TRIPOLAR HIP ARTHROPLASTY

Essay

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TRIPOLAR HIP ARTHROPLASTY

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Tripolar procedure was introduced in the middle 1980s and involves the use of a bipolar femoral prosthesis that articulates with a standard THA acetabular component, during this time, case reports were published documenting the early success of this technique in treating difficult cases of recurrent instability

Tripolar hip arthroplasty can be used in in primary total hip arthroplasty in following conditions: alleviation of incapacitating pain in patients older than 65 years of age who could not be relieved sufficiently by nonsurgical means and for whom the only surgical alternative was resection of the hip joint.:Of secondary importance was the improved function of the hip. After the operation had been documented to be remarkably successful in patients with rheumatoid arthritis, inflammatory arthritis osteoarthritis(primary or secondary), avascular necrosis of the femoral head, and nonunion of the femoral neck, Fractures , Tumors and when Conservative treatment tried at first with increased weight, non steroidal anti inflamatory, walking stick in contralateral hand

Tripolar procedure consists of femoral and acetabular components, femoral components has many designs as (Charnley, Muller, Exeter, Furlong, C-stem) and there are cemented and cementless, Cemented as Polished, Textured and PMMA coated ,cementless are press-fit,hydroxyl apatite coating types And there are constrained ,unconstrained acetabular components to prevent recurrent dislocation, there are currently 21 constrained designs available, we found that a majority of the reports available describe the use of the Secure Fit/Trident , Constrained tripolar liners are the Duraloc/S-Rom and The other designs commonly used are the Ring Loc and Ring Loc II, which are similar in design to the Duraloc system.

There is no consensus as to the optimum surgical approach used in tripolar hip arthroplasty. Most approaches can be categorized as variations of the posterior approach (also known as Kocher Langenbock or Southern/Moore approaches), the anterolateral or Watson Jones approach, and the lateral or Hardinge approach. The two most popular approaches are the posterior approach and the anterolateral approach, each with their variations. It is generally thought that surgeons should not be rigid in their approach and technique should be based on patient profile and procedure planned.

Some complications of tripolar hip arthroplasty are specifically related to the procedure, whereas others are inherent to any major surgical procedure in elderly individuals. Some complications, such as nerve palsy, hemarthrosis, and thromboembolism, occur early after surgery. Loosening, component failure, and osteolysis typically are late complications that occur a number of years after initial success. Still others, such as infection, dislocation, and femoral fracture, can occur at any time in the postoperative period, depending on a number of circumstances.

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Introduction

Instability is the most common complication after total hip arthroplasty, also recurrent dislocation is one of the major challenges facing orthopedic surgeons. The etiology for postoperative dislocation stems arised from factors related to the individual patient, surgical technique and implant design. Current treatment options include a modular component exchange (headliner), trochanteric advancement and conversion to a bipolar hemiarthroplasty, the use of jumbo femoral heads then placement of a constrained or unconstrained tripolar joint arthroplasty **(Beaule et al;2002).**

The concept of a tripolar articulation was introduced in the middle 1980s and involves the use of a bipolar femoral prosthesis that articulates with a standard THA acetabular component, during this time, case reports were published documenting the early success of this technique in treating difficult cases of recurrent instability **(Grigoris et al;1994).**

The tripolar hip prosthesis consists of two bearing surfaces: the outer bearing surface between the acetabular cup and an intermediate component, and the inner bearing surface between the intermediate component and the femoral head componenet. While the underlying mechanism by which tripolar prostheses reduce the dislocation remains unknown, it is beliveved to be related with the motion of the intermediate component ***(Shrader et al; 2003)***.

The constrained triploar design consists of a femoral head that snaps into a polyethylene shell which in turn articulates within an outer polyethylene liner, This bipolar construction is then snapped into an osteonics acetabular shell provided by the outer polyethylene. The metal locking ring design employs a reinforcing titanium ring ***(Padgett & Warashina; 2004).***

Tripolar joint has many advantages over other arthroplastic devices that this system is designed to face recurrent instability, multidirectional intraoperative instability, abductor insufficiency, neuromuscular disability, extensive acetabular bone loss, inability to repair the greater trochanter, massive femoral bone loss requiring allograft or replacement, revision following resection arthroplasty, neuromuscular disorders, revision following periprosthetic fracture, failed previous attempts at stabilization, revision following hip arthrodesis, proximal insertion deficiency, six or more previous dislocations ***(Goetz et al; 2004).***

Biomechanical principles

The biomechanics of tripolar hip arthroplasty are different from those of the screws, plates, and nails used in bone fixation because the latter implants provide only partial support and only until the bone union. Tripolar hip components must withstand many years of cyclic loading equal to at least 3 to 5 times the body weight and at times they can be subjected to overloads of as much as 10 to 12 times the body weight. Therefore a basic knowledge of the biomechanics of the hip and hip arthroplastic procedures are necessary to perform the procedure properly, to manage the problems that may arise during and after surgery successfully and to counsel patients concerning their physical activities **(Guyen et al;2004).**

Forces acting on the hip:

Hip is affected by 3 forces: The body weight infront second sacral vertebrae**,** the abductor force equal to 2 times body weight and the total femoral head force equal to 3 times body weight in stance.

