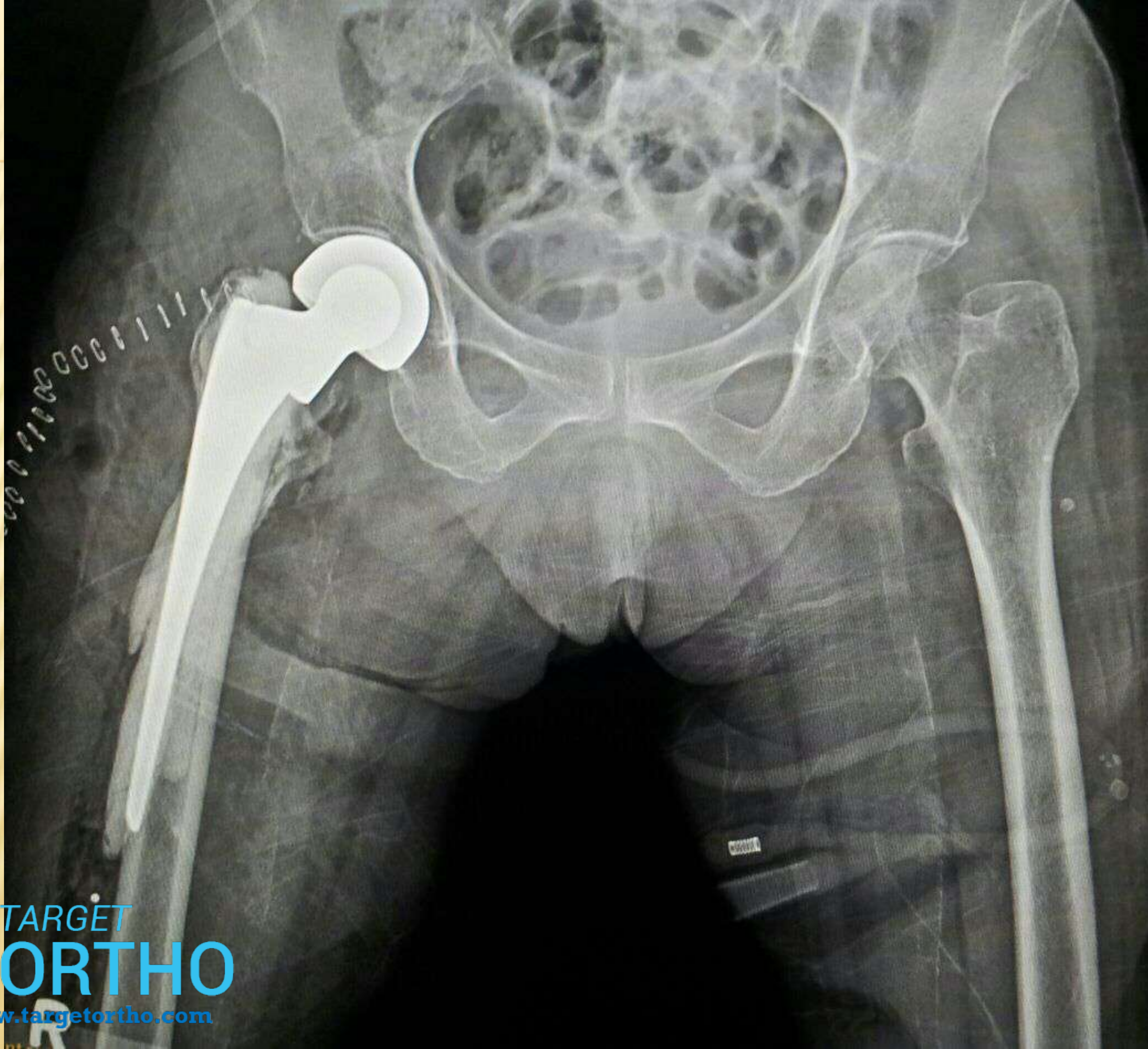
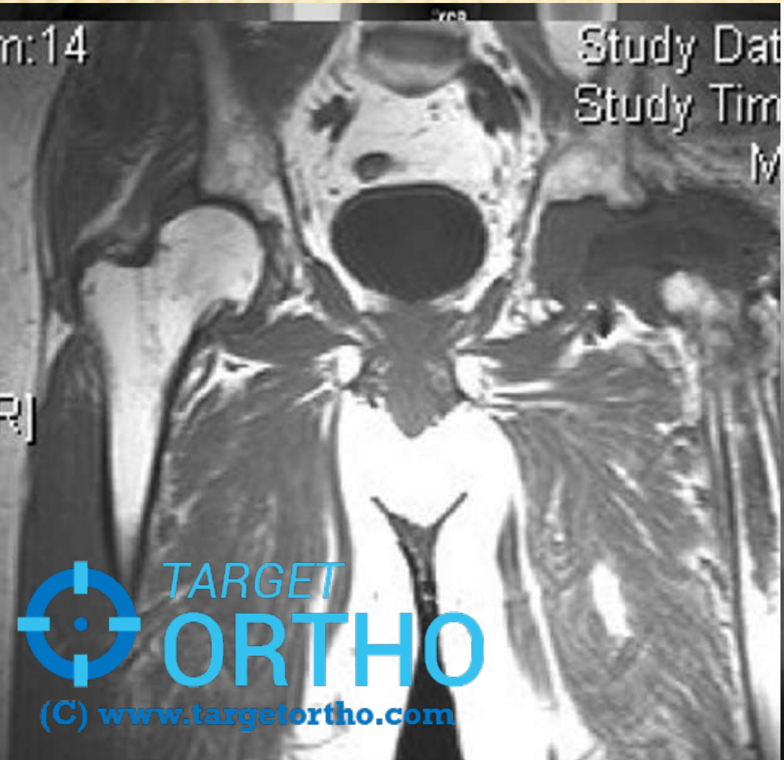
PRINCIPLES OF HIP ARTHROPLASTY



TYPES OF ARTHROPLASTY



TYPES OF ARTHROPLASTY

INDICATIONS

- Inflammatory arthritis
- Degenerative joint disease
- Tuberculosis (Healed)
- Osteonecrosis
- Congenital dislocation- neglected
- Fused hip for movement
- Bone tumours involving proximal femur or acetabulum
- Hereditary disorders like Achondroplasia

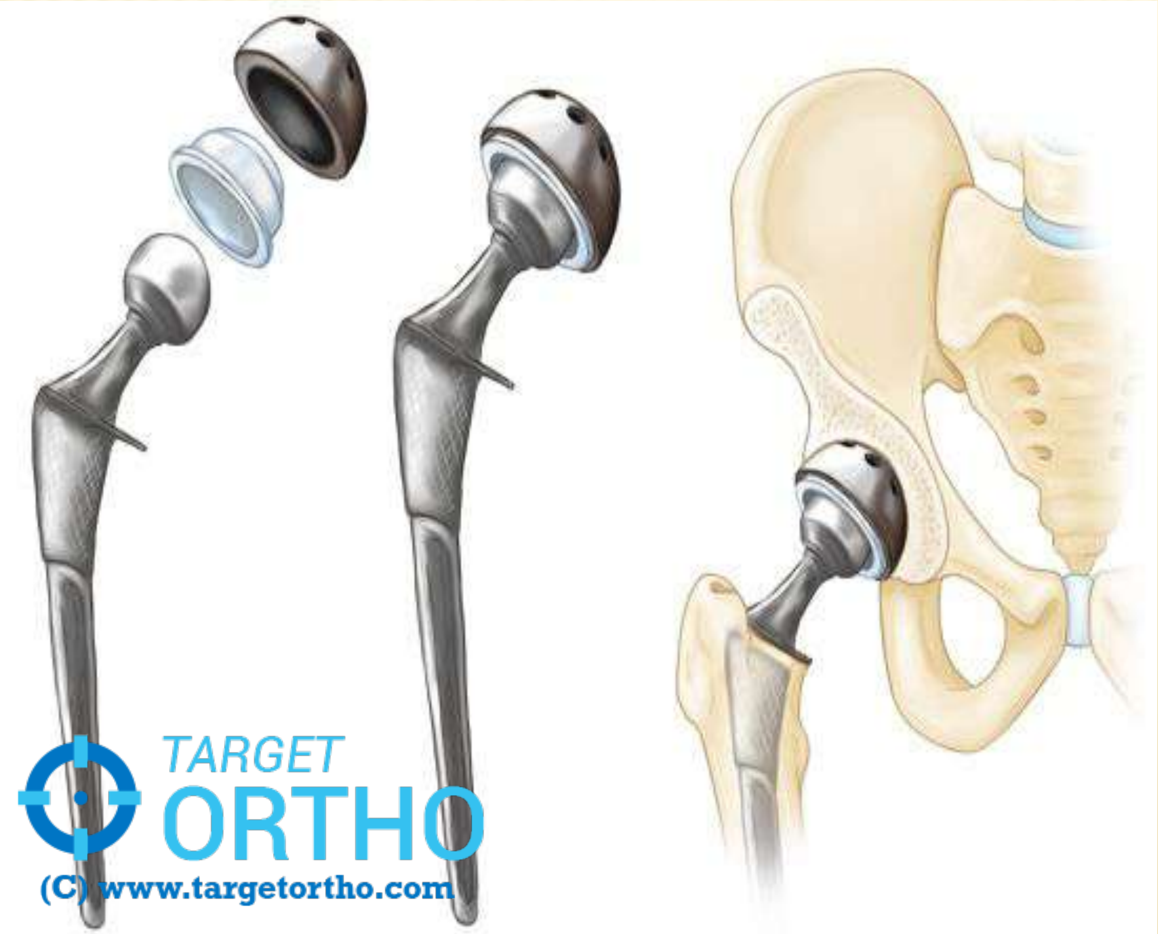
CONTRAINDICATIONS

- Absolute – active infection
- Relative

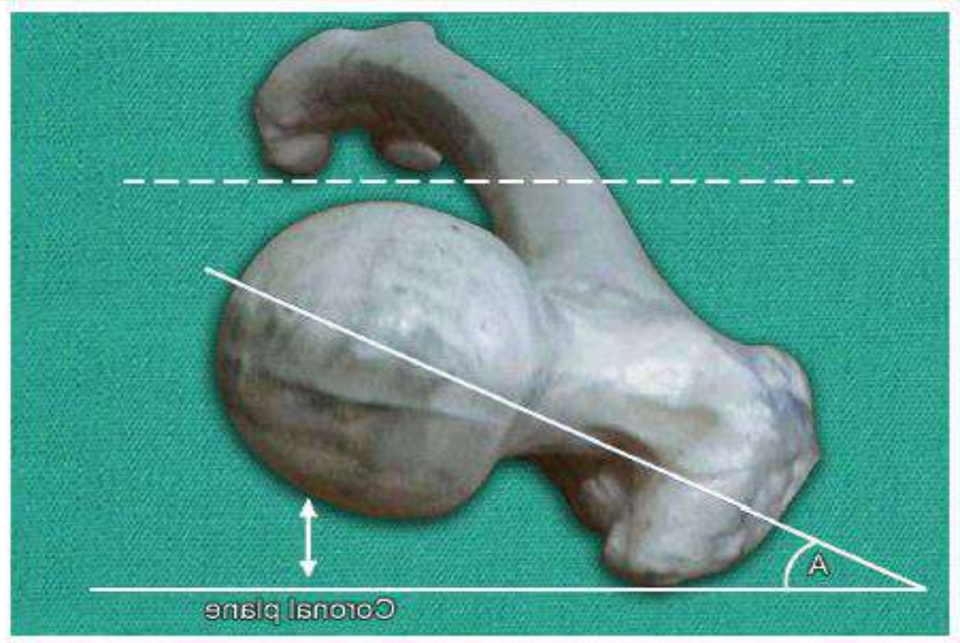
1) Neuropathic arthropathy
2) An absence or relative insufficiency of abductor musculature
3) Rapidly progressive neurological disease

