Practical Orthopedic Examination
MADE EASY®
To
My doting wife Neeta Verma
My loving son Siddhant
and
All my respectable teachers
and
Caring students...
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Preface to the Second Edition

After moving out of my parent institute, I realised that there are a few cases that postgraduates encounter during exams which are not covered in the current text. Brief teaching experience at Lady Hardinge Medical College and associated hospitals reaffirmed the need for second edition incorporating some more cases. I have not changed the original text to a large extent for simple reason that the basic approach to questions and their answer remain the same. Minor changes have been done in examination section of hip, knee and spine and ankle and foot cases. Additions are in the form of new cases for malunited distal radius fracture and intertrochanteric fractures. Hand section has been upgraded to large extent and now additionally carries cases on cut tendon injuries, carpal tunnel syndrome and malunited distal radius fractures. Some more questions have been added to Chapters 11 and 12. My current practice as joint replacement and arthroscopy surgeon has segregated me from most of the usual instruments and implants, so I could not gather enough courage to add chapter on instruments and implants, though I feel there an erstwhile need for the same. I promise to include section on instruments and implants and surgical exposures that are commonly asked in exams in future reprints/edition. I am thankfully obliged to my previous mentor Prof PP Kotwal for encouraging me to remain in academics and timely guiding me for current needs, he himself is a great academician. My current head Dr VP Singh had immensely cooperated by omitting my inconsistencies at work and extracurricular activities while providing me time and support to finish the writing work. New author, Dr Ram Kinkar Jha has given good support to revise spine section and writing carpal tunnel syndrome. Dr Aditya Soral has re-contributed in the form of new inputs and editing few deficiencies in the previous text. I am thankful to all the DNB students for making
the text a success, while myself being able to continue with my initiation of helping in academics for postgraduate students.

Most importantly in the end, I urge all DNB students who have read or are reading the current text (or even previous text) for providing me with regular inputs either at Facebook (Manish Kumar Varshney) or writing to me at manish.varshney@tatamotors.com (y unknowingly removed from this new e-mail ID). This will help me in generating the quality work useful to all.

Manish Kumar Varshney
Preface to the First Edition

The first edition of Practical Orthopedic Examination Made Easy has emerged after giving immense thought over the imminent need for a text that could serve to guide the postgraduates in the field for preparing through the ultimate acknowledgement of degree. The book specifically serves the stratified group of people preparing for orthopedic practical exams but also it does help a beginner in the field; gain theoretical knowledge and grab some basics often not found in modern orthopedic textbooks.

It has been an endeavor to keep the text as simple and directed to maintain interest of the reader. Also preservation of continuity in the text and standardization of information has been specifically dealt with. This gives an advantage for reader rehearse the examination scenario virtually and identify weaknesses to improve upon and strengths to maintain. While providing the most frequently asked questions and the 'expected' answers, consideration has also been given to some uncommon or unique questions with diligent answers. I have tried to provide as non-controversial an answer as possible with direct impact on the next possible questions while simultaneously being adequate. Still some controversial answers are detailed and are expected to be accepted by prevailing popular choice.

The examination points given at the beginning of every region serve as a quick synopsis along with comments on some uncommon tests that are still uncommonly asked. Figures have deliberately been omitted to make the material less bulky which considering the same are easily found in standard textbooks for orthopedic clinical examination. This work should be perceived in the deserved perspective and is not expected to substitute the standard orthopedic textbooks that have been the masterpieces in the field. When read as contemporary to the
standard textbooks, this work helps one understand the meaning of ‘reading between lines’ that is often the basis of some formidable questions stumbling even some avid book lovers. Organization of the book into regional affections and pertinent cases is more deliberate than accidental considering the relevance of ‘regions’ to examination cases. Some short cases however, have to be clubbed into miscellaneous section as they are either common to various sections or are full sections by themselves. Named signs, tests, procedures have been kept only to bare minimum necessary level as they are stressed only by an exceptionally uncommon unrealistic examiner unless one heads for a gold medal. No work is impeccable (that’s why future editions follow) and readers’ comments are delightfully welcome to improve upon the present text.

I personally wish appreciation to the various chapter contributors, colleagues and my seniors and junior residents in bringing this book to fruition in a timely manner. Particularly the constructive criticism and helpful suggestions given by Dr Mohit Singh in formatting the book needs mention. The book is a concise upshot of training and teaching from the expert and experienced teachers at Department of Orthopaedics, All India Institute of Medical Sciences to whom I am grateful.