These forces affect the hip joint through 2 lever arms: the abductor and body wight lever arms which meet in the hip center of rotation which is nearly the center of the femoral head which is opposite to the tip of the greater trochanter. To describe the forces acting on the hip joint, the body weight can be depicted as a load applied to a lever arm extending from the body's center of gravity to the center of the femoral head . Abductor musculature, acting on a lever arm extending from the lateral aspect of the greater trochanter to the center of the femoral head, must exert an equal moment to hold the pelvis level when in a one-legged stance, and a greater moment to tilt the pelvis to the same side when walking or running. Since the ratio of the length of the lever arm of the body weight to that of the abductor musculature is about 2.5 : 1, The force of the abductor muscles must approximate 2.5 times the body weight to maintain the pelvis level when standing on one leg. The estimated load on the femoral head in the stance phase of gait is equal to the sum of the forces created by the abductors and the body weight and is at least 3 times the body weight; the load on the head during straight leg raising is estimated to be about the same (**Rydell;1996).**

The forces on the joint act not only in the coronal plane, but because the body's center of gravity (in the midline anterior to the second sacral vertebral body) is posterior to the axis of the joint, they also act in the sagittal plane to bend the stem posteriorly. The forces acting in this direction are increased when the loaded hip is flexed, as when arising from a chair, ascending and descending stairs or an incline, or lifting. During the gait cycle, forces are directed against the prosthetic femoral head from a polar angle between 15 and 25 degrees anterior to the sagittal plane of the prosthesis. During stair climbing and straight leg raising, the resultant force is applied at a point even farther anterior on the head. Such forces cause posterior deflection or retroversion of the femoral component, rotational stability of the stem can be increased both proximally and distally. Increasing the width of the proximal portion of the stem to better fill the metaphysis increases the torsional stability of the femoral component, especially when it is implanted without cement. Freeman found that rotational stability of both cemented and cementless femoral components also can be improved substantially by retention of a longer segment of the femoral neck. Modifications of the distal portion of the stem may add to rotational stability as well **(**fig. 1) **(Guyen et al;2005).**

