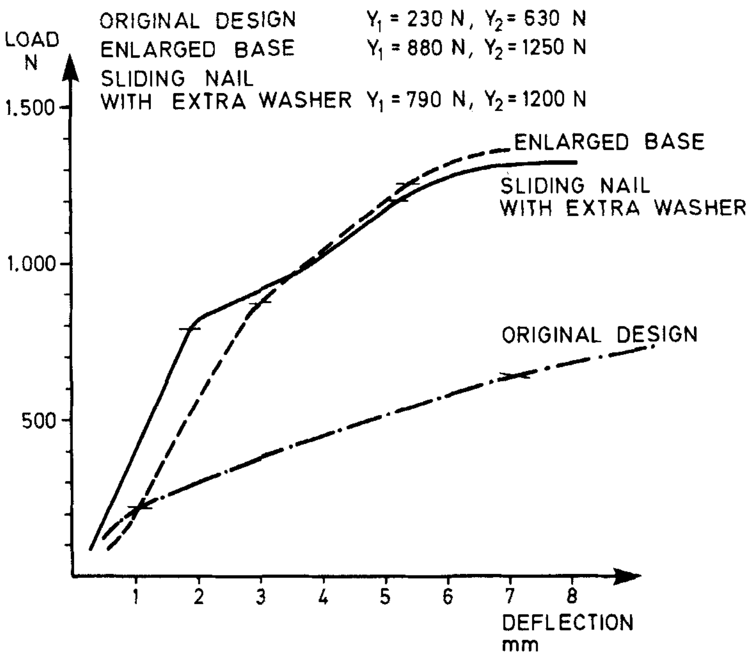

Figure 4. Load-deflection diagrams for 132° McLaughlin hip implants (Co-Cr-Mo).

permanently at the lower contact points with the curved plate extension. The top bolt will even become loose due to distortion of the threads, and progressive deformation of the washer between the top bolt and the plate extension will be experienced.

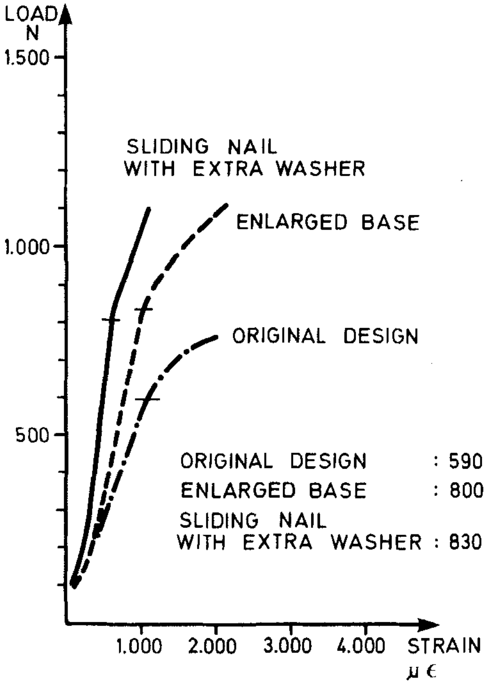

Figure 5. Load-strain diagrams for 132° McLaughlin hip implants (Co-Cr-Mo).

The bending moments about the nail-plate junction were calculated according to the equation:

$$M_B = J \times (MA + \Delta MA),$$

where MA is the moment arm about the junction (49.7 mm) and ΔMA the recorded elongation during the testing procedure. J is the applied load.

The bending moment about the junction was calculated to be 67.4 Nm for the implant with extended nail base (ΔMA = 4.24 mm) and 65.2 Nm for the sliding nail with an additional washer (ΔMA = 4.60 mm). The comparative figure for the original design was 11.4 Nm.

The varus angulation of the nails was 5.8° and 5.7°, respectively, for the two modified implants at the second yield point, corresponding to failure of the nail-plate junction.