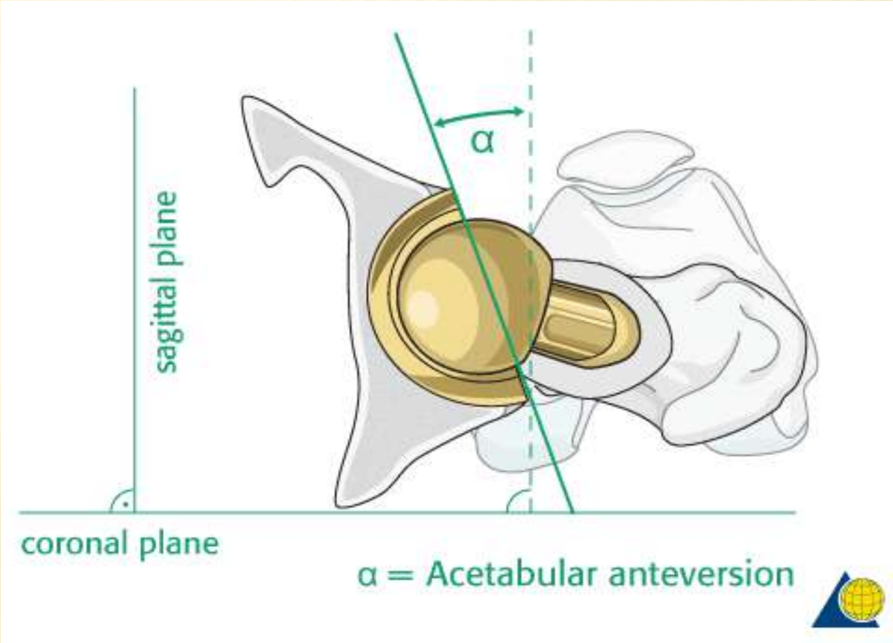
SURGICAL ASPECTS

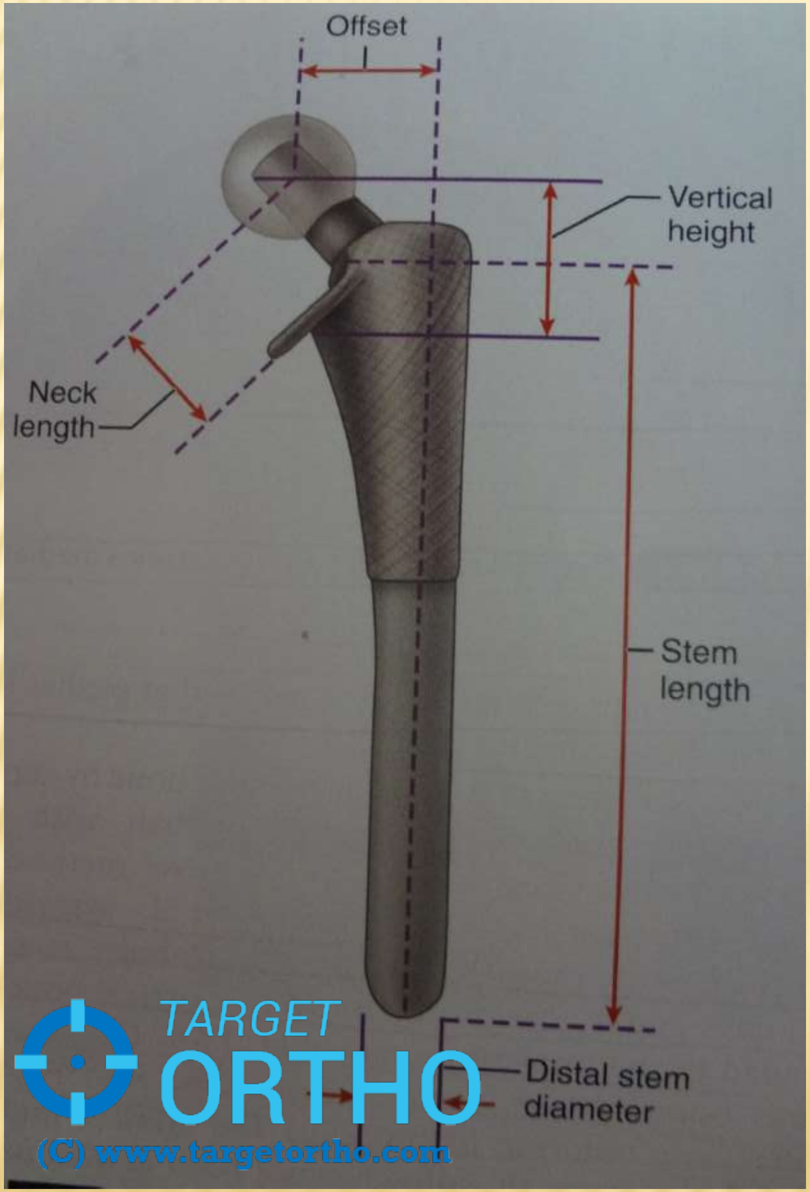
COMPONENTS



SURGICAL GOAL






Offset
Vertical height
Neck length
Stem length
Distal stem diameter
TARGET ORTHO
(C) www.targetortho.com


R

HISTORICAL PERSPECTIVE

Q: First attempt to replace hip joint by foreign material was made by:

A. Smith Peterson from Norway
B. Thomas Gluck from Germany
C. Philip Wiles from UK
D. John Charnley from UK

HISTORICAL PERSPECTIVES

- Anthony White of the Westminster Hospital in London, is credited with the first excision arthroplasty in 1821. (Girdlestone → 1943)

- Then came era of Interpositional arthroplasty in 1840 when Auguste Verneuil and later Leopold Ollier of Paris, France began using foreign materials- including muscle, fat, and connective tissues between contacting surfaces in the hip joint.

- German surgeon Themistocles (Thomas) Gluck in 1891 FIRST attempted the hip arthroplasty by physically replacing bone with a foreign Material!

MOULD/CUP ARTHROPLASTY

Smith-Petersen's (1938, Norway) Vitallium cup

Temporary implantation of this mould between the reshaped surfaces of the femoral head and acetabulum, he conjectured, would allow for the physiologic generation of smooth, repaired articular surfaces. Once the mould was subsequently removed, it was believed the incongruous surfaces of the joint would be healed and the procedure would permit the return of normal joint articulation and function

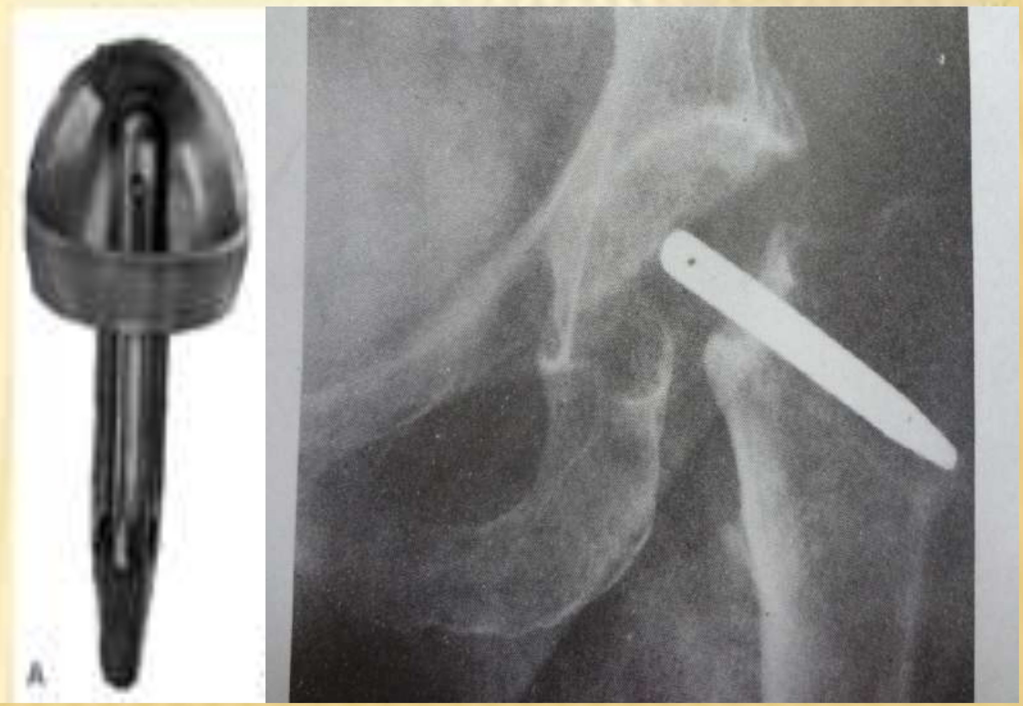
HIP ARTHROPLASTY: EVOLUTION

TOTAL HIP ARTHROPLASTY	HEMI-ARTHROPLASTY
Wiles prosthesis	Judet brother's prosthesis
Mckee and farrar	Austin Moore
Charnley's hip	Thompson
Modern Day prosthesis	Bipolar prosthesis

EVOLUTION OF HEMIARTHROPLASTY

JUDET BROTHERS PROSTHESIS (1940)

Cervical fixation prosthesis!
had an acrylic head piece and a stem that was inserted through femoral neck and a hole in lateral cortex

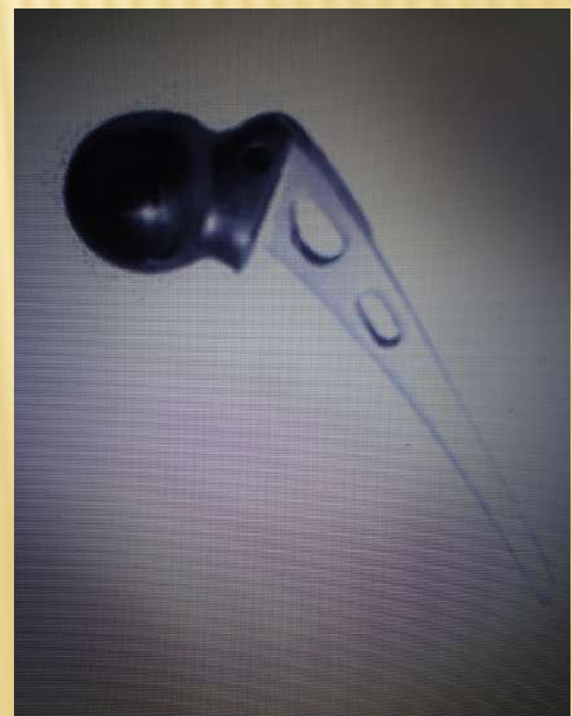


Fallacies :-

Not a intramedullary type so loosening, displacements, breakage of acrylic head etc.

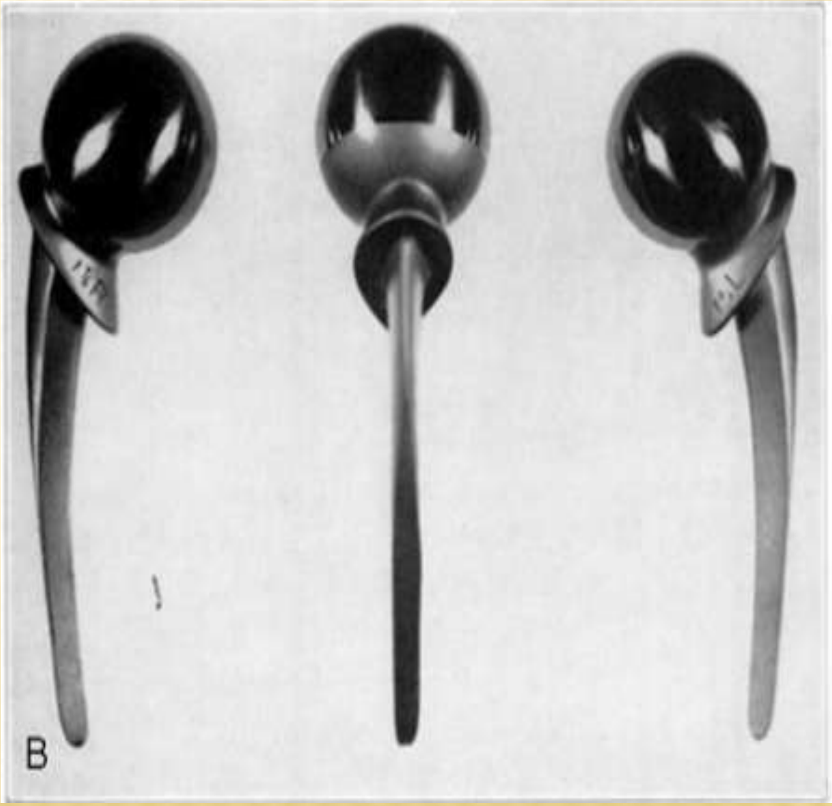
AUSTIN MOORE PROSTHESIS (1950)

Intramedullary type prosthesis made of Vitallium. Collar was present that extended medially over calcar and upper portion of stem was fenestrated for bone growth.



THOMPSON PROSTHESIS (1953)

- Thompson developed a non fenestrated stem to reduce incidence of breakage and to facilitate the removal of prosthesis.
- He extended the medial contact base at collar and removed femoral neck completely so that stresses were carried on to lesser trochanter.