All my sincere dedications and gratitude towards my wife Mrs Neeta Verma, will always fall short of the immense help I received from her in preparing the major part of this work.

Finally, I am highly indebted to the dedicated team of M/s Jaypee Brothers Medical Publishers(P) Ltd, New Delhi for giving constant encouragement and sage advice in the preparation of this book.

I wish the readers astounding success in examinations and accomplishments!

Manish Kumar Varshney
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GAIT

Gait analysis is an important part of examination for lower limb and spine evaluation and no candidate would be spared if he does not possess the requisite knowledge of the same. The topic is difficult and needs lots of practice and guidance for proper presentable knowledge.

Read: 5-7 times (MS Orth and DNB candidates)

1. What do you understand by gait?
   Ans. Gait is a dynamic posture allowing bipedal unassisted mobility by virtue of sound interplay between coordination and balance primarily of the lower limb and pelvis. Gait involves complex neuromuscular coordination of the lumbar spine, pelvis, hips and those structures distal to them. Any dysfunction in the lower limb will become observable during gait.

2. What do you understand by walking, running and jumping?
   Ans. Walking: Bipedal unsupported gait pattern where at any time at least one foot is in contact with the ground.
   Running: Gait pattern where at least at some point of time feet are in air and one foot touches the ground in alternation.
   Jumping (both feet): Where at any point of time either both feet are touching the ground or are in air. In single foot jump the other foot never comes in contact with ground!

3. What are the prerequisites for gait evaluation?
   Ans. The following needs to be closely conformed to:
   1. Gait should be observed in all three planes with and without shoes (bare foot).
   2. Patient should be covering the private parts only during the gait examination.
   3. Observe gait while the patient walks along walkway of 1.1 m wide and 6m long.
4. **What is gait cycle?**

**Ans.** It consists of two distinct phases – the swing phase and the stance phase with their sub-phases.

A. Swing phase (40% of the gait cycle – remember body tries to preserve energy)
   1. Acceleration phase
   2. Mid swing phase
   3. Deceleration phase

B. Stance phase (60% of the gait cycle – even while walking we rest more; actually balance if more important than speed. So as a corollary one is more ‘unstable’ while running).
   1. Heel strike
   2. Foot flat
   3. Mid stance
   4. Heel off (Push off)
   5. Toe off

*Two periods of double support:*
   I. Immediately after the initiation of stance phase
   II. Just before the end of stance phase

5. **What are the various dysfunctions that can influence the gait?**

**Ans.**

1. Neurological (may involve dysfunction of one or a combination of the following parts of the CNS and/or PNS):
   a. Motor: CVA, Cerebral palsy
   b. Sensory: Tabes dorsalis, blindness
   c. Cerebellum: Friedreich’s ataxia
   d. Basal ganglia: Parkinson’s disease

2. Systemic disease:
   a. Joint disease: Rheumatoid arthritis, Osteoarthritis, JRA
   b. Crystal arthropathies: Gout
   c. Muscle disease: Duchenne’s muscular dystrophy, Dermatomyositis
   d. Bone disease: Rickets, Osteomalacia, Paget’s disease
3. Structural:
   a. Limb length inequality: DDH, Polio, femoral/tibial fracture
   b. Alignment disorder: Coax valga/vara, Genu varum/valgum, tibial/femoral torsion.

6. How to describe gait?

Ans. Observe the following anatomical & functional features during gait: (Observe from front, back and side)
1. Head position
2. Shoulder position
3. Arm swing
4. Trunk position/rotation
5. ‘Base’
6. Pelvic tilt
7. Limb motion
8. Thigh segment
9. Patellar position/rotation
10. Knee position
11. Tibial position/rotation
12. Ankle
13. Calcaneal position
14. Navicular position
15. Mid-tarsal joint
16. Metatarsals
17. Toe position
18. Foot position/shape
19. Propulsion
20. Swing phase

The patient is walking with a bipedal unsupported gait having equal smooth alternating and rhythmic stance and swing phases with a normal base. The patient walks with a steady head in coronal plane centered over the shoulders. The shoulders are at same height. There is no trunk sway or rotation. Arm swing is equal and alternate on both sides. There is no pelvis drop on either side and the limbs move in coordination alternately during swing phase. During stance phase the patellar and knee heights
are equal and there is no pelvic drop. The foot on both sides maintains its arch and stance phase progresses smoothly through heel strike, foot flat, mid-stance, heel off and toe off. This patient has a normal gait!

