Technical considerations and functional results in primary uncemented hip arthroplasty using short femoral stems through mini-invasive techniques

Moga M, Pogarasteau ME
Orthopedics – Traumatology Clinic, "Dr. Carol Davila" Central Military University Emergency Hospital, Bucharest, Romania

Correspondence to: Marius Moga, MD
Orthopedics – Traumatology Clinic, "Dr. Carol Davila" Central Military University Emergency Hospital, Bucharest, Romania
88 Miresei Vulcaenescu Street, District 1, code 010825, Bucharest
Phone: +40 21 319 30 51, Fax: +40 21 319 30 30, E-mail: mariusmoga2001@yahoo.com

Received: March 25th, 2014 – Accepted: June 30th, 2014

Abstract
Primary hip arthroplasty is a surgical procedure through which the coxofemoral joint is replaced with a prosthetic implant. Arthroplasties can be total or partial, cemented or uncemented. These procedures are generally indicated as a form of treatment for arthritic pain or in the case of severe trauma, such as femoral neck fractures. The most commonly used approaches are: Smith Peterson, Watson Jones, Hardinge, Moore Southern and Ludloff. Recently, mini-invasive approaches have started being used, while correlated with short femoral stems. Short metaphyseal femoral stems have been introduced as an alternative to conventional stems, having a series of advantages: preservation of bone stock (high cervical osteotomies), preservation of the anatomical anteversion of the femoral neck, decrease in cortical stress forces, decrease in the remaining thigh pain, a longer life of the prosthesis, with the possibility of revision to a conventional prosthesis, and the possibility to be used in correlation with mini-invasive procedures. Short femoral stems implanted through a mini-invasive approach allow the conservation of the femoral bone stock, permitting an ulterior re-intervention, in the context of an ageing population, with a globally rising long-term survival rate. Moreover, the superiority of the total hip arthroplasty with a short femoral stem was discussed through mini-invasive approaches, in the day-to-day realities of our Clinic.

Keywords: hip arthroplasty, short femoral stem, mini-invasive technique

Introduction
Primary hip arthroplasty is a surgical procedure, in which the coxofemoral joint is replaced with a prosthetic implant, as a treatment for arthritic pain, avascular femoral head osteonecrosis, or in the case of severe trauma, like femoral neck fracture.

During the last three decades, the total hip arthroplasty procedure has undergone a continuous process of development, becoming one of the best understood and cost-efficient procedures in orthopedic surgery.

The post operatory results are remarkable with any of the approaches: anterolateral, lateral, posterolateral, posterior or medial. These are typically made with an incision of 25 to 40 centimeters in length. The survival rate of this procedure is close to 100%.

Despite the classical total hip arthroplasty, the procedure’s established success, technical evolution and high patient demands have lead to a need of exploring new possibilities of improving the procedure. Pain and functional deficit tend not to be the only clear indications for surgery, while ever younger patients resort to hip arthroplasty in order to regain an active life.

Conservatory surgery aims both at protecting soft tissues and at conserving bone capital; if we cannot be confident that the expected functional life of the prosthesis is greater than the patient’s life expectancy, it is absolutely necessary to consider successive interventions, thus attempting to preserve a maximum of bone stock, by resecting as little at the time of surgery and by optimizing the physiological load in the proximal femur, in order to preserve bone capital on long term. The most adequate prostheses in this sense are the ones with a short femoral stem, having a metaphyseal support.

Short femoral stems, also called metaphyseal stems, have been introduced in the surgical practice as an alternative to conventional femoral stems in the primary uncemented total hip arthroplasty as they offer a number of advantages [1,2].

Short femoral stems are a current-day approach to dilemma concerning the need to preserve bone stock in total hip arthroplasty, with regard to a possible reintervention, with an ageing target population, an increase in the mean long-term global survival rate.

Biomechanical studies have shown that most short femoral stem prostheses (i.e. PROXIMA) do not function according to the “fit and fill” principle, thus providing an excellent axial and rotational stability within the spongy bone, in which the prosthesis lies “suspended” and with which it moves in unison. This reduces the rotational stress within the fixation interface and optimizes the transfer of forces at the metaphyseal level [3-5]. A study by Jakubowitz et al. shows that there
is no high periprosthetic fracture risk involved in using short stem femoral prosthesis, compared to a standard cementless prosthesis, but that rather the risk is dependent on the patient's body mass index, in the context of a fall [6].

Short stem prostheses are designed by the manufacturers to be used in correlation with a mi-neck resection line, preserving bone in the neck and diaphysis area [7]. This extra portion of femoral neck also maintains a structural integrity in the femur, adding to the long-term stability, and giving an added degree of torsional stability, crucial in an active, young patient [8,9]. This is also enhanced by the general “fit and fill” design of the short stem prosthesis. The technique of implantation is generally the “round the corner” technique, curving to follow the medial cortical wall, thus preventing the stem from exiting through the lateral wall, white preserving bone mass and providing a favorable angle of approach to the femoral canal.