BIPOLAR PROSTHESIS (1974)

BATEMAN

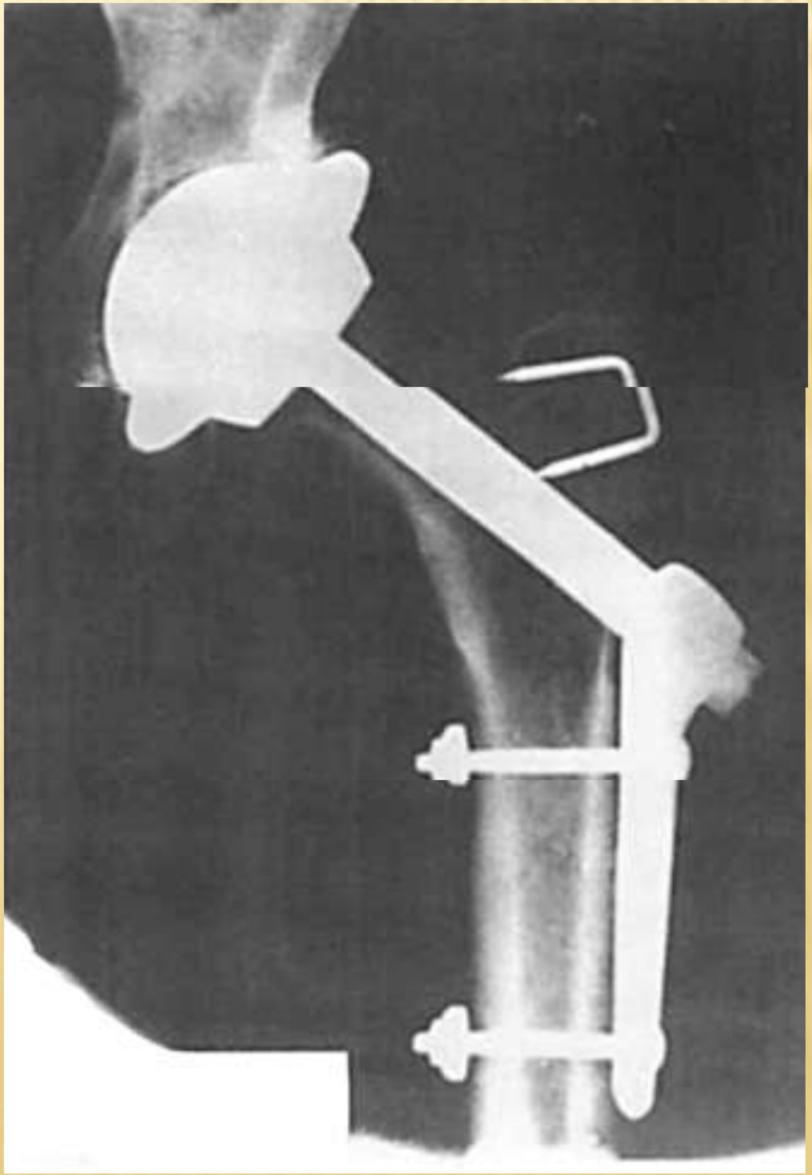
A 22 mm stainless steel femoral head surmounted in an acetabular cup of high density polyethylene enclosed by a rounded metallic polished shell.

As motion takes place at two interface, frictional forces acting on acetabular surface are greatly reduced.

EVOLUTION OF THR

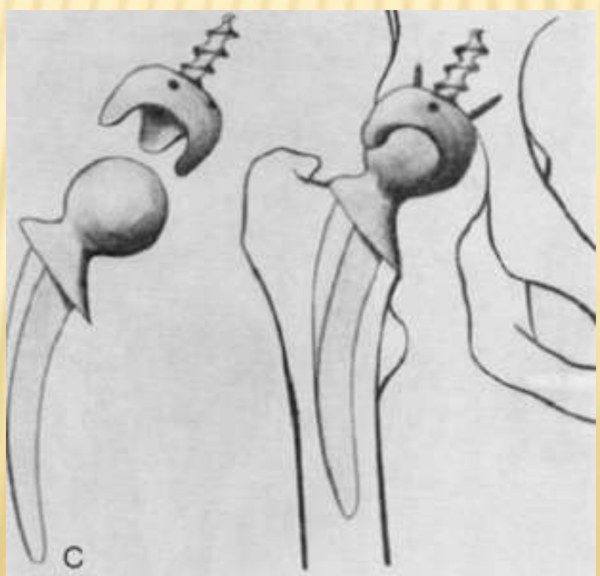
ERA OF THR BEGINS

- The first metallic total (i.e., both the femoral head and acetabulum) hip arthroplasty is credited to Philip Wiles of London, in 1938.



MCKEE AND FARRAR PROSTHESIS (1950-1960)

- McKee devised a method of screw-fixation of the cup within the acetabulum, and a stainless steel device was used in 1950.



CHARNLEY'S ERA

Early 1960s

SIR JOHN CHARNLEY

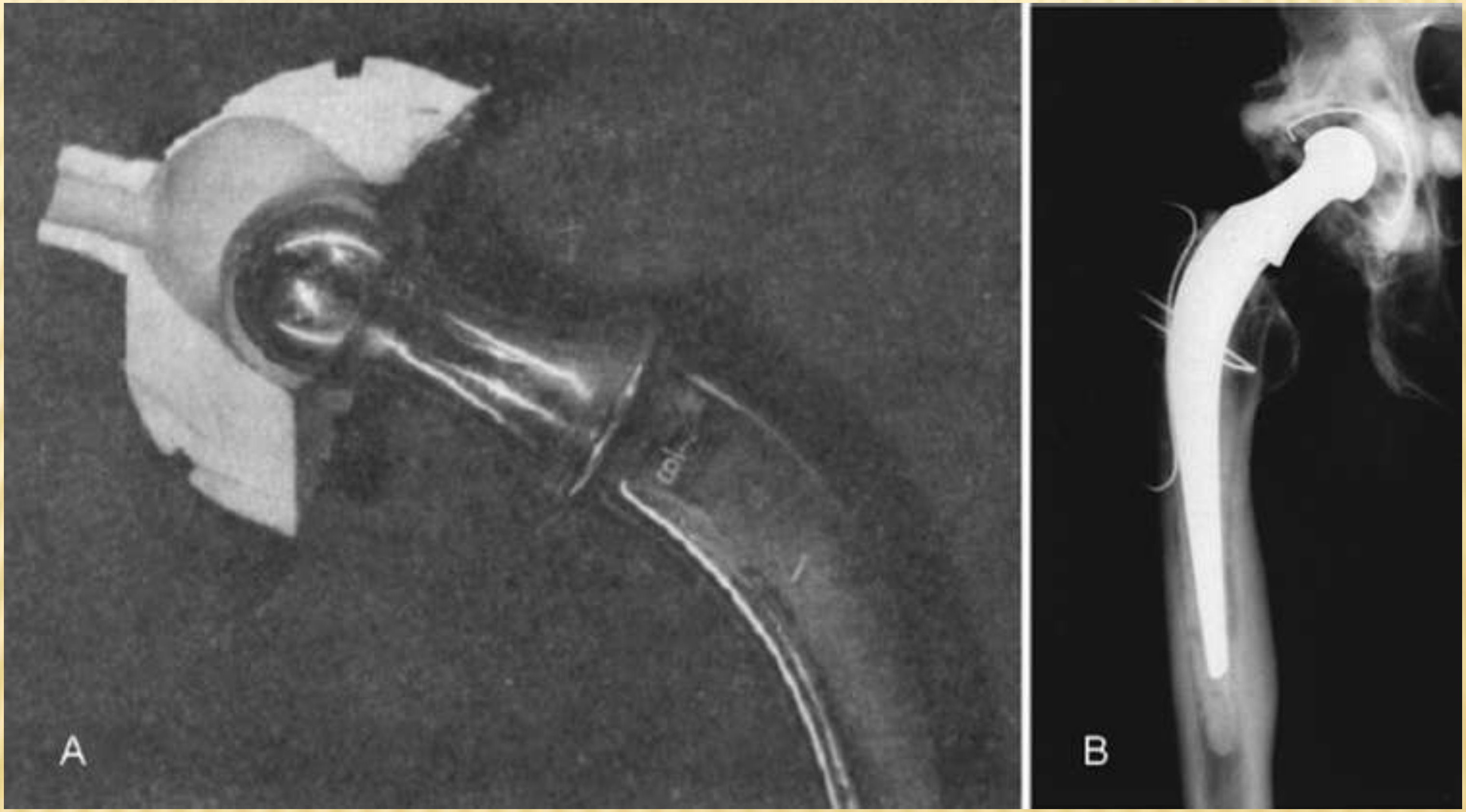
FATHER OF HIP ARTHROPLASTY

CHARNLEY'S ERA

Q. John Charnley is called Father of Orthopedics for all except

A. Advocating use of bone cement
B. Advocating intra medullary fixation for the prosthesis
C. Advocating the use of bone cement for fixation
D. Devising the Principles of Low Friction Arthroplasty

CHARNLEY'S PROSTHESIS



CHARNLEY'S ERA

- Builded upon the prior demonstration of utility of bone cement (polymethylmethacrylate)

"Low friction arthroplasty"

- Charnley sought to overcome what he considered to be the greatest deficiency of the Moore, Thompson and McKee-type prostheses, i.e. *their inability to resist torsional stresses*.

CHARNLEY'S PRINCIPLES OF HIP ARTHROPLASTY

Aim is to get ratio of lever arm 1:1

Shorten lever arm of body by deepening acetabulum (centralisation of femoral head)

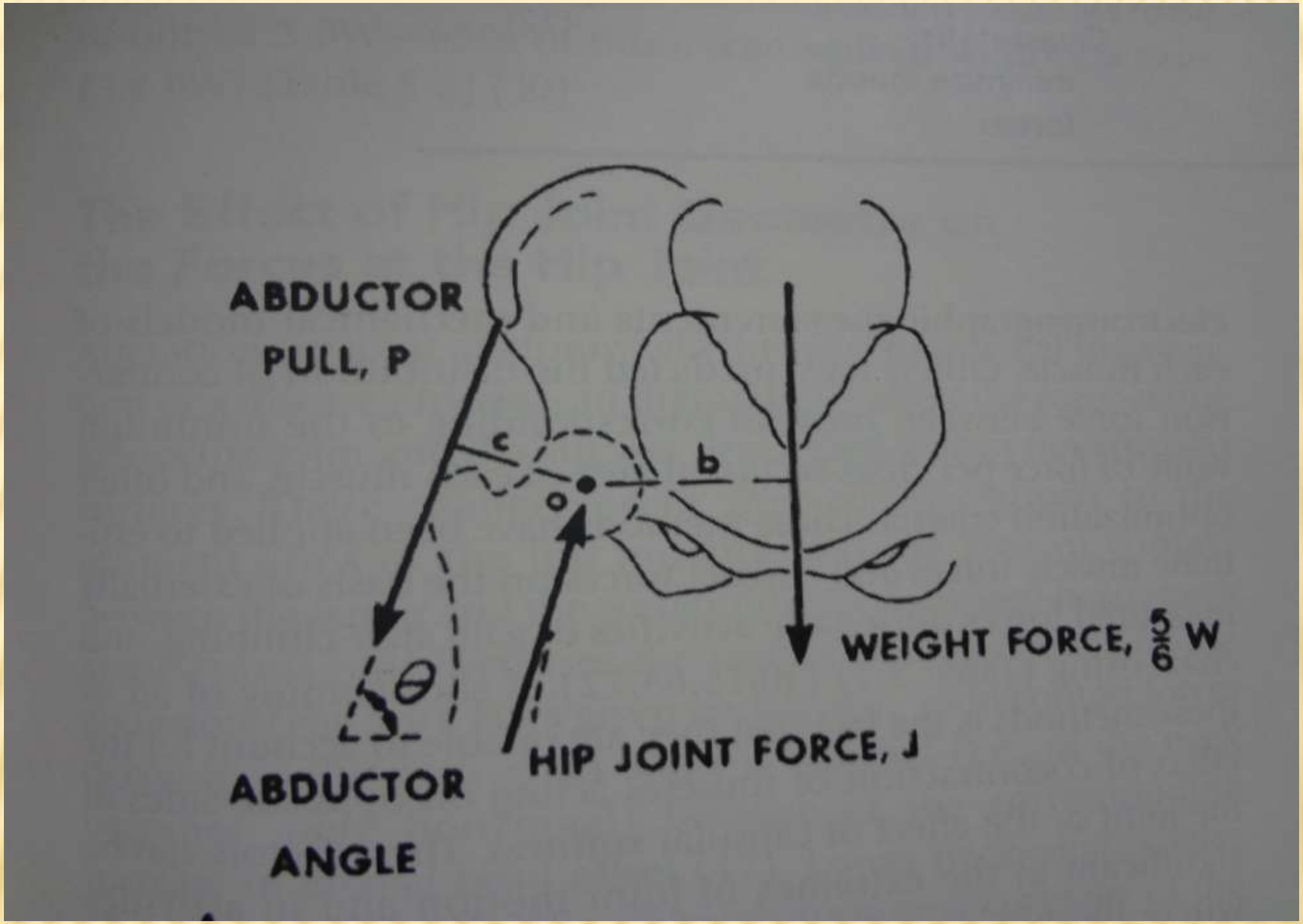
Greater trochanter to be transferred to more lateral position.

