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Femoral Neck Fracture Complicating Resurfacing Hip Arthroplasty

Essay

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CHAPTER I

Vascular Anatomy of the Femoral Neck

Vascular Pattern :

The intra-articular isolation of the femoral head and neck restricts their vascular connections almost exclusive to the pericapsular basal anastomosis and its ascending cervical (retinacular) branches

Pericapsular:

A vascular anastomotic ring surrounds the capsular attachment to the acetabular margin. It derives its blood supply from the inferior and superior gluteal vessels and smaller contributions from the obturator and medial femoral circumflex. It supplies the adjacent bone, muscles, and capsule and often sends pericapsular branches laterally to the joint to form the larger and more important trochanteric anastomsis at the base of the neck.

The major blood supply to the proximal femur is derived from the medial and lateral femoral circumflex arteries with smaller contributions from the obturator and superior gluteal arteries.

These vessels form two continuous anastomotic rings: one (basal) situated on and around the femoral attachment of the joint capsule and the other subcapital under the synovial membrane at the subcapital chondrosynovial junction (DeLee, 1996).

Subcapsular:

These vessels contribute the major vascular channel for the cervical metaphysis and the epiphysis. Topographically, on the neck they are named superior (lateral), postroinferior (or medial), and anterior in order of size. The lateral (superior) vessels carry the major blood supply to the femoral head from the trochanteric anastomosis. They enter the head through the lateral nonarticular foramina.

Blockage of the cervical vessels, by whatever means, leads to osteonecrotic changes. This concept was repeated by Steinberg 1991, at symposium on osteonecrosis of the femoral head.

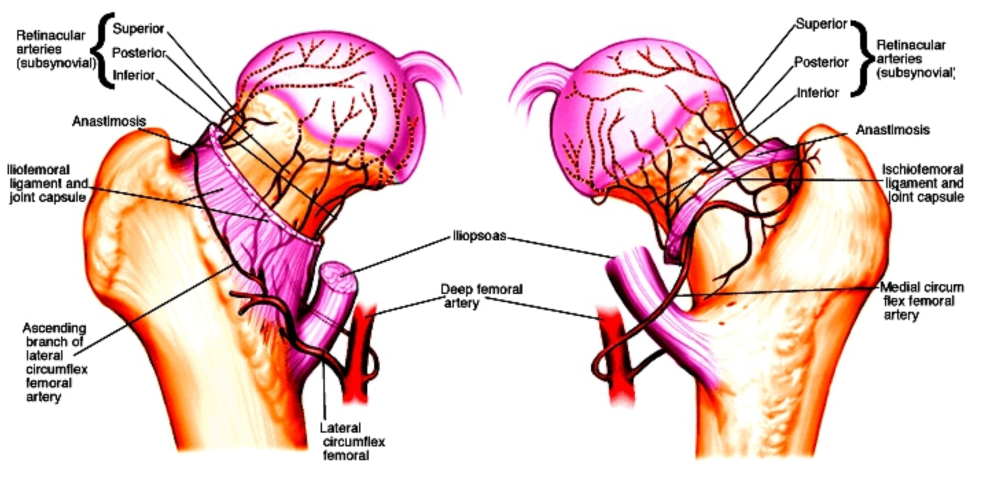

Figure no. 1:
Blood supply of femoral head & neck.

CHAPTER II

Resurfacing Arthroplasty of the Hip Joint

Historical Review

The first interpositional arthroplasties to"resurface" the Joints were performed by Ollier in France during the 1880s to alleviate hip pain by using periarticular soft tissues, including muscle. Ollier's work stimulated Lexer (1908) and Payr (1910) in Europe to use fascia, and Loewe (1913), also in Europe, to utilize skin. Murphy (Chicago) published results of 16 hip arthroplasties by 1913, and Baer (Baltimore,1919) used the chromicized submucosa of a pig's bladder. Putti in Italy and Campbell and Mac Ausland in the United States refined arthroplasty using fascia lata. ***(Amstutz and Clarke, 1991)***

Surface replacement arthroplasty is a significant development in the evolution of hip arthroplasty. It is a direct descendant of the cup arthroplasty conceived by Smith Petersen, who implanted the first glass mold arthroplasty for an ankylosed hip in 1923. Smith Petersen presented his preliminary report on mold arthroplasty in 1925. Glass was the materiel for first molds but was abandoned because some broke. Smith Petersen reported 29 cases using mold arthroplasty and suggests that the advent of the vitallium mold in 1938 will obviate the need for a second stage procedure (removal of the glass mold) and in 1948 he reported on 500 vitallium mold arthorplasties on which fifty-three revisions were performed. There were twenty cases of sepsis, eight in previously septic hips. ***(Coutts and Gustafson, 1991)***

In 1951 John Charnley experimented with a cementless all Teflon (polytetra fluoro ethylene) double cup arthroplasty. Loosening of both components due to rapid wear and an intense tissue reaction resulted in clinical failure. In the mid 1960s Muller and Boltzy used a metal-on-metal (Co-Cr-Mo) resurfacing system which was a press fit. Despite satisfactory early results, this system was abandoned because of loosening of the components. ***(Amstutz and Grigoris, 1996).***

In 1970, Gerard in France also implanted metal-on-metal resurfacing prostheses, with motion occurring not only between the components but between the components and bone.