(First mention bipedal or single limb or three/four point gait commenting type of support used. Then comment on the two phases of gait, their length, smoothness, coordination, alternation and any abnormality. Then one may differ and would describe the pathological features first (like short stance phase with ipsilateral shoulder dip and trunk sway, etc. for antalgic gait) and then describe the other normal findings. Otherwise one may describe the features observed during swing and stance phases sequentially – both are correct and choice is yours – *Always remember to conclude with your diagnosis of type of gait*).

7. What do you understand by base of gait?
**Ans.** The distance between medial borders of both foot (normally 2-4 inches).

8. What is ‘double support’ during gait cycle?
**Ans.** Also known as ‘double leg stance’. During gait cycle the body is supported on both foot for a brief period that extends from somewhere between push-off and toe-off on one foot and between heel strike and foot-flat on contralateral side. This comprises some 10% of gait cycle.

9. What is cadence and its importance?
**Ans.** Number of steps taken in one minute (normal 90-120/min). The period of double support is inversely proportional to cadence.

10. Can you comment on some common types of gait and their mechanism?
**Ans.** The various types of gait observed are (see also Chapter 3):  
1. *Trendelenberg’s gait* (abduction lurch gait): It may be unilateral or bilateral. It depends upon the abductor lever
When present unilaterally, the patient lurches on the affected side and the pelvis drops on the opposite hip. Bilateral Trendelenberg’s gait is also known as *waddling gait*.

2. **Short limb gait**: The patient lurches to the affected side and the pelvis drops to the same side (different from Trendelenberg gait in which the pelvis drops to the opposite side). If the shortening is less than 4 cm, it is compensated by the hyperextension at the knee and equinus at the ankle. Typical short limb gait is seen only when the shortening is more than 4 cm.

3. **Antalgic gait**: Patient walks with shortened stance phase (avoids taking weight on the same limb). Any condition leading to pain in the lower limb (from hip to foot) leads to antalgic gait.

4. **Stumbling gait**: Gait of bilateral CTEV.

5. **Waddling gait or duck walk gait**: It is wide base gait with increased lumbar lordosis, the patient sways to the same side after putting weight on the limb. Seen commonly in pregnancy, bilateral DDH, osteomalacia and myopathies.

6. **Knock knee gait**: While walking the knees point to each other and cross each other and the feet are kept apart. Typical in-toeing gait except the position of the knees on flexion are crossed or near to each other.

7. **Quadriceps gait or ‘hand to knee gait’ or ‘five fingers quadriceps gait’**: In cases of weakness of the quadriceps (PPRP – quadriceps are the most common muscles affected in the polio) the patient walks by supporting his knee with his hand during the extension to bear weight. The typical gait is produced to stabilize the knee. The patient does this typical action externally or by putting his hand through the pocket.

8. **Gluteus maximus gait or ‘extension lurch gait’**: The gait is rarely seen these days as the most common cause was the weakness of the gluteus maximus due to PPRP. The patient lurches backward during walking.
9. *Gluteus medius gait*: The gait is similar to the Trendelenberg’s gait as the abductor forces of the hip are affected.

10. *Stiff hip gait*: The patient walks by moving his whole pelvis along with the affected side (swaying to opposite side to clear ground); there is no or minimal movement at the affected hip.

11. *Stiff knee gait*: The patient lifts his pelvis during the swing phase of the gait cycle to get the ground clearance.

12. *High stepping gait or Russian march gait*: The gait is seen in cases of foot drop, patient lifts the affected limb higher and puts the forefoot first over the ground while entering into the stance phase. (Remember- normal gait cycle starts with heel strike)

13. *Scissors gait*: This pattern of gait is seen in cases of weakness with spasticity (weakness is more than the spasticity) of both lower limbs (CVA, cerebral palsy, early stages of lathyrisms etc.). One leg crosses directly over the other with each step as the blades of the scissors. This is also called as the circumduction gate.

14. *Hemicircumduction gate*: The patient moves his limb while dragging his body along with the limb in hemicircle. The pattern is seen in cases of hemiparesis (CVA, cerebral palsy).