The primary cementless fixation in the femur is done through “scratch fit”, which creates a very high coefficient of friction, while long-term fixation is accomplished through osteoconduction. Some short stem prostheses (MiniHip) have anti-rotational fins to add stability in the torsional plane, thus keeping micromotions to a minimum.

Considering that most, if not all the patients operated with the short femoral stem are young and active, their high activity levels demand a high range of motion; this is accomplished through the low profile neck and taper of the prosthesis, thus maximizing the head/neck ratio and the safe range of motion [10-13].

The femoral offset also has to be taken into consideration when conducting a hip replacement procedure and short femoral stem prosthetics offers a varying offset and neck lengths, thus allowing a customization of the prosthesis to each patient's characteristics.

Densitometric studies have also shown bone remodeling at the proximal femur following preferentially metaphysary loading in short femoral stem prosthesis [14].

As new minimally invasive surgical techniques are explored in hip arthroplasty, we gain a progressive understanding of the fact that, in most cases, "mini-invasive" is associated with a decrease in morbidity, a faster recovery and a more attractive cosmetic result [15,16].

In order to facilitate the mini-invasive procedure, a dedicated set of instruments has been developed; including a set of retractors which help achieve an adequate exposure, while at the same time limiting the potential to damage soft tissues, ligaments, or vascular and nervous structures [17].

From our point of view, only through documentation, exploration and research may we can gain enough knowledge to evaluate the clinical consequences of the long-term use of total hip arthroplasty through the mini-invasive method. Our aim is to establish a context in which to compare the functional results of this procedure with those of the classical procedure.
Case Presentation

- A. B., 35 years old, male;
- Diagnosis at admittance:
  POST-TRAUMATIC LEFT HIP ARTHROSIS WITH FUNCTIONAL IMPAIRMENT AND 2 CM LIMP SHORTENING.

  ROAD ACCIDENT POLYTRAUMA (MOTORCYCLE DRIVER) 24 MONTHS AGO.
  MULTIPLE FRAGMENT FRACTURE OF THE ILIAC WING, ISCHION, ACETABULUM AND HEIPUBIS ON THE LEFT SIDE – OPERATED (OPEN REDUCTION AND OSTHEOSYNTHESIS WITH PLATE AND SCREWS) – CONSOLIDATED.
  MULTIPLE FRAGMENT INTRA-ARTICULAR FRACTURE OF THE DISTAL THIRD OF THE LEFT FEMUR WITH ARTICULAR – OPERATED-CONSOLIDATED.
  MULTIPLE FRAGMENT FRACTURE OF THE DISTAL THIRD OF THE LEFT TIBIA – OPERATED-CONSOLIDATED.
  FRACTURE OF THE MEDIAL THIRD OF THE LEFT TIBIAL AND FIBULA – OPERATED-CONSOLIDATED.
No other known pathology.

Fig. 4 Preoperative radiography

Fig. 5 Impaction of the short stem femoral prosthesis into the metaphysis

Fig. 6 The ceramic prosthetic femoral head

Fig. 7 The acetabular cup with the ceramic insert

Fig. 8 Postoperative radiographic control

Case particularities
-a national first in Romania, regarding total uncemented hip arthroplasty, with a short femoral stem, through a mini-invasive approach.
- a technically demanding case, due to the associated,
Results and Discussions

Considering our observations up to this date, and analyzing the current day literature, we were able to differentiate a series of advantages and disadvantages regarding the mini-invasive short femoral stem total hip arthroplasty versus the classical method [18-22]:

Advantages:
1–conservation of femoral bone stock, through high neck osteotomies, preserving a large percentage of the neck, and preserving its natural anteversion;
2—a decrease in the cortical stress forces, thus significantly decreasing the percentage of thigh pain, one of the causes of painful hip prosthesis;
3—the possibility of implantation through mini-invasive techniques;
4—a longer expectancy of functionality, with the possibility of revision to a conventional femoral stem (a standardized procedure);
5—a viable alternative in important femoral deformities, in which a femoral prosthesis would be unsuitable;

Disadvantages:
1–routine intraoperatory radiographic control, the procedure having a learning curve;
2—if used in hip dysplasias, a much too antevered implantation in the femoral neck would predispose to prosthesis displacement.

Conclusions

Our current research suggests the superiority of surgical treatment through total hip arthroplasty with a short femoral stem, by using a minimally-invasive approach, versus the traditional method, based on the data showing a great number of significant advantages opposing the relatively minor disadvantages.

Acknowledgements

This work was supported by the staff in the Orthopaedics – Traumatology Clinic of the Central Military University Emergency Hospital in Bucharest, to whom we would like to extend our gratitude.