Minimize friction (Low friction arthroplasty)

Small diameter femoral head (22 mm) made of stainless steel

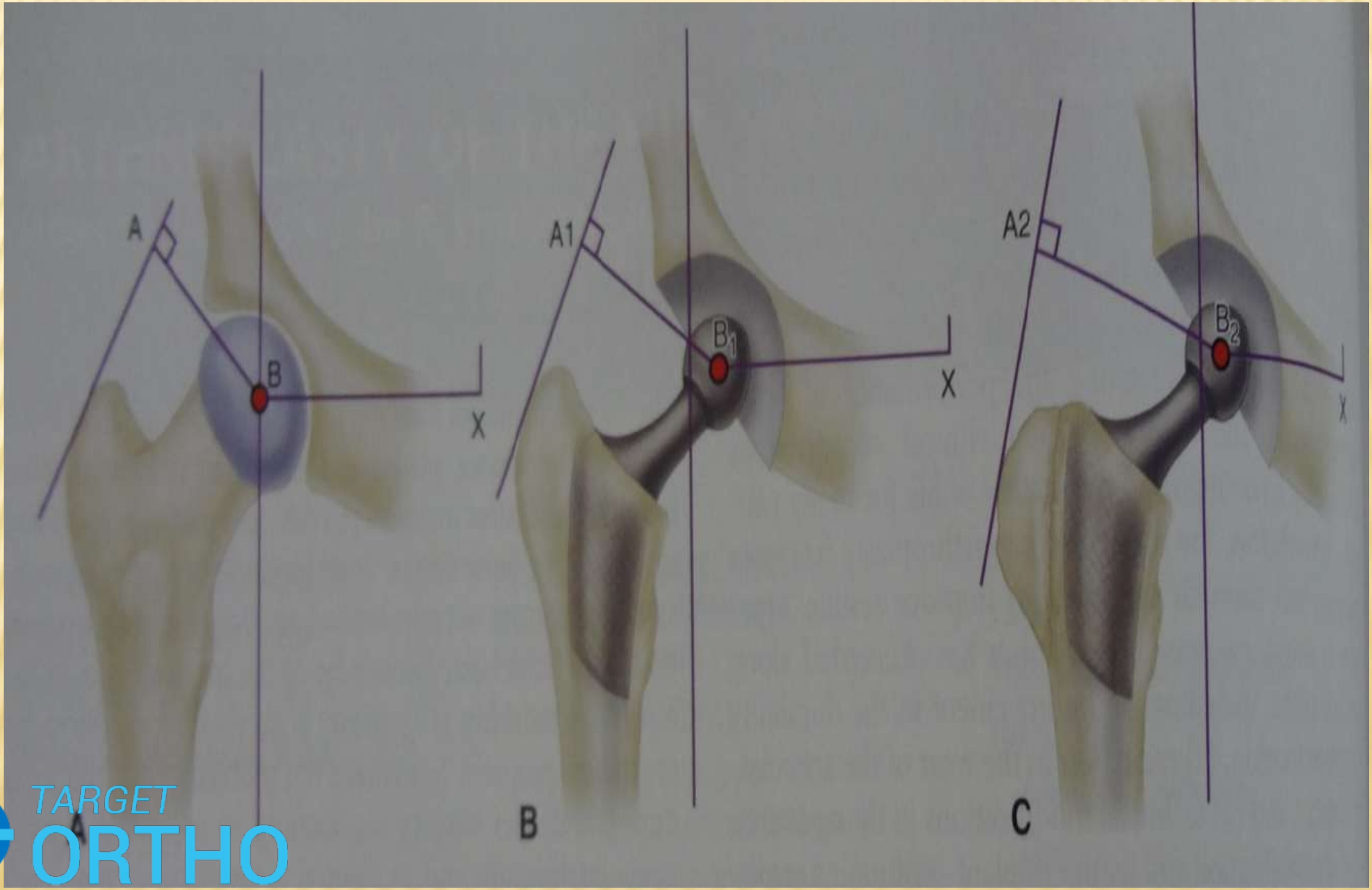
Thick plastic socket of high molecular weight polyethylene

BIOMECHANICS OF HIP JOINT



In normal hip ratio of B:C is 2.5:1, hip experiences a force about 4 times body weight.

BIOMECHANICS OF HIP JOINT

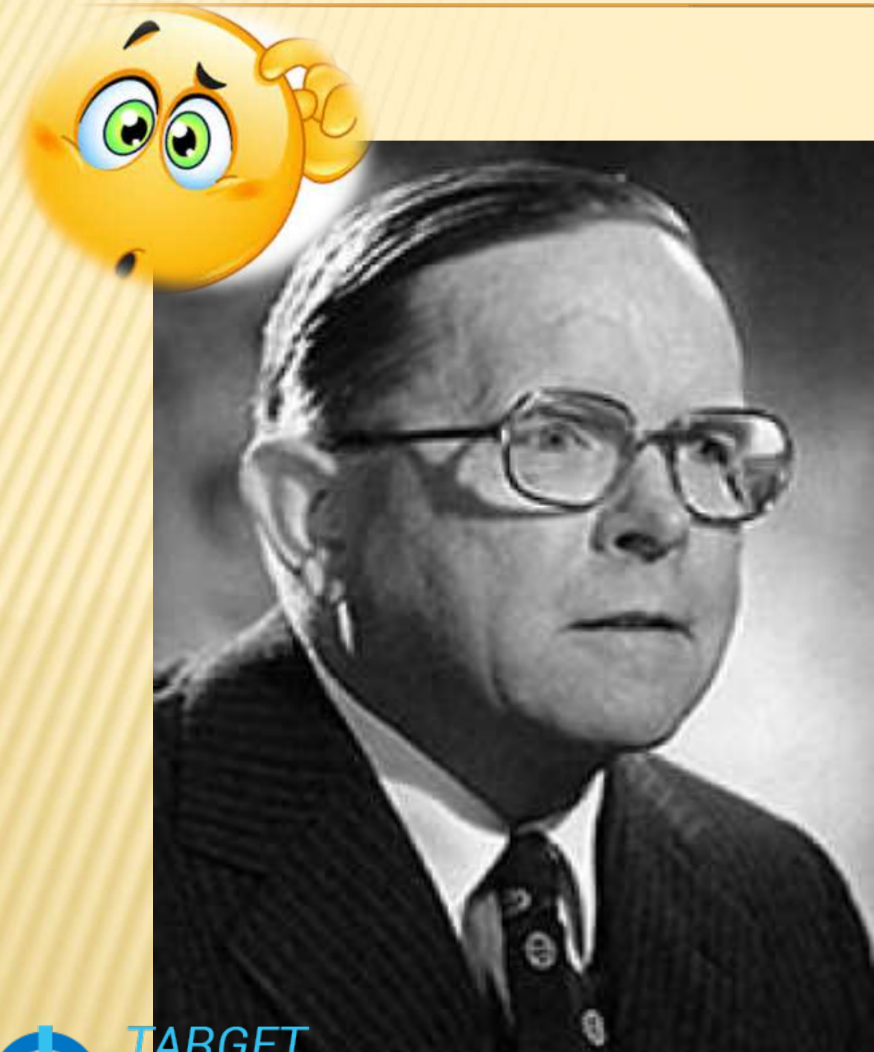


PROBLEMS WITH CHARNLEY CONCEPTS

Charnley had used a small (22.225 mm) femoral head, to decrease the frictional torque at the bearing surfaces to minimize polyethylene wear. However, small diameter femoral heads constituted a substantial risk factor for dislocation following THR.

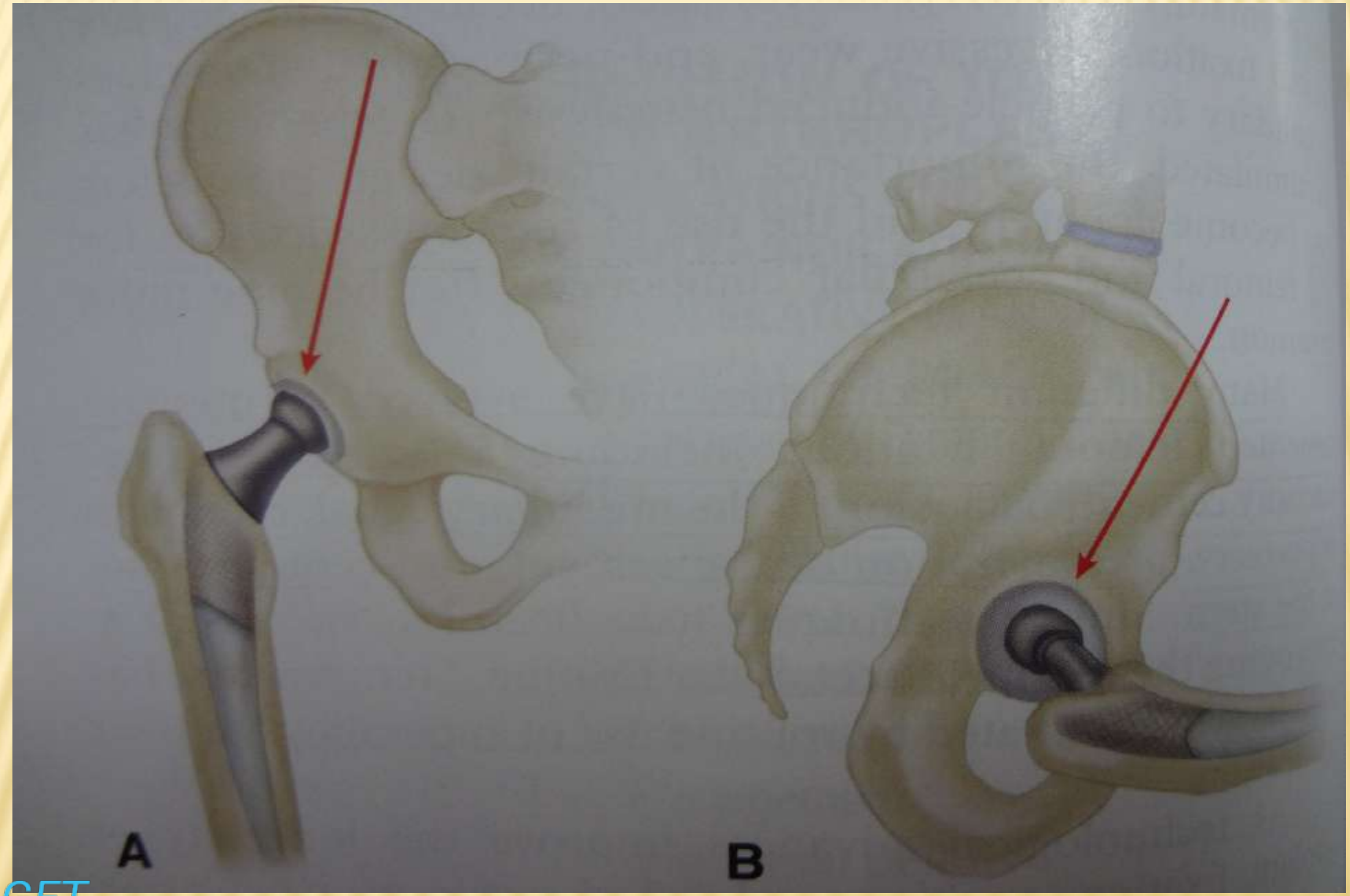
Trochanteric osteotomy may end up in non union, at times, complicating matters.