15. *Stamping gait*: It is seen in cases of loss of proprioception (sensory ataxia, tabes dorsalis, Vitamin B₁₂ deficiency, alcoholism). The patient walks as he has no idea where his foot is leading to thumping noise over the ground due to sudden striking of the foot. The pattern can be imagined as descending the stairs in complete darkness.

16. *Short shuffling gait or festinating gait*: Difficulty in starting and stopping the gait cycle with forward stooping posture and short steps. Typically seen in cases of Parkinsonism.

17. *Charlie Chaplin gait*: This is seen in cases of alkaptonuria, external rotation deformity of tibia and flat feet with valgus deformity of ankle.

18. *Drunkards or reeling gait*: The patient has wide base gait and he swings to each side with tendency to fall with every step. This is seen in cases of cerebellar lesions or alcohol poisoning.
19. **Hysterical gait (Helicopod gait):** The patient walks in bizarre fashion with a tendency to fall on every step; often seen in females with a typical tendency to fold in themselves. Typically the patient does not fall, or falls in safer position and places hence are never hurt. The pattern is present in front of others only.

20. **Calcaneus gait:** The patient has broad heel due to malunion of the calcaneum fracture. The patient has no calcaneal pick up and push off due to weakness of triceps surae. The patient walks with tendency to rotating the foot outwards and genu recurvatum.

21. **In-toeing gait:** Seen in – clubfeet, metatarsus varus, medial tibial torsion, genu valgum, femoral intorsion, acetabular dysplasia.

22. **Peg-Leg gait:** Congenital vertical talus.

11. **What are the various crutch gaits and the gait patterns?**

   **Ans.** Depending upon the support assistance provided by the crutch and weight bearing limb the gait patterns are divided on the total points of contact bearing the weight at a time.

   - **Four-point gait**
     - Partial weight bearing both feet
     - Maximal support by crutches
     - Constant shift of weight over points

     **Gait pattern:**
     1. Advance right crutch
     2. Advance left foot
     3. Advance right crutch
     4. Advance right foot

   - **Three-point gait**
     - Requires good balance and arm strength
     - Non-weight-bearing one foot
     - Faster gait
     - Can be used with walker assistance
Gait pattern (assuming right foot is affected):
1. Advance left foot with both crutches
2. Advance right foot
3. Repeat sequence to move forward

Two-point gait
- Partial weight bearing both feet
- Minimal crutch support
- Faster than a four-point gait

Gait pattern:
1. Advance left foot and right crutch
2. Advance right foot and left crutch
3. Repeat sequence to move forward

12. What do you understand by “swing-through” and “swing-to” gaits?

Ans. These are the manner in which the feet are brought forward in two-point gait.

Swing to gait:
- Weight bearing both feet
- Requires stability and arm strength
- Faster gait
- Can be used with walker

Gait pattern:
1. Advance both crutches
2. Lift feet → swing forward → land feet next to crutches.
3. Repeat the sequences again to move forward

Swing through gait:
- Weight bearing both feet
- Requires stability and arm strength
- Most advanced gait

Gait pattern:
1. Advance both crutches
2. Lift both feet → swing forward → land feet in front of the crutches
3. Repeat the sequences again to move forward
13. What is the advantage of walker and what are the various types of walker?

**Ans.** Walker provides more support and stability than a cane or a pair of crutches (*the obvious difference between a four-wheeler and a two-wheeler*).

**Types of walker:**
1. *Pick up walkers:* One that has to be picked up and moved forward with each step, it does not permit a natural walking pattern and is used for patients who have poor balance or limited cardiovascular reserve or who can't use crutches.

2. *Rolling walkers:* It allows automatic walking and is used by the patients who cannot lift or who inappropriately carry a pick-up walker.

14. What is the role of cane during walking?

**Ans.** Cane provides an additional point of contact that assists patient during gait by redistributing the weight and hence shifting the centre of gravity and line of weight bearing.

**Types of canes:**
- Quad canes (four footed canes) provide more stability
- Single foot cane one

**Placement of the cane:**
- 15 cm lateral to the base of fifth toe
- Hold in the hands over less affected (or unaffected) side (line of weight bearing shifts to the side where cane is held; unloading the affected side)
- Hold the handle of cane at the level of greater trochanter.