The bending moments about the strain gauge centre at the nail could be calculated to be 30.7 Nm and 27.1 Nm, respectively.

In the present tests the telescoping ability of the sliding nail was locked, but in clinical application telescoping is expected to take place. The actual strength of the sliding nail can thus be calculated (Jensen 1980c) to be 958 N with 10 mm of telescoping compared with 1,217 N with 20 mm of telescoping. These figures correspond to a load bearing capacity of about 1.6–2.0 times the body weight. The strength of the nail plate junction is also increased through the telescoping, which results in a reduced moment arm. The yield loads can thus be calculated to be 1,350 N and 1,542 N, respectively, corresponding to a load bearing capacity of 2.3–2.6 times the body weight.

DISCUSSION

Internal fixation of unstable trochanteric fractures places very great demands on the mechanical strength of the implant, which transmits the majority of the hip joint load in cases with little or no bone contact over the fracture line. Clinically (Jensen et al. 1980) and experimentally (Jensen 1980c) the sliding screw-plate implant has proved to be the only implant suitable for the internal fixation of these fractures.

During normal walking the hip joint is loaded to about 3–5 times the body weight and this load must be transmitted through the implant to the femoral shaft.

It is possible to produce a strong implant, but in clinical use the number of failures of fixation due to penetration of the osteoporotic femoral neck and head will increase (Jensen et al. 1980).

The basic idea of the sliding screw-plate implant is to allow telescoping in order to establish bony contact over the fracture line.

Mechanical testing of the existing McLaughlin hip implants (Jensen 1980a, b) has shown extremely low failure loads of the nail-plate junction, corresponding to about 40 per cent of the body weight, and the clinical experiences have been disappointing (Jensen et al. 1980). In the present series the mechanical strength of the McLaughlin implants could be considerably improved by enlarging the contact area at the nail-plate junction and ensuring a perfect surface fit. In this case figures comparable with the mechanical strength of 125° and 135° Jewett implants were obtained. This is, however, not the perfect solution to the problem, as more failures due to osteoporosis can be expected.

If the McLaughlin implant is to survive as a free angle implant for the internal fixation of unstable trochanteric fractures, it is suggested that the stiff trifin hip nail be replaced by an ordinary sliding nail. The base of the sliding nail should either be modified according to the above mentioned description, or an additional shape contoured washer should be introduced between the base of the nail and the curved plate extension. In this case the pure mechanical strength of the implant will be comparable with that of a low angled Jewett nail and the ability to telescope will improve the actual strength and allow the fracture to impact until bony contact is established over the fracture line.

In the present tests the plate was also modified to avoid bending of the curved plate extension. The benefit of this modification is quite obvious from the mechanical tests, but is of doubtful importance if telescoping of the implant is allowed.

In conclusion, the possible future of the McLaughlin implant in the internal fixation of unstable trochanteric fractures depends on replacement of the trifin nail with a sliding nail and modification of the nail-plate junction giving an increased area of contact.

REFERENCES

Jensen, J. Steen (1980a) Mechanical strength of Jewett and McLaughlin hip nail plates manufactured from Cobalt-Chromium-Molybdenum alloy. *Acta Orthop. Scand.* **51**, 145–156.

Jensen, J. Steen (1980b) Mechanical strength of McLaughlin hip nail plates manufactured from 316 LVM stainless steel. *Acta Orthop. Scand.* **51**, 439–444.

Jensen, J. Steen (1980c) Mechanical strength of sliding screw-plate hip implants. *Acta Orthop. Scand.* **51**, 625–632.

Jensen, J. Steen, Sonne-Holm, S. & Tøndevold, E. (1980) Unstable trochanteric fractures. A comparative analysis of four methods of internal fixation. *Acta Orthop. Scand.* **51**, 949–962.

Correspondence to: J. Steen Jensen, Dr. med. Sc., Hestkøb Vænge 63, DK-3460 Birkerød, Denmark.