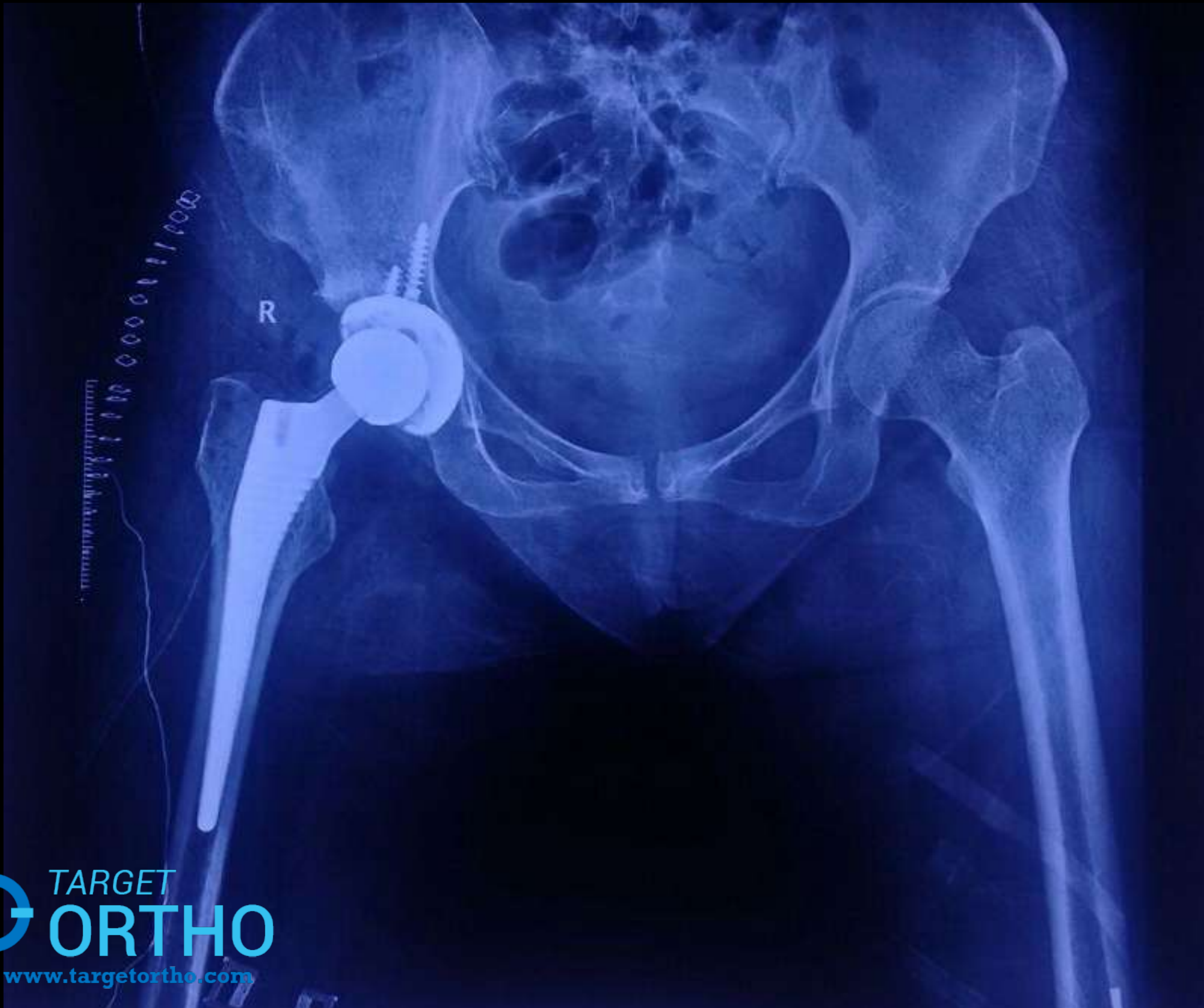
Medialization of head is not favored by most surgeons. Accidental perforations can occur and idea is to preserve bone stock for revisions.



- Objectives must be reasonable
- No one can make artificial hip that will last 30 years or make a patient play football

UN THOUGHT OF STRESSES

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FURTHER EVOLUTION OCCURRED ON

- Fixation method: Cemented or Cementless fixation
- Design (shapes) of total hip components
- Modularity of components
- Bearing/ articulating surfaces

  (i.e. biomaterial to be used)

FIXATION METHODS

CEMENTED

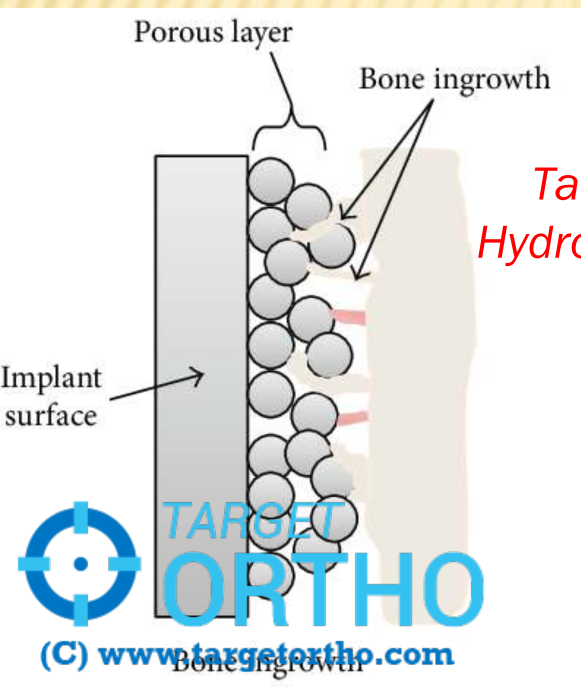
PMMA
(non-adhesive)

HYBRID HIP

CEMENTLESS

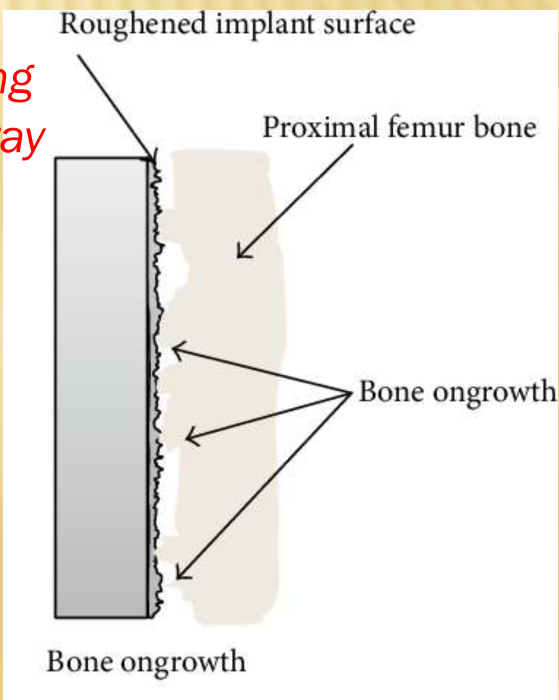
Initially PRESS FIT

OSTEOINTEGRATION



Tantalum
Hydroxyapatite

Grit Blasting
Plasma spray



ALL THAT GLITTERS IS NOT ALWAYS GOLD!

STRESS SHIELDING

CEMENTLESS fixation

DESIGN OF TOTAL HIP COMPONENTS

CHOOSING MATERIALS

MODULOUS OF ELASTICITY (MOE)

TITANIUM	COBALT CHROMIUM
CEMENTLESS	CEMENTED
↓	↓
STRESS SHIELDING	NO STRESS IN CEMENT MANTLE
↓	↓
LOW MOE (Less Stiff)	HIGH MOE (More Stiff)

MOE

PE < Cement < Bone < Titanium < Steel < Co-Cr < Ceramics

STIFF NESS

DESIGN – FEMORAL COMPONENTS

CHOOSING SHAPES

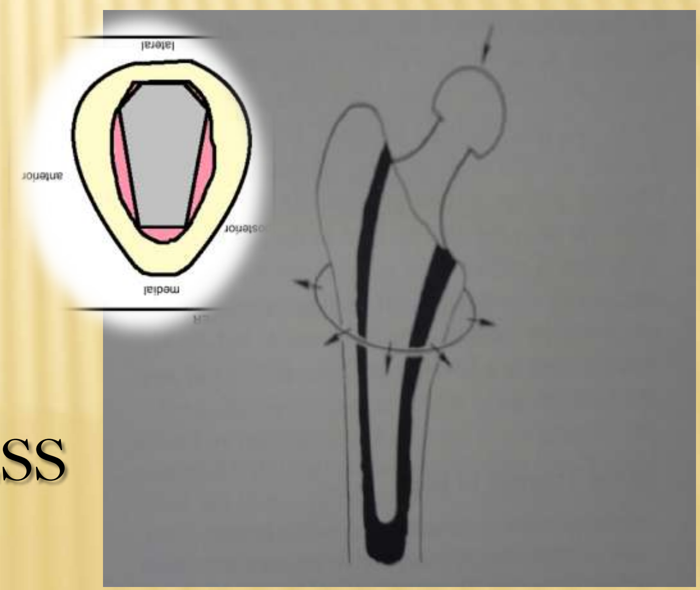
More Diameter → More Strong → More Stiff → More Stress shielding → **Distal Taper**

when stem is loaded it produces circumferential hoop stresses!

PROXIMAL WEDGING

Trapezoidal neck

CEMENTELESS



DESIGN – FEMORAL COMPONENTS

CHOOSING TAPERS

MORSE TAPER/
TRUNION

DESIGN – FEMORAL COMPONENTS

SURFACE MODIFICATIONS

Grooves/ Porous coatings

COLLAR

Polishing

DESIGN – ACETABULAR COMPONENTS

FIXATION

CEMENTED

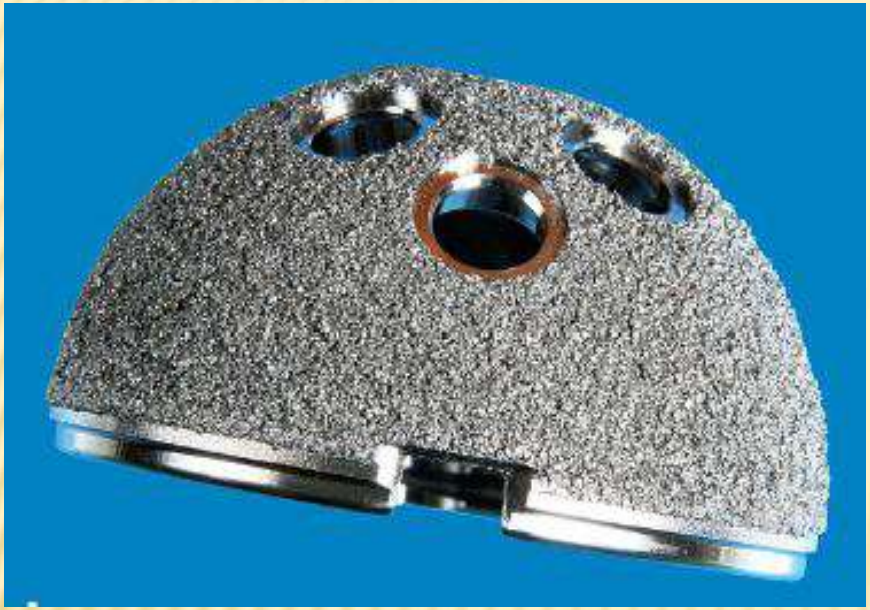
↓

Cement mantle- 3mm thick (PMMA spacers help)

Flange at periphery ensures pressurization

CEMENTLESS (RULE)

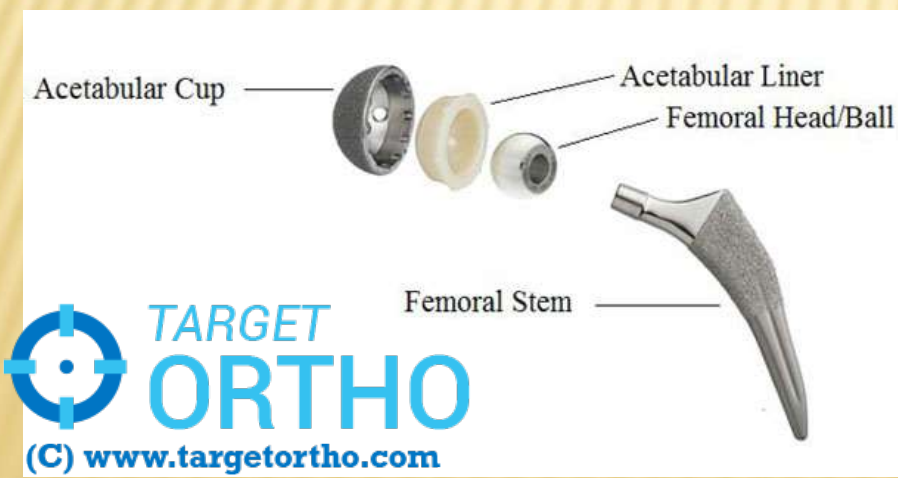
DESIGN – ACETABULAR COMPONENTS



Metal backing essential in uncemented for screw fixation!

It reduces stress transfer to pelvis.

Decreases polyethylene thickness and can allow bigger head to be accommodated.



MODULARITY

Modularity is the degree to which systems component may be separated or recombined.

