The Corail® Stem: Does a Collar Improve the Immediate Stability Even in a Present Calcar Split? A Mechanical Study

Tom Adler*, Thomas Schaefer and Piers Yates
Department of Orthopaedic Surgery, Fremantle Hospital and Health Service, Australia

Abstract

The help of collared Corail® stems in present calcar fractures as well as the influence on stability in a standing position were investigated. 24 femur Sawbones® were divided in 4 groups: Collared stems were compared with collarless as well as calcar split and intact femurs. Mechanical testing was performed on a Zwick/Roell Z010 material testing machine with preloading of 2400 Newton and followed by external rotational load. No loosening was found in intact femurs with collared stems, but loosening with collarless stems at 55.8 Newton. Significantly fewer loads (31.7 N, 24.8 N) were needed in fractured femurs. A collar did not improve the stability significantly. A collar improves the immediate stability, but not in a present calcar fracture of the femur.

Introduction

The Corail® stem is a reliable implant in hip surgery and was first implanted in 1986 [1-7]. A split in the calcar during implantation is relatively common, and may impair the stability of the stem. A collared stem may help in such situations. Advantages and disadvantages about using a collar have been reported in the last decades. Disadvantages include difficulties in achieving proper calcar contact and thus not achieving optimal axial load for immediate stability or offloading of the stem intramedullary leading to a more instability in regard to torsion. Furthermore, a flat collar can decrease the stress transfer in the stem what is needed for proper in growth. Advantages include the avoidance of over-insertion, lower subsidence and aiding to a more stable implant in both young patients with un-cemented stems and older patients with cemented stems [2-12]. For the Corail® stem it is proven that the immediate stability is increased due to the use of a collar for axial load as well as horizontal load imitating torsional load. However, the loads are not tested in combination in order to imitate rotational motions in a standing position [13]. Furthermore, we investigated the influence of a present calcar split on the immediate stability comparing collared and collarless stems.

Material and Methods

Twenty-four femur Sawbones® (item # 3403, medium size, 4th generation) were used for mechanical testing. The use of Sawbones® has been validated in recent studies [14-17]. The implants (Corail® Cementless Standard Offset Stem) as well as the instruments were provided by DePuy/Johnson&Johnson. We compared collared with collarless stems (Figure 1). The 24 Femur Sawbones® were cut in the diaphysis in order to have identical femurs with the same length (16 cm). The femurs were then prepared according to the usual practice in theatre. Finally, the calcar reamer was used in order to achieve perfect contact with the collar (Figure 2 and 3). Half of the prepared femurs were cut in the calcar to simulate a crack (Figure 4). The mechanical testing was performed on a Zwick/Roell Z010 material testing machine with torsion load as well as axial load sensors. The femurs with implanted stems were fixed in the machine and a metal-metal acetabular cup/head were used in order to imitate the acetabular fixation (Figure 5).

All femurs were preloaded with 2400 Newton imitating the average vertical force of a hip in a single leg stand of an average person with an eighty kilogram body weight [18-20]. After preloading, all femurs were tested with torsional load in an external rotation direction of the femur. A fracture of the femur or a sudden loss of load (loosening of the stem) was count as the endpoint of the test.

Results

All tested constructs were able to rotate but with increasing torsion load due to the head-cup
fixation proximally. The limit of external rotation in our test setup was 90 degrees, when the greater trochanter came in contact with our metal box containing the acetabular cup. In our test construction all femurs with collared stems without calcar fracture showed neither loosening of the stem nor a fracture of the femur with loosening of the stem. Two of the 6 femurs showed a fracture in the diaphysis close to the fixation in our test construction (Figure 6). Strictly, these fractures could be named as periprosthetic Vancouver Type C fractures. The 4 other femurs reached the construction limit with contacting the greater trochanter with the metal box. The group with collarless stems and intact calcar showed with an average of 62.4 degrees (±8.8°) of external rotation and an average torsion load of 55.8 N (±11.6N) before a fracture with loosening of the stem. The difference is very significant. The calcar split femurs showed a decreased resistance against torsion load with an average load of 31.7 N (±16.1N) with an external rotation of 19° (±7°) even with collared stems. In all femurs the fracture pattern was similar (Figure 7). The same femurs tested with collarless stems fractured with an average torsion load of 24.8N (±7.3N). The difference (p=0.3) is not significant. The difference between collarless stems without calcar split and collared stems with a calcar split is significant (p=0.014).

**Discussion**

With our test setup we found a benefit of using collared stems in order to improve immediate axial stability. Our result is comparable with current literature [4,5,13]. However, the won some studies could not show that immediate stability does not lead to a better or earlier in growth [5,14]. Thus, the calcar provides additional stability for immediate postoperative time period, which may be useful if any concerns exist in the bone quality, for instance.

A perfect contact between calcar and collar is mandatory in order to achieve the desired improved stability. In our pretest we also tested femurs with collared stems but without perfect contact to the calcar. The behavior was comparable to collarless stems. But due to
the unstandardized testing and very low number of tests these results cannot be used for evidence. The collar provides an additional surface as a counterpart especially against axial loads. We hypothesize that the additional surface creates a higher resistance to torsional load. This hypothesis could be confirmed and is comparable with the current literature [5]. In our pretest we also tested 2 femurs with a fracture in the greater trochanter. The collared stems implanted in these femurs showed similar behavior to collared stems implanted in intact femurs. This result cannot be used for evidence. Nonetheless, the question became interesting, if the collar provides adequate stability in femurs with a calcar split since calcar fractures can occur in implanting of stems like Corail® stems. Although a trend towards higher stability can be seen with the use of a collared stem in a calcar split femur, a significant difference could not be found. This finding is important information for surgeons using these kinds of stems, because it supports the need for stabilizing an occurred calcar fracture. In cases of an occurred calcar fracture the collared stem does not give adequate stability alone. An additional fixation like a cercalage should be used.

**Conclusion**

The collar provides an improved immediate stability if the collar has a perfect contact to the calcar. In cases of an occurred calcar fracture the collared stem does not give adequate stability alone. An additional fixation like a cercalage should be used.

**References**