Geraci et al., Orthop Muscul Syst 2013, 2:3
DOI: 10.4172/2161-0533.1000134

Orthopedic & Muscular System: Current Research

Mini Review Open Access

Rational in the Preservation of the Femoral Neck in Patients with High Functional Demands. Always or Almost Always?

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Total hip arthroplasty [THA] is a cost-effective treatment for dysplastic or senile osteoarthitis. Arthritis of the hip has traditionally been perceived by the general population as a condition of the elderly, although the incidence in younger patients has been well documented [1,2]. Arthritis of the hip can refer to a number of different disorders of the joint and it may arise from many causes, for example: degenerative joint disease, osteonecrosis, dysplasia, Perthes-like deformity, fractures. Young and active patients have much higher expectations of functional outcome from their hip replacement [work related activity as well as recreational activities]. Wear of a mechanical joint is dependent on its usage. THA may be entertained for young patients with advanced intra-articular disorders that are not amenable to treatment with joint-preserving surgeries [3]. The preferred method of fixation of THA remains controversial. Reported rates of cemented and uncemented THA [4] show rates of wear of 0.12 mm/year for both cemented and uncemented components [5]. Patients under 40 years of age have shown slightly inferior outcome with uncemented components when compared with patients older than 40 years in the same study [6].

The fact is that in a young patient, the hip prosthesis must be performed when the joint is completely damaged, and for this reason we must restore the function of the diseased joint. When you performed the surgery, you must also think about the future consequences of this surgery because a review to wear the prosthesis will probably be required. Saving the bone, therefore, means to preserve an anatomical condition that will help us in a possible [hopefully remote] revision of the prosthesis.

The femoral neck [FN] is a flattened pyramidal process of bone, connecting the head to the body, and forming with the latter a wide angle opening medialward. In the adult, the neck forms an angle of about 125° with the body, but this varies in inverse proportion to the development of the pelvis and the stature. In the female, due to the increased width of the pelvis, the neck of the femur forms more nearly a right angle with the body than it does in the male. The FN is flattened from before backward, contracted in the middle, and broader laterally than medially. The vertical diameter of the lateral half is increased by the obliquity of the lower edge, which slopes downward to join the body at the level of the lesser trochanter, so that it measures one-third more than the antero-posterior diameter. The FN is the most solid structure of the proximal femur because it is designed to distribute the forces of compression, traction, rotation to the shaft of the femur. The proximal femur is one of the most important bones in the body. The entire weight of the upper body is transmitted to the legs through the femur. The ball and socket joint of the hip are also critical to the mobility of the lower limbs. Thus an understanding of the stress distributions in the proximal femur will be helpful in enhancing the success of hip operations and improving the mobility of post-hip operation patients [7].

The preservation of the FN in total hip prosthesis allows to optimize the distribution of gravitational forces in the three planes of space [8]. The reduction of the alteration of bone osteotomy, improves the mechanical forces on the pelvis-femur. A better distribution of forces implies a better integration of the prosthetic implant and a subsequent best bone remodeling. The preservation of the FN should be understood not only as the preservation of normal bone anatomy, but also neck-shaft angle [9]. The solidity of the structure and geometric shape angled at 125° neck-shaft of the femur ensure maximum primary stability to the stem. The concept of femoral neck preserving hip replacement was introduced in the mid 1990s [9]. The preservation of the neck retains the trabecular systems of the metaphyseal cancellous bone, and thus allows for a more physiological load distribution along the diaphysis and the greater trochanter [10].

Retention of the neck further permits an increased bone ingrowth, probably due to the protection of blood supply.

Short femoral stems provide the opportunity to avoid such resurfacing-specific complications while potentially saving more femoral bone stock than conventional femoral stems. Short femoral stems allow the preservation of proximal bone stock [11] by subcapital resections of the femoral neck, apparently, by exerting more proximal load transfer than distally anchored, conventional stems.