MODULARITY

ADVANTAGES

Biomechanical – restoration of offsets and versions for soft tissue balancing (reducing abductor muscle imbalance, pain and rates of wear)

Allows leg length/ versions to be adjusted independently

Facilitation of revision arthroplasty
Facilitation of small incision surgery

Modularity can be in both femoral and acetabular component

FEMORAL MODULARITY

HORIZONTAL OFFSET

FEMORAL MODULARITY

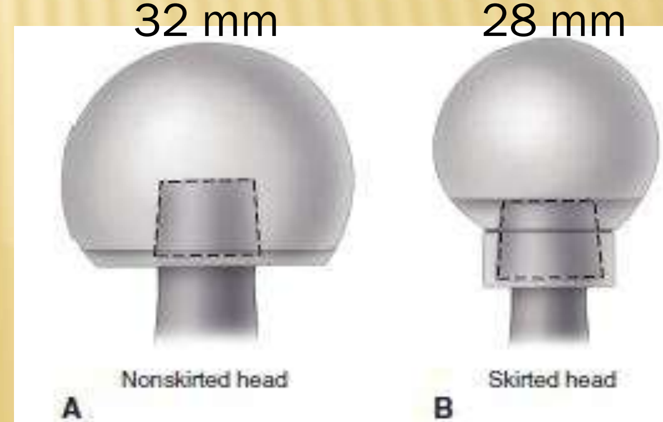
VERTICAL OFFSET

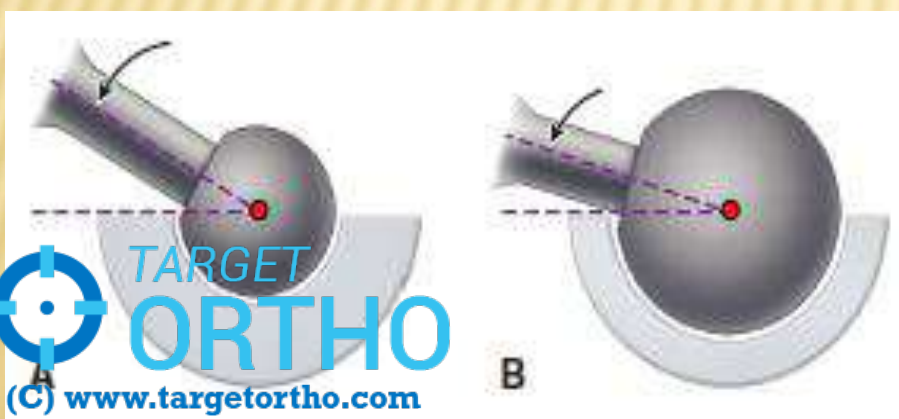
Neck length
(25-50 mm)

Femoral
head size
(22-40 mm)

32 mm

28 mm





FEMORAL MODULARITY

STEM LENGTH (12-15 CMS) → Determined by canal length

STEM DIAMETER

CEMENTED

↓

80 % canal fill

(2 mm cement mantle distally and 4mm proximal)

↓

< 13.5mm

UNCEMENTED

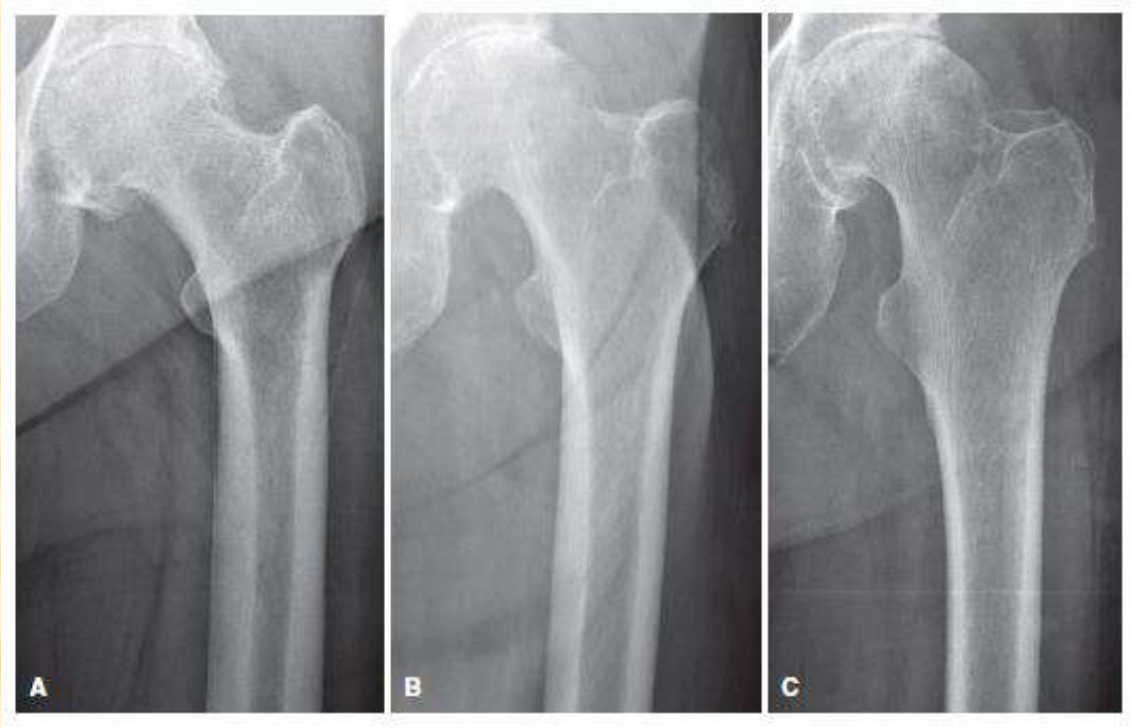
↓

Press fit fixation needed

(Diameter → shape of canal)

DORR CANAL TYPES + KHANDUJA STEM TYPES

DORR FEMUR TYPES



Proximal femur classified according to cortical thickness & canal dimension

1) Type A -femur with thick cortex. Champagne flute appearance.
2) Type B - exhibits bone loss from medial and posterior cortex.
3) Type C – femur has lost medial and posterior cortex. Stovepipe shaped

FEMORAL STEM TYPE 1

- Single wedge stem
- Flat in AP plane and taper in medio-lateral plane.
- Dorr Type B & C.

FEMORAL STEM TYPE 2

- Dual wedge stem
- Engages both in AP and Medio-lateral plane.
- Used safely in Dorr type A.

FEMORAL STEM TYPE 3

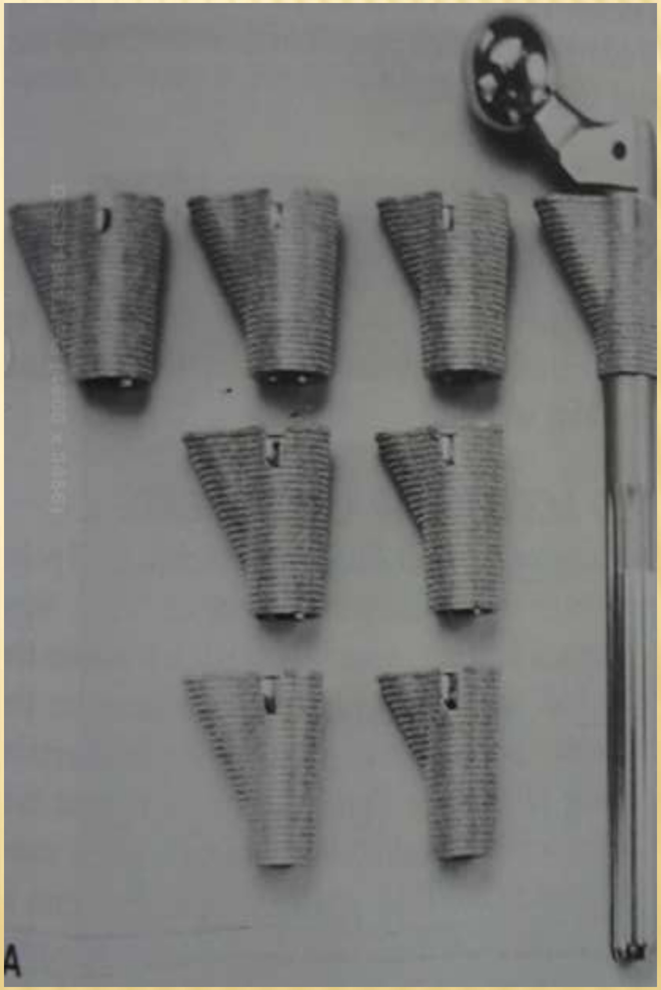
- Stem tapered in two planes
- Round or rectangular profile
- Fixation largely at meta-diaphysial junction.
- Gained popularity in revision cases.

FEMORAL STEM TYPE 4

- Entirely coated implant with fixation along whole length (Diaphyseal fit).
- Some are associated with thigh pain and stress shielding.
- Not suitable for type C dorr.
- Mainly used in Revisions

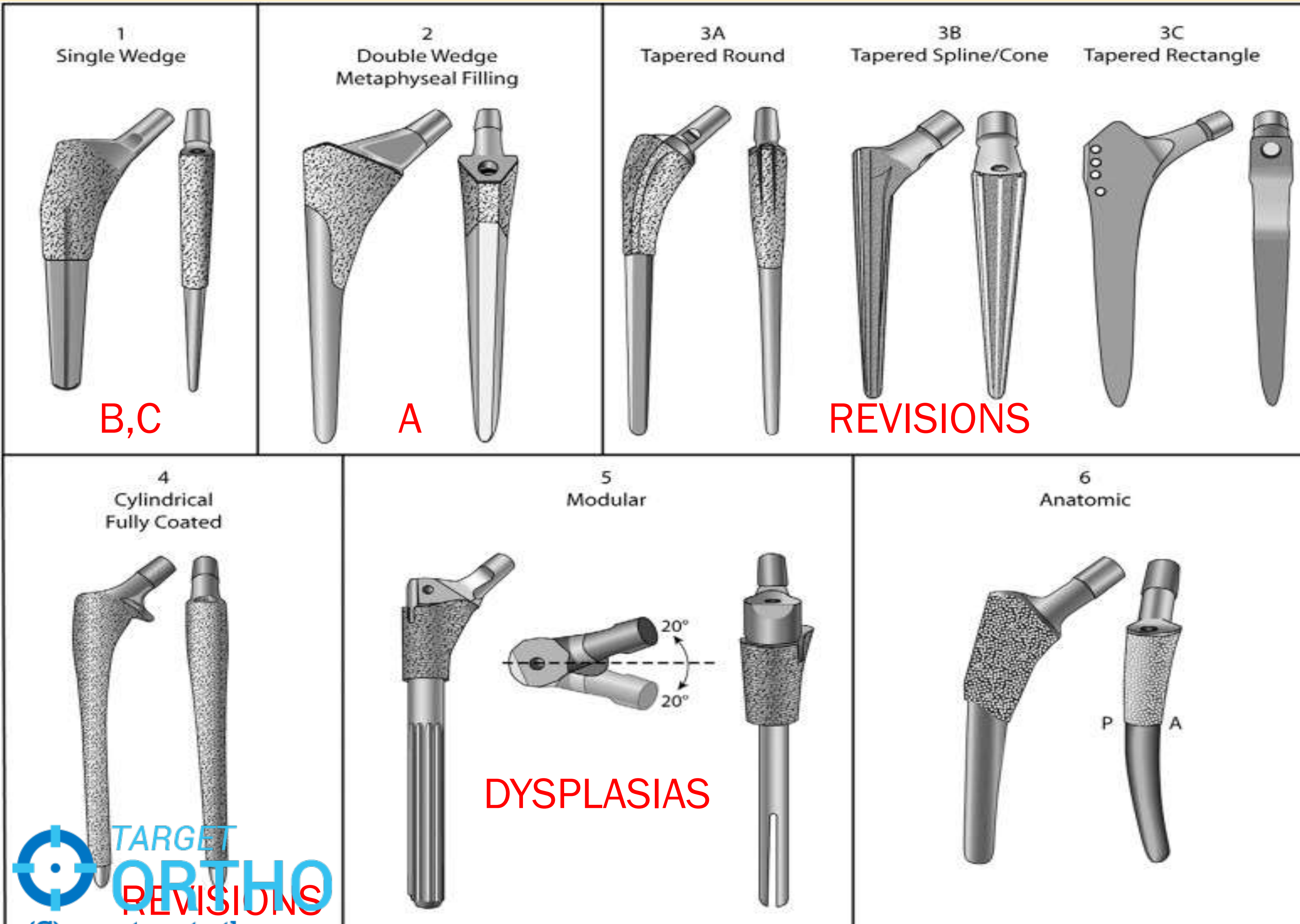
FEMORAL STEM TYPE 5

- Highly Modular stems
- Separate metaphyseal sleeves and diaphyseal segments
- Recommended for patients with altered femoral/ acetabular anatomy
- For all Dorr types



FEMORAL STEM TYPE 6

- Anatomical stem
- Incorporate posterior bow.