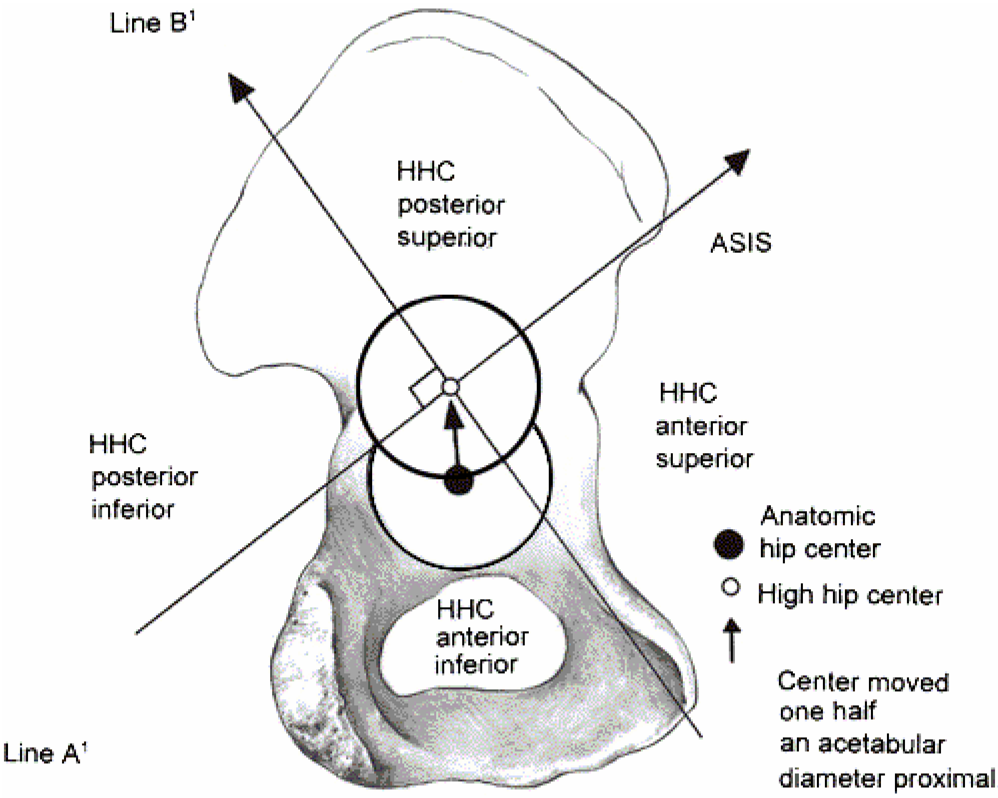

Fig. 1: Forces acting on the hip joint **(Guyen et al;2005).**

Centerlization of head and lengthening of abductor lever arm:

By deepening the acetabulum (centralization of the femoral head) and to lengthen the lever arm of the abductor mechanism by reattaching the osteotomized greater trochanter laterally. It is important to understand the benefits derived from centralizing the head and lengthening the abductor lever arm; however, neither technique is currently emphasized. The principle of centralization has given way to preserving as much subchondral bone in the pelvis as possible and to deepening the acetabulum only as much as necessary to obtain bony coverage for the cup. Because most tripolar hip procedures are now done without osteotomy of the trochanter, the abductor lever arm is altered only relative to the offset of the head to the stem. These compromises in the original biomechanical principles of total hip arthroplasty have evolved to obtain beneficial trade-offs of a biological nature namely, to preserve pelvic bone, especially subchondral bone, and to avoid problems related to reattachment of the greater trochanter **(Ekelund; 1993) .**

Neck lengh and offsets:

The primary function of the femoral component is the replacement of the femoral head and neck after resection of the arthritic or necrotic segment. The ultimate goal of a biomechanically sound, stable hip joint is accomplished by careful attention to restoration of appropriate neck length and offsets:

1. Vertical offset (vertical height) is determined primarily by the base length of the prosthetic neck plus the length gained by the modular head used. In addition, vertical height is determined by the depth the implant is inserted into the femoral canal. When cement is used, the vertical height can be further adjusted by variation in the level of the femoral neck osteotomy.
2. Horizontal offset is primarily a function of stem design,Individual femoral components must be produced with a fixed neck-stem geometry that determines the offset between the center of the head and the longitudinal axis of the stem .
3. Anterior offset (Proper neck version) usually is accomplished by rotating the component within the femoral canal.This presents no problem when

cement is used for fixation; however, when press-fit fixation is used, the femoral component must be inserted in the same orientation as the femoral neck to maximize the fill of the proximal femur and achieve rotational stability of the implant (fig. 2) **(Davey et al;1993).**

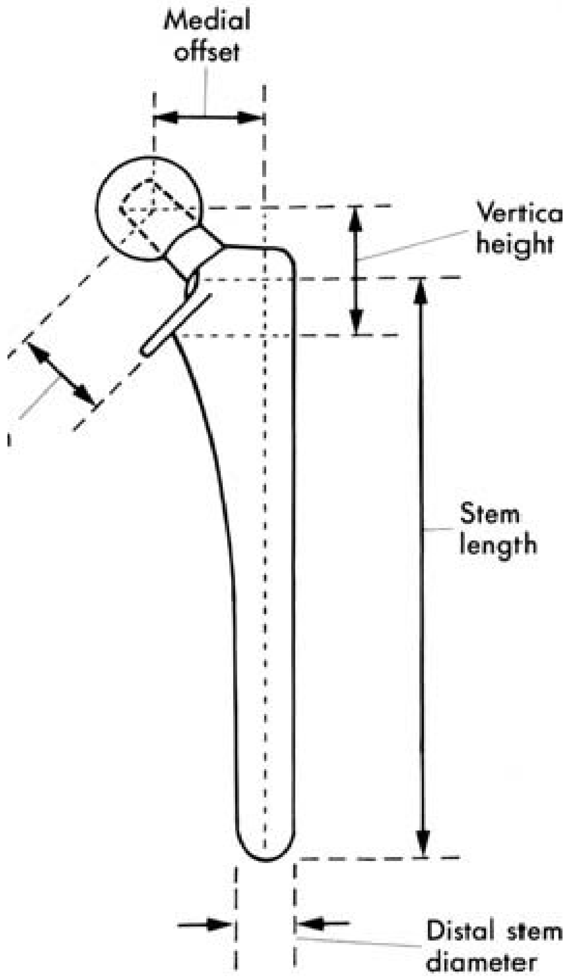

Fig. 2: Femoral neck length and offsets **(Davey et al;1993).**

Femoral neck offset is increased by:

. High level of the femoral neck osteotomy (neck take off point).

. Varus insertion of the femoral component .