**PROSTHETICS AND ORTHOTICS**

1. What is prosthesis?

**Ans.** Prosthesis is a device designed to replace as much as possible the function or appearance of a missing limb or body part.
2. **How does it differ from an Orthosis?**

Ans. An orthosis (orthos (G.) – straight) is a device designed to supplement or augment the function of an existing limb or body part. It controls the abnormal movement or allows restricted normal movements. The following can be devised as functions of splints:

1. **Static splints (Immobilize or stabilize joints)**
   - Protection
   - To put joints to rest
   - To decrease inflammation
   - To decrease pain
   - To prevent undesired motion
   - To resolve fixed joint contractures (e.g., serial casting)
   - To substitute for lost muscle function
   - To substitute for loss of a digit

2. **Dynamic splints (Mobilisation or traction to joints)**
   - To resolve tendon tightness
   - To resolve joint contracture
   - To increase activity range on motion to given joints
   - To increase muscle strength

3. **How do you classify prosthesis?**

Ans. Prosthesis may be classified in three broad categories:

1. **Endoskeletal**: Most widely used for lower limbs throughout the world. This type of prosthesis consists of a central structural tube to which a joint and socket can be attached. The central tube is mostly made of carbon fiber or aluminum. This basic structure can then be covered by an outer cosmesis in form of shaped foam.

2. **Exoskeletal**: In these prostheses, the main structural component is the “outer visible skin”. Now a days, mostly DURAL (aluminum alloy) or plastic laminates are used. Majority of the upper limb prosthesis are of plastic exoskeletal structure.

3. **Temporary “pylon” prosthesis**: This consists of two self locking side struts resembling above knee calipers. They are rarely used in the current circumstances.

   The term *pylon* is also used to describe the central structural tube in the endoprostheses.
4. What components should you specify while prescribing prosthesis?

Ans. While prescribing prosthesis, following details have to be furnished:
1. Type of prosthesis
2. Level of amputation
3. Type of socket
4. Material of socket
5. Hip, knee, elbow mechanism
6. Foot/ankle or hand/terminal appliance
7. Suspension
8. Cosmesis

5. What are various types of sockets?

Ans. From the viewpoint of patient, socket is the single most important factor in prosthesis.
- Sockets may be made of various materials for e.g. Leather, polypropylene, fiberglass, etc.
- Sockets may be standard sockets, which are worn over a stump sock. Now a days, suction sockets are available which remain in close contact to the skin and are worn without a sock.
- Recently, silicone impregnated sock or sock lined by a layer of polyurethane gel have been developed to increase comfort and reduce sweating.

6. What are various types of suspension mechanisms?

Ans. The prosthesis may be:
A. Suspended with the help of belt, cuff or sleeve.
B. Self suspending: These may again be divided into mechanical or suction.

7. What are the various knee mechanism options available?

Ans. The knee systems have met the most advance-ment, the simplest being single axis constant friction type. Other mechanisms are:
### MISCELLANEOUS TOPICS

<table>
<thead>
<tr>
<th>Type</th>
<th>Typical patient</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single axis, constant friction</td>
<td>Sedentary, poor access to maintenance</td>
<td>Inexpensive, Durable, Easy to maintain, Light weight</td>
<td>No swing phase control, Gait optimal only at one speed, Little inherent stability</td>
</tr>
<tr>
<td>Weight activated stance phase control (safety knee)</td>
<td>Elderly, Neurologic compromise</td>
<td>Inexpensive, Durable, Provides stability during heel strike and stance phase</td>
<td>No swing phase control, Gait optimal at one speed only, Reduced legibility</td>
</tr>
<tr>
<td>Polycentric four bar knee joint</td>
<td>Knee disarticulation, Amputation</td>
<td>Can be less expensive, Stable, Hydraulic swing phase control may be added</td>
<td>Bulky, Poor cosmesis, Increased weight, Frequent maintenance</td>
</tr>
<tr>
<td>Hydraulic or pneumatic swing phase control</td>
<td>Active young patients with access to maintenance facility</td>
<td>Best swing phase control, Adapts to speed, Best gait pattern</td>
<td>Expensive, More frequent maintenance, Heavier</td>
</tr>
<tr>
<td>Manual locking knee</td>
<td>Elderly/weak instability, Unstable</td>
<td>Maximum stability, Very light</td>
<td>Unnatural gait, Must be unlocked to sit</td>
</tr>
</tbody>
</table>

8. **What are the various foot and ankle mechanisms available?**

**Ans.** Main groups include:
1. Articulated ankle joints
2. Dynamic response and energy storing foot
3. Non-dynamic response and/or energy storing foot
   The simplest mechanism is SACH which stands for “solid ankle, cushion heel”. It consists of a non-articulated ankle and non-dynamic response foot. It is least efficient. Articulated ankle has the following disadvantages:
   • Heavier
   • More frequent maintenance
   • When combined with dynamic response foot, it prevents loading of toes to provide push off.