1
Single Wedge
2
Double Wedge
Metaphyseal Filling
3A
Tapered Round
3B
Tapered Spline/Cone
3C
Tapered Rectangle
B,C
A
REVISIONS
4
Cylindrical
Fully Coated
5
Modular
20°
20°
6
Anatomic
P
A
DYSPLASIAS
REVISIONS

ACETABULAR MODULARITY

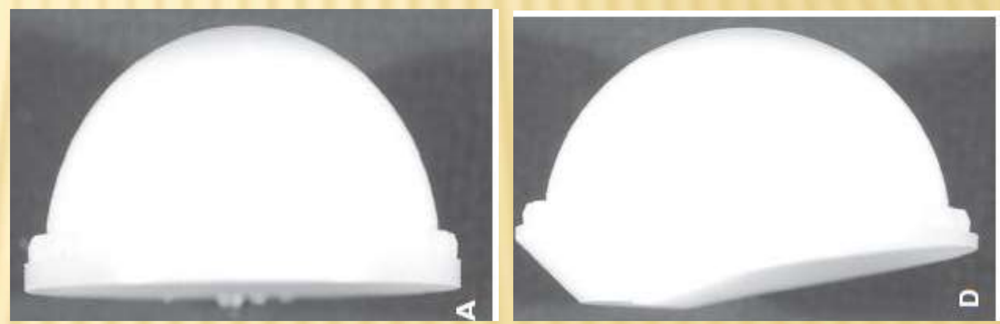
SHELL (40-75 MM) → Should be able to accommodate 22-40 mm heads

Minimum 5 mm thick polyethylene is essential!

LINERS → Simple (Non constrained)

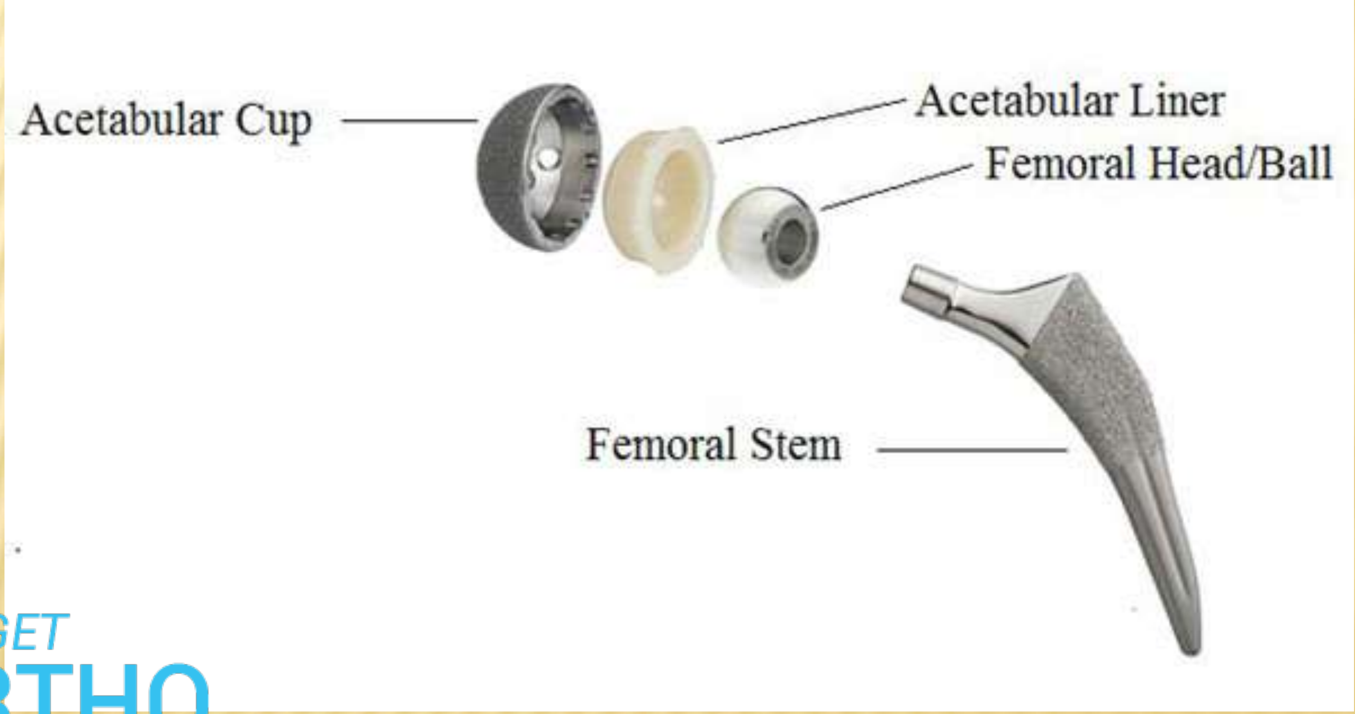
Straight/ Offset liners

LINERS ↓ Constrained liners



BEARING SURFACES (BIOMATERIAL TO BE USED)

Considering the general requirements, about 15 metals , 3 polymers and 4 ceramics were selected as biomaterials for THR.

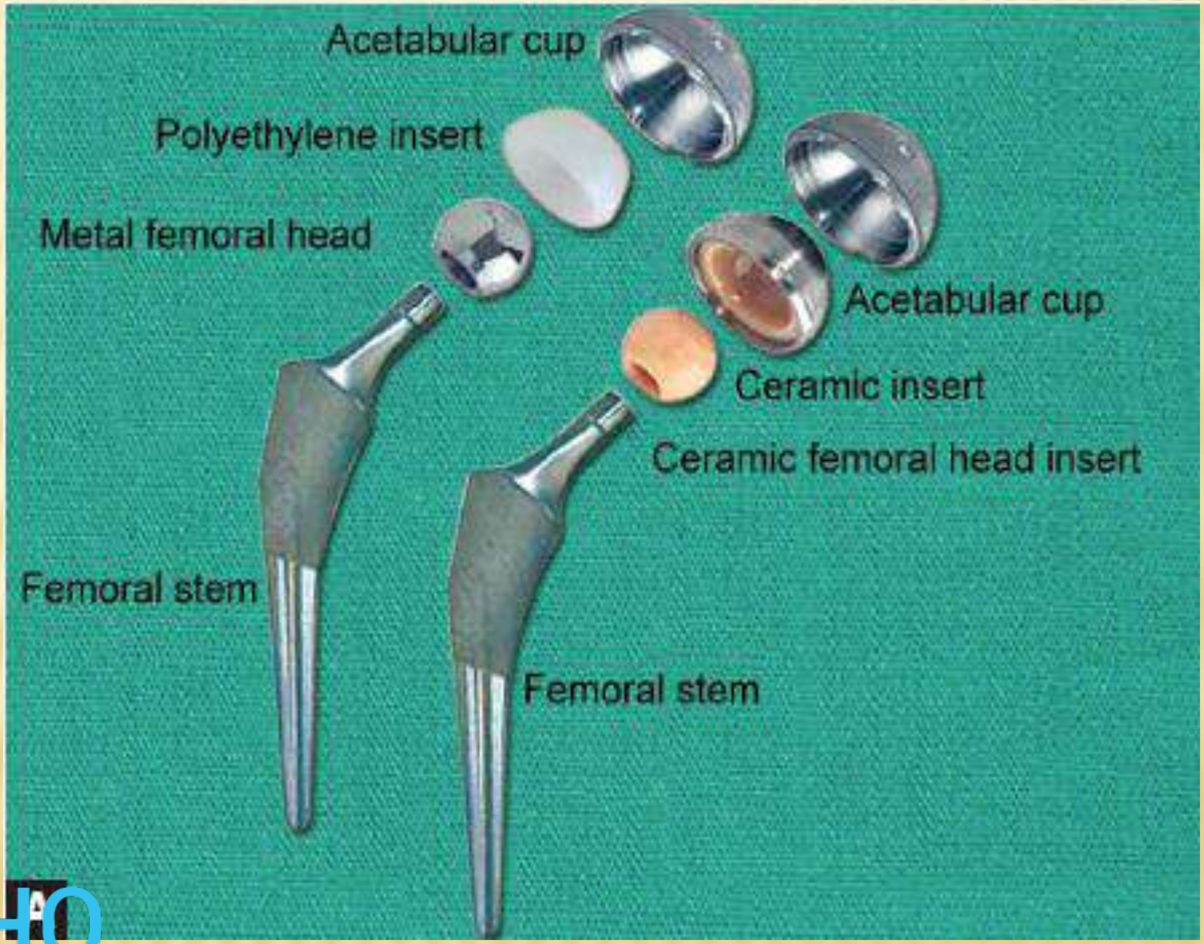


BEARING SURFACES

Q4. ALVAL lesion is seen in association with

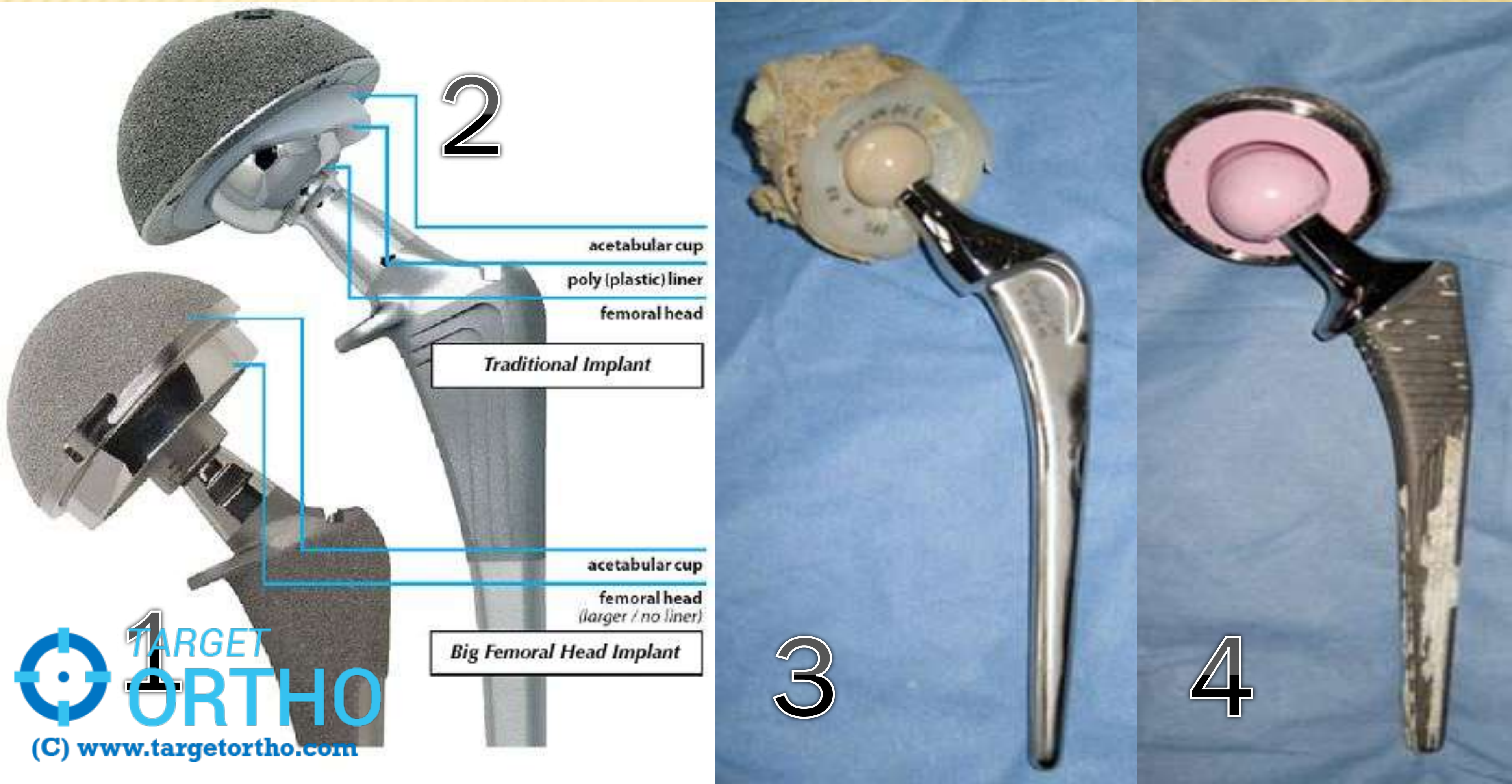
A. Metal on Poly THR
B. Metal on Metal THR
C. Ceramic on ceramic THR
D. Metal on ceramic THR