Hip resurfacing theoretically provides the most marked preservation of the proximal femur, but, femoral neck fractures, early loosening due to osteonecrosis, development of pseudotumours, and other complications, have diminished the initial euphoria associated with this procedure [12]. A study on a conventional uncemented stem indicated that the loss of periprosthetic bone mineral density [BMD] is less pronounced around smaller stems [13]. However, little is known about the results after the insertion of short femoral stems, and there have been very few investigations of periprosthetic BMD around short femoral stems. Short femoral stems, also named metaphyseal stems, have been designed and introduced into the surgical practice in order to improve the results of the standard non-cemented stems [14]. A wide range of short stems are available, with differences in design, surgical technique, and published outcomes. Several advantages have been advocated in favor of short stems over standard non-cemented stems. Short stems: preserve the proximal femoral bone stock, decrease stress shielding, decrease the tight pain rate, ease minimally invasive surgical procedures, improve long-term stem survival, ease the surgical procedure during revision [15,16]. There are two main groups of short stems, those that are neck-preserving and those that do not preserve the femoral neck. Another feature that differentiates them in the

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Received July 24, 2013; **Accepted** October 30, 2013; **Published** November 10, 2013

Citation: Geraci A, Geronazzo V, Geronazzo P (2013) Rational in the Preservation of the Femoral Neck in Patients with High Functional Demands. Always or Almost Always? Orthop Muscul Syst 2: 134. doi:10.4172/2161-0533.1000134

availability of modularity. In the Table 1 there is a list of same used short stems. In the literature there are studies that show a good result of these prostheses [17-20].

In general, the clinical outcome after cementless hip replacement can be significantly affected by the occurrence of thigh pain which is mainly caused by micromotion of the stem accompanied by radiolucent lines [21,22].

The CFP stem (Figure 1) seems to provide sufficient rotational stability in a short- and mid-term clinical follow-up and bony ingrowth and fixation of the stem was excellent at the time of follow-up [18]. Falez et al. have seen that for 160 implants with Mayo Conservative stem (Figure 2) followed over a period of 4.7 years, survivorship was 97.5% with 4 failed implants [23]. Lerch et al. have shown using Metha stem [Aeesculap] (Figure 3) that stress shielding seems to occur at the greater trochanter due to the vast cross-section of the implant. However, the aim of proximal load transfer of the Metha stem seems to be partially achieved. DEXA analysis revealed a concentrated load distribution on the medial portion of the femur, which is an important region to guarantee long-term implant survival [19]. Ettinger et al. have seen in a mean follow-up of 6 years using the Nanos stem (Figure 4) that None of the 72 stems were revised, providing a survival rate of 100%. Radiolucent lines were visible radiographically in two patients during follow-up. The NANOS short stem demonstrated a satisfactory outcome at midterm follow-up [24].

Some short-stemmed prosthesis	characteristics
Mayo Conservative Stem (Zimmer)	Non-neck preserving and no modularity
CFP	Neck-preserving, no modularity
Metha (Aeesculap)	Neck-preserving, modularity
Cut (ESKA)	Neck-preserving, no modularity
Taperlock Microplasty (Biomet)	Neck-preserving, no modularity
Nanos (Smith and Nephew)	Neck-preserving and no modularity
Proxima Stem (DePuy)	Can be neck-preserving, no modularity
Silent (DePuy)	Neck-preserving, no modularity
Mini Hip (Corin)	Neck-preserving, no modularity
Collo-MIS (Lima)	Neck-preserving, no modularity

Table 1: List of short stem

Figure 1: CFP stem

Figure 2: Mayo conservative stem

Figure 3: Metha stem (Aeesculap)

Figure 4: Nanos stem

From the literature it is clear that the use of these implants in a patient with good bones and of a young age is a great way for a resumption of the good function of the hip. But can the short femoral stems be used in all patients?

The influence of conditions such as obesity, metabolic bone diseases, or osteoporosis on the stem survival rate is yet to be defined. The failure pattern of these stems is yet to be known; it still has to be proved that the surgical revision is eased and that the revision can be made with a primary conventional stem.

In general, short stem implants are designed to require less resection of the upper femur and/or less reaming of the femoral shaft. This serves the dual purpose of facilitating future revision while providing a postoperative follow up. According to Santori, short stem implants generally rely on metaphyseal stem placement, but some do not utilize any support on the metaphyseal bone, which may make them more prone to failure or loosening if the bone stock is of poor quality closely mimicking the originally functioning hip.

One finding in the current literature is that the predominance of failures requiring revision associated with short stem implants occur in the short-term postoperative period, suggesting that achieving immediate stability is critical to success [25].

Clinical evidence thus far suggests that if stability is achieved in the immediate postoperative period, performance of short stems appears to be on par with conventional stems.

Our personal opinion is that the indications for the use of a femoral stem should be sought in the short quality of bone and muscle component, features that are almost exclusive in young patients exclusively.

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