References

1. Morrey BF, Adams RA, Kessler M. A conservative femoral replacement for total hip arthroplasty. A prospective study. J Bone Joint Surg Br. 2000; 82(7):952-8.
2. Hube R, Zaage M, Hein W, Reichel H. Early functional results with the Mayo-hip, a short stem system with metaphysisal-intertrochanteric fixation. Orthopade. 2004; 33 (11): 1249-58.
3. Ghera S, Pavan L. The DePuy Proxima hip: a short stem for total hip arthroplasty. Early experience and technical considerations. Hip International. 2009; 19(3): 215-220.
4. Gilbert RE, Salehi-Bird S, Gallacher PD, Shaylor P. The Mayo Conservative Hip: experience from a district general hospital. Hip Int. 2009 Jul-Sep; 19 (3): 211-4.
5. Goebel D, Schultz W. The Mayo cementless femoral component in active patients with osteoarthritis. Hip Int. 2009 Jul-Sep; 19 (3): 206-10.
6. Pons M. Learning curve and short-term results with a short-stem CFP system. Hip Int. 2010; 20 (Suppl 7) (S7): 52-57.
7. Briem D, Schneider M, Bogner N, Botha N, Gebauer M, Gehrke T, Schwantes B. Mid-term results of 155 patients treated with a collum femoris preserving (CFP) short stem prosthesis. Int Orthop. 2011 May; 35(5):655-60.
8. Tóth K, Mecs L, Kellermann M. Early experience with the Depuy Proxima short stem in total hip arthroplasty. Acta Orthop Belg. 2010 Oct; 76(5):613-8.
9. Sangüesa-Nebot MJ, Soriano FC, Gabarda RF, Valverde C. Revision hip arthroplasty with a short femoral component in fractured hydroxyapatite fully coated femoral stem. J Arthroplasty. 2010; 25: 1168.e13.
10. Steens W, Skripitz R, Schneeberger AG, Petzing I, Simon U, Goetzte C. Cementless femoral neck prosthesis CUT-­‐clinical and radiological results after 5 years. Z Orthop Unfall. 2010 Aug; 148(4):413-9.
11. Gill IR, Gill K, Jayasekera N, Miller J. Medium term results of the collum femoris preserving hydroxyapatite coated total hip replacement. Hip Int. 2008; 18(2):75-80.
12. Santori FS, Santori N. Mid-term results of a custom-made short proximal loading femoral component. J Bone Joint Surg Br. 2010 Sep; 92(9):1231-7.
13. Synder M, Dobrniekiewski M, Pruszczynski B, Sibiski M. Initial experience with short Metha stem implantation. Ortop Traumatol Rehabil. 2009; 11(4):317-23.
14. Jakubowithz E, Seeger J, Lee C, Heisel C, Kretzer J, Thomsen N. Do short-stemmed-prosthesis induce periprosthetic fractures earlier than standard hip stems? A biomechanical ex-­‐vivo study on two different stem designs. Arch Orthop Trauma Surg. 2009; 129:849-855.

Present and Future Applications of Biomaterials in Bone Disease – a 3D Microcomputed Tomography Study (The Romanian Review Precision Mechanics, Optics & Mecatronics. 2008; (18), 34, 121-128.
Clinical and Radiographic Evaluation of Silicate-Substituted Calcium Phosphate Ceramic in Posterolateral Lumbar Spinal Fusion. The Romanian Review Precision Mechanics, Optics & Mecatronics. 2008; (18), 34, 45-50.
The Use of Highly Dispersed Hydroxapatite Grafting Material in Patients with Marginal Periodontitis. The Romanian Review Precision Mechanics, Optics & Mecatronics. 2008; (18), 33, 87-90.
Attitudes of Surgical Treatment in Haemophilic Arthropathies. SOMOS-Sentinel. December 2008; VI, 4, 36-39.
Considerations and Clinical Prospectives in the Treatment of the Anterior Shoulder Instability. The European Journal of Orthopaedic Surgery and Traumatology/Springer, doi: 10.1007/s00590-009-0447-5, Ref: EJO/EJOS-D-08-00142R1.
Modern Alternative Bearing Surfaces for Total Joint Arthroplasty. The Romanian Review Precision Mechanics, Optics & Mecatronics. 2009; 35.
21. Milea PL, Stefan G, Moga M, Barbilian A, Mitulescu S, Cernat E, Oltu O, Moldovan C, Pompilian S. Hardware & Software Package for Locomotory Disabled Patients Training. International Journal of Systems Engineering, Applications and Development, March 2011; pp. 1, 5, 436-443.

22. Milea L, Zafiu A, Dascalu M, Barbilian A. Software and Hardware for Locomotory Disabled Patients Assisted Training and Prosthetic Solutions Choosing. Proceedings of International Conference on Computational Intelligence, Man-Machine Systems and Cybernetics, Cimmacs. December 14-16 2010; 269-273.