BEARING SURFACES



BEARING SURFACES

1- METAL ON METAL 2- METAL ON POLY
3- POLY ON CERAMIC 4- CERAMIC ON CERAMIC



METALS

COROSSION

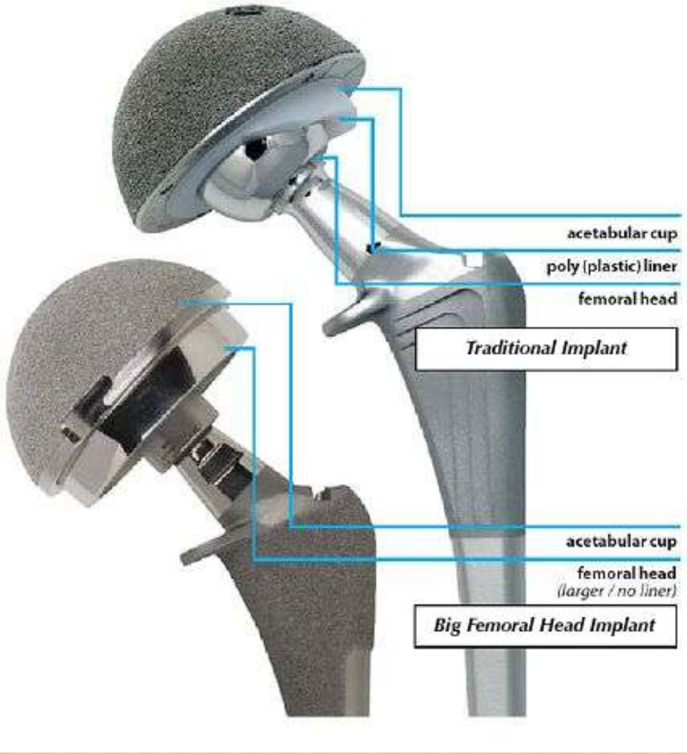
Three types

- Iron-based (stainless steel)
- Cobalt-based
- Titanium-based

HARD
STRONG
STIFF

MODULOUS OF ELASTICITY

Cement, bone, titanium, cobalt: 1, 10, 50, 100



TARGET ORTHO

METAL ON METAL BEARING SURFACE

- Metal-on-metal (M-on-M) prostheses are experiencing a revival after falling out of favour in the 1970's
- Now thought that the cause for aseptic loosening in first generation models was due to poor design and improper implantation technique rather than the M-on-M bearings themselves.

TARGET ORTHO

METAL ON METAL BEARING SURFACE

- Prosthetic wear in M-on-M has been reported to be 60 times less than expected with conventional M-on-PE prostheses. Minor cracks if occur, they self polish over time (Self healing couple)
- In addition, as the metal femoral heads are less brittle than other materials they can have a larger diameter, increasing joint stability, and therefore the incidence of dislocation in these arthroplasties is lower. Large heads give best range of motion.

METAL ON METAL BEARING SURFACE

?? METAL IONS EFFECT

MALPOSITION INTOLERANT

Diametral clearance refers to the gap between two implants at the equator. Should be 100-200 µm

Inadequate clearance or too large a clearance both increases wear rate. Current implants promote polar contacts.

FIGURE 13 | Equatorial Contact

FIGURE 14 | Polar Contact

METAL ON METAL BEARING SURFACE

ALVAL

(5% cases)

ALVAL- *Aseptic lymphocytic dominant vasculitis associated lesion*

- Pseudotumor like mass formation
- Typically cystic in nature
- Located at posterolateral aspect of the joint, often in continuity with the greater trochanter

TARGET ORTHO

METAL ON POLYETHYLENE BEARING SURFACE

- John Charnley first used PTFE because of its softness and low coefficient of friction.
- Currently available is Ultra high molecular weight polyethylene (UHMWPE).
- Polyethylene-based implants almost completely have displaced all other bearing surfaces today.
- Safe, predictable, cost-effective and good enough longetivity (Gold standard)

TARGET ORTHO

POLY EHTYLENE (CARBON POLYMER)

Characteristics *(THERMOPLASTIC)*

low strength
low hardness

Ductile
low friction
limited wear resistance

Oxidize with 5-10 Mrad gamma rays

For crosslinking

Remelting
Annealing
Vitamin E soaking

Osteolysis → Loosening!

POLY ETHYLENE

Sterilisation is problem

☐ cannot be autoclaved as causes softening and permanent degradation

☐ ethylene oxide sterilisation does not sterilise throughout

☐ high-dose radiation causes oxidisation

Usually sterilised by low-dose gamma radiation!

CERAMICS

- An inert (non conductor of heat and electricity) non metallic mineral
- Classified as: alumina
  zirconia
  bioactive (hydroxyapatite)

Characteristics

high surface hardness (extremely resistant to wear)
high strength

Material of choice in young!

~~Metals~~

high surface wet-ability
high surface tension

→ *No friction*

high elastic module
brittle (mechanical/notch sensitivity)
poor crack resistance

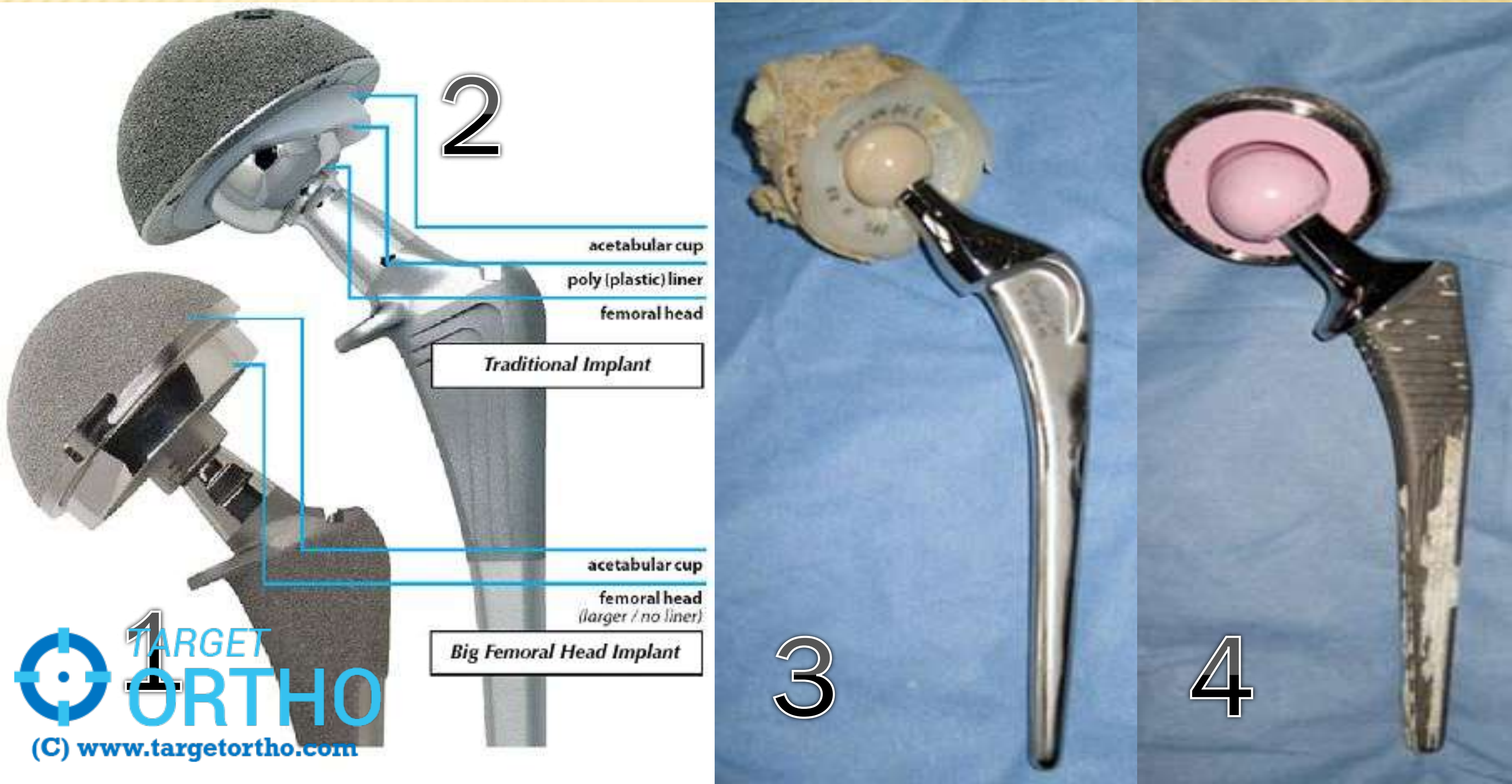
Non uniform loading
↓
catastrophic failure possible

CERAMIC ON CERAMIC BEARING

- Impingement between femoral neck and rim of ceramic acetabular component creates problem unique to this articulation.
- Repetitive contact at extremes of motion can lead to notching of metal femoral neck by harder ceramic.
- C-on-C is more sensitive to implant mal position leading to **stripe wear** which is a long, narrow area of damage resulting from contact between the head and edge of ceramic liner.
- Micro-seperation of implant during swing phase is also recognized phenomena.
- Reproducible noise, particularly squeaking while walking.

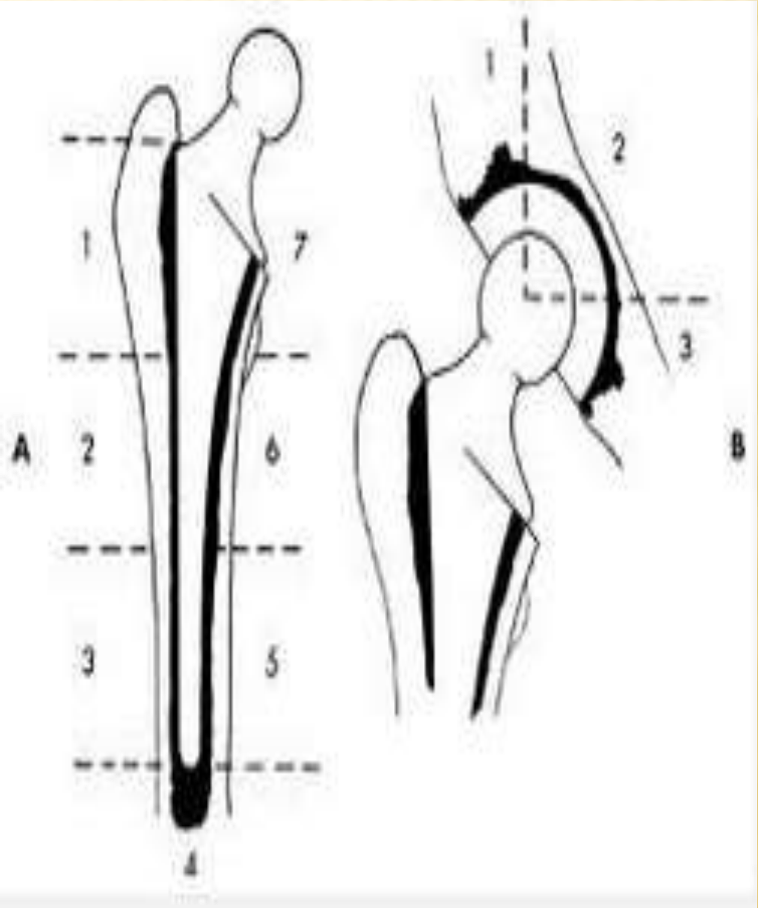
BEARING SURFACES

1- METAL ON METAL 2- METAL ON POLY
3- POLY ON CERAMIC 4- CERAMIC ON CERAMIC



COMPLICATIONS

- N/V injuries
- Dislocation/ Subluxation
- Infection
- MI
- DVT and PE
- Periprosthetic fractures
- Heterotopic ossification



- Failure due to Loosening- Osteolysis


R


DARSHNA KUMARI 92 Yrs/F
953543
18-Jul-2020
ru0
R
18-Jul-2020
DARSHNA KUMARI 92 Yrs/F


AP/LAT 13158/20
DARSHAN KHANNA 92Y/F
955776
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3158
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DARSHAN KHANNA 92Y/F
955776
19-Aug-2020
R-13158
19-Aug-2020
955776
DARSHAN KHANNA 92Y/F

DUAL MOBILITY CUPS

Dual mobility cups have two points of articulation, one between the shell and the polyethylene (external bearing) and one between the polyethylene and the femoral head (internal bearing). Movement occurs at the inner bearing; the outer bearing only moves at extremes of movement.

Dual mobility cups provide an increased range of movement and a may reduce the risk of dislocation.

TARGET ORTHO

SYN **TRIPOLAR CUPS**

EVOLUTION IS ONGOING PROCESS

THANK YOU !