9. What is SCAH foot?
   Ans. SACH stands for (solid ankle cushion heel). No true ankle joint, contains a ‘simulated ankle joint’ by compressed wedge shaped rubber heel. Consists of a solid wooden keel, high density rubber for dorsum, low density rubber for toes and plantar aspect (ensures smooth transition from toe-off to heel strike, variable density rubber for heel. The advantages are as follows:
   • Absorbs the impact of heel strike.
   • ↓ vertical excursion of centre of gravity.
   • Allows some simulated movement of metatarsal head.

10. What is Jaipur foot?
    Ans. Developed by Prof P.K. Sethi. Contains two wooden keels (broken keel). There is provision of toe break. The fundamentals if these types of prosthetic foot would get cleared by the following table:

<table>
<thead>
<tr>
<th>Jaipur foot</th>
<th>SACH foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance similar to normal foot</td>
<td>Dissimilar to normal foot</td>
</tr>
<tr>
<td>Can be worn without shoe but if someone wishes to wear one he can use a flat heel shoe.</td>
<td>Requires a closed shoe to protect and hide it.</td>
</tr>
<tr>
<td>No restriction of movements at ankle as the metallic keel (carriage bolt) is confined to ankle only and all movements take place at natural site.</td>
<td>Solid ankle consisting of long wooden keel restricts movements in nearly all directions.</td>
</tr>
</tbody>
</table>

Contd...
11. What are the various upper limb prostheses available?

Ans.

1. **Passive/cosmetic**: They are useful in those individuals who want a near life like cosmesis or those who have a high level amputation and they want light weight prosthesis for cosmetic reasons. These are non-functional.

2. **Body powered**: This involves the use of gross body movements to move the components through a system of harnesses and straps.
   a. **Advantages**:
      - Does not depend on battery power
      - Quicker reaction time
      - Less expensive
      - Durable
      - Maximum proprioception
   b. **Disadvantages**:
      - Repetitive injury to activating muscles and joints
      - Limited pinch force control of terminal device
      - Harnessing effect

3. **Externally powered (myoelectric, switch control)**: Myoelectric components are controlled by voluntary muscle action via an electronic signal. The signal is picked up and amplified by electrodes placed over muscle fibers and the downloaded over to a computer to provide a
specific function. Before prescribing this type of prosthesis, myoelectric testing has to be done.

a. **Advantages:**
   - Better cosmesis
   - No need for harness
   - Prevents repetitive injury
   - Increased anatomic function
   - Voluntary wrist rotation

b. **Disadvantages:**
   - Heaviest
   - Slower response time
   - Expensive
   - Frequent maintenance
   - Battery dependent
   - Less durable, non water proof
   - Longer training period

4. **Hybrid systems:** Hybrid system has a combination of body powered and myoelectric components. This combination reduces the weight as well as the cost of the prosthesis.

   **Various upper limb units:**
   1. Terminal devices: passive or powered (myoelectric/body powered) hand or hook.
   2. Wrist units: both body powered and myoelectric units are available.
   3. Elbow units: passive, body powered and myoelectric units
   4. Shoulder: only manual units are used.

12. What is immediate post-operative prosthesis?
    **Ans:** Immediate post operative prosthesis- this consists of a specialized dressing covered by a plaster cast molded to provide the patient with weight bearing areas to enable them to ambulate as soon as possible.

    The IPOP incorporates an adapter in the distal end that has a removable pylon with a prosthetic foot attached.

    **Disadvantages of IPOP**
    - Pistoning action due to plaster loosening, leading to tissue breakdown
– Repeated changing of casts
– Heaviness of cast leading to reduced movement of contained joints and subsequent muscle atrophy
– Difficulty in regular monitoring of the wound
– Auxiliary suspension may be required.