Cemented surface replacement system using a high density polyethylene acetabular component and a metal femoral cup were first implanted in Italy by Paltrinieri and Trentani (1971), Furuya in Japan (1971), Freeman in England (1972), Capello et al in the United States, Amstutz et al in the United States, Wagner in Germany (1974) and Tanaka in Japan (1979). Wagner in 1982 used a ceramic femoral component. ***(Amstutz et al, 1991)***

Figure no. 2 :

A-Paltrinieri-Trentani design

B- Freeman design

C- D.The Indiana comcrvative cup

E- F. The original Wagner design

G- H. THARIES

(Peltier. 1998)

In the University of California, Los Angeles (UCLA) Medical center in 1973 the THARIES (Total Hip Articular Replacement using Internal Eccentric Shells) was developed by Zimmer and Warsaw. The prosthesis was cemented and consisted of a (Co-Cr-Mo) femoral component, and an all polyethylene acetabular component. Both components were eccentric. The technique was designed on the principle of resecting all non-viable femoral head bone and preserving as much of the head and neck as possible. Aseptic loosening of one or both components was responsible for most of the failures. ***(Amstutz et al, 1998)***

In 1982 Townley (Port Huron, Michigan) described Total articular replacement arthroplasty (TARA) which includes a metallic hemi-spheric cup attached to a curved thin stem and a thin polyethylene acetabular component that may be metal backed. Polymethylmethacrylate has usually been used for fixation, although components may be press fit. ***(Treuting et al , 1997)***

Cementless fixation was introduced in 1983 because acrylic cement was initially thought to be the weak link. The initiation of surface hemi-arthroplasty began in 1980; this procedure maximizes tissue conservation by preserving proximal femoral bone. This procedure is indicated for cases with relatively normal acetabulum. Wagner reported no revisions at 4 years maximum follow-up in a series of ceramic hemi-arthroplasties. Nelson, using hemispherical titanium alloy component for femoral head resurfacing, presented survivorship of 82% at 5 years. ***(Hungerford et al, 1998)***

Resurfacing procedures addressed the problem of preserving femoral bone stock at the initial operation and also had the potential of easy revision since the femoral canal was not violated. The early results of this procedure were encouraging but the longer follow-up was often disappointing. Because of unpredictable results, resurfacing procedures were largely abandoned in the 1980s.

Although failure is multi factorial, it is now understood that bearing weight debris-induced osteolysis is the main problem. Surface replacement failure was primarily due to high volumetric polyethylene wear, which was secondary to a large prosthetic head. The large diameter of surface replacement components results in polyethylene wear rates, which are four to ten times higher than that of convential total hip arthroplasties. ***(Amstutz et al, 1998)***

A new era of full surface replacement began recently with the following features considered essential:

1. Thin components to avoid undue resection of the femoral head or acetabular bone stock.
2. The articulation of a large diameter head femoral component against a socket without excessive production of wear debris.
3. Use of materials and design criteria with a known track record in clinical use.
4. Technique and instrumentation to avoid femoral neck notching and varus placement of the femoral component- ***(McMinn et al, 1996)***

Published results showed that a metal on metal articulation using CoCr could satisfy the material requirement. Metal on metal provides a low wear-bearing material, and so there will be a reduction in volumetric wear debris that will reduce the local inflammatory response to a level insufficient to cause interface destruction and prosthetic loosening. ***(Dorr et al, 2000)***

Several types of metal on metal prostheses were developed in the 1960s but by the mid 1970s they had been completely displaced by polyethylene bearings. These early metal systems fell out of favor as a result of high frictional torque, which led to "Seizing and loosening". Some of these joints are believed to have been prone to early failure because of bearing design flaws, and manufacturing limitations of the bearing surface quality. By the late 1960s, the bearings had improved but metal tissue staining was noted at revision surgery and this was attributed solely to wear of the bearing surfaces. Another likely cause of loosening was the poor head-neck diameter ratio, leading to prosthetic impingement and adverse stem features, such as curvaceous design with sharp edges introducing stress concentrations in the cement. Limitations of the recommended implantation techniques at that time and early cementing methods also contributed to premature failures. ***(McMinn et al,1996)***

Most of these factors have now either been improved or can be reinvestigated. However, despite the limitations, a significant number of these hips have survived for 25-30 years because of low wear rates and minimal osteolysis. The survivors had, often by chance, the necessary polar bearing, component orientation to avoid impingement, as well as good cementation, suggesting that with these systems the prosthesis could be extremely durable despite poor stem design and technique. ***(Amstutz et al, 1998)***

Review of the metal-on-metal literature reveals no bearing seizures, and no significant bearing wear or metallosis in the post-1967 era, when most of the gross bearing design flaws had been eliminated. Recent research suggests that the volumetric wear of cast cobalt chrome alloy bearings is 40-100 times less than that of the metal-on-polyethylene combination. ***(Hilton et al, 1996)***

Three metal on metal surface replacements have been developed- two in Europe, by Wagner in Germany and McMinn et al in England. The third device designed in the USA. ***(Amstutz et al, 1998).***

Indications of total surface replacement arthroplasty of the hip joint:

Surface replacement should especially be considered for patients who might be in their lifetime require a revision and a second replacement. This includes the young and/or active, slightly older patients who want to participate in activities which are generally predicted to shorten the durability of replacements. ***(Amstutz, 1991)***

Generally, surface replacement candidates are in the 40- to 65-year-old age range. Slightly older patients are included if there are varying combinations such as smart build, potentially high activity level (either in sports or in heavy-duty labor). There are several especially good indications for this surgery. These include:

1. Patients who have some deformity of the proximal femur, which would make a stem-type replacement either impossible or extremely difficult technically, or could adversely, affect the result. ***(Coutts and Gusto/son1991)***

2. Patients who have some neuromuscular disorder should be considered for resurfacing, The large diameter ball of the surface replacement will produce additional stability of the replacement and minimize the risk of dislocation.
3. Patients who are high sepsis risk either because of previous infection in the hip region or because of a high susceptibility due to disease and/or drug therapy with steroids or other immunosuppressive disorder or due to general debility. In these patients, the rate of sepsis that may follow surface replacement at some point in the patient's lifetime is low, and so the magnitude of revision surgery is reduced. ***(Wagner, 1983)***
4. Patients under 40 who are required to do heavy work, if there is not suitable alternative (such as coring for osteonecrosis; osteotomy for early osteoarthritis or dysplasia; or arthrodesis).
5. Patients with traumatic or non-traumatic osteonecrosis.
6. Osteoarthritis secondary to:
   - Slipped capital femoral epiphysis
   - Dwarfism
   - Coxa vara
   - Legg-Calve-Perth's disease
   - Congenital hip dysplasia
   - Post trauma arthritis with significant symptoms and functional loss are also included. ***(Davlin et al, 1990)***

7. Primary osteoarthritis in the young where because of good bone stock the results are likely to be durable.
8. Rheumatoid arthritis.
9. Patients with multiple joint arthropathy, such as those with juvenile rheumatoid arthritis.

(Amstutz et al, 1998)

Contraindications of total surface replacement:

Absolute contraindications:

Are active sepsis and open epiphyseal plates,

Relative contraindications:

Generally based on abnormalities of bony anatomy that can not be corrected with a resurfacing system, such as:

- Marked loss of bone stock (especially femoral)
- Severe limb length discrepancy.
- Extensive osteonecrosis.
- Severe neuromuscular deficiency.
- Severe osteoporosis.

(Amstutz, 1991)

Indications of Hemi-surface replacement:

Hemi-surface replacement arthroplasty or resurfacing only of the femoral head is reserved for those hips in which the concentricity and supportive bone structure of the acetabulum are essentially normal. It is appropriate for young patients with osteonecrosis with significant head involvement, collapse of the femoral head over 3mm, and separation of the hyaline cartilage from the underlying bone. These patients where classified as Ficat stage III. ***(Nelson and Walz, 1997)***

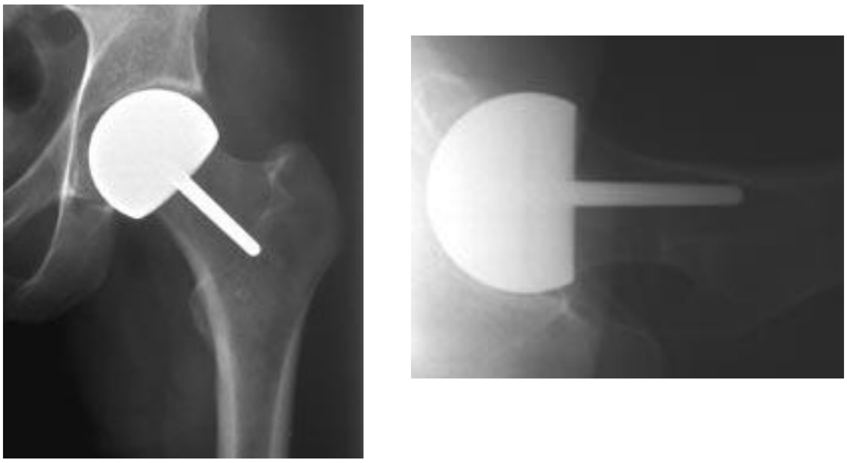

Figure no. 3:
Postoperative AP and lateral radiographs with the hemisurface component. Note the preservation of the acetabular cartilage space.