13. What is post-prosthetic care?
Ans.
1. Balancing, stretching and muscle strengthening exercises may be started as soon as possible. This helps in maintaining flexibility, prevent flexion contractures and preserve muscle mass and strength.
2. An aerobic conditioning program must be designed and incorporated in the rehabilitation process.
3. Gait training should begin with first step. Initially walking stick or walker may be allowed but there use should be terminated as soon as possible.
4. In case of upper limb amputations, early fitting of prosthesis and promotion of two handed function leads to reduced rejection rate.

14. What is Milwaukee brace?
Ans. A brace designed by Blount, Schmidt and Bedwell (1958) known by the city of origin of these men. This brace is used for controlling curve deterioration and to maintain the post-operative correction in patients with scoliosis. The brace has three parts:
- The pelvic mould
- Vertical bars
- Mandibulo-occipital assembly
The pelvic girdle uniformly fits over the iliac crests and is the most important part of brace. It helps reduce lordosis, derotates the spine, and corrects frontal deformity. Uprights have localized pads to apply transverse force which is effective for smaller curves. The main corrective force is the thoracic pad which attaches to two posterior and one anterior upright. Discomfort from the same creates a righting response. Neck ring is another
corrective force and is designed to give longitudinal traction. The throat mould allows the use of distraction force without producing jaw deformity.

Complications

- Pain
- Skin breakdown
- Jaw deformity
- Unsightly appearance
- Increased energy expenditure with ambulation, etc.

WOUND INFECTION, WOUND COVERAGE AND DRESSINGS

(This is typically a topic for DNB exam ward rounds and hardly if ever would be of any utility to MS Orth candidate. The practical utility is however immense and one may read it just out of interest!

Read: 3-5 times for DNB candidate)

1. Describe the wound.
   
   **Ans.** Wound or ulcer is basically described under following headings:

   1. *Inspection*
      
      a. Size & shape
      b. Number
      c. Position
      d. Edge
      e. Floor
      f. Discharge
      g. Surrounding area
   2. *Palpation*
      
      a. Tenderness
      b. Edge and margin
      c. Base
      d. Depth
      e. Bleeding
f. Relations to deeper structure

g. Surrounding skin

- **Inspection findings:** This is a single, oval shaped, roughly 3 cm in length, ulcer (wound) situated over middle one third of right leg on the medial aspect in healing stage. The edge of the ulcer is sloping and pale and smooth granulation tissue is visible at the floor. Discharge is scanty. Surrounding skin is normal. *(look for appendages and colour).*

- **Palpation findings:** The ulcer is slightly tender to palpation and its 5 mm in depth. The base is indurated. It is mobile and not fixed to the deeper structures.

2. **What else you would like to examine in this case?**

   **Ans.** I would like to examine the regional lymph nodes, peripheral pulses, vascular insufficiency and sensory status *(for neurological status–neuropathic ulcer).*

3. **How do you classify an ulcer?**

   **Ans.** Ulcers can be classified either on the basis of clinical type or on the basis of pathological type.

   **Clinical types** are – spreading ulcer, healing ulcer, chronic or callous ulcer.

   **Pathological ulcer**:
   - Non-specific (traumatic, arterial, venous, neurogenic)
   - Specific (tuberculous, syphilitic, actinomycotic)
   - Malignant (epithelioma, Marjolin’s ulcer, rodent ulcer)

4. **What are the characteristics of a healing ulcer?**

   **Ans.** The floor of a healing ulcer is covered with pinkish or red healthy granulation tissue. The edge is reddish with granulation, while the margin is bluish with growing epithelium. The discharge is slight and serous if at all present.

5. **How can you say that an ulcer is a chronic ulcer?**

   **Ans.** These ulcers show no tendency towards healing. The floor is covered with pale granulation tissue. Discharge may
be scanty or absent. The base is considerably indurated and so is the edge and surrounding skin.

6. **When an ulcer or wound is called as infected?**

   **Ans.** Clinical indicators of infection seen on wound examination are -
   - Poor quality granulation tissue
   - Thinning of granulation tissue
   - Increased volume of exudates
   - Pain
   - Formation of adherent fibrinous slough.

7. **Classify a wound?**

<table>
<thead>
<tr>
<th>According to the type</th>
<th>According to the extent</th>
<th>According to local environment of wound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incisional wound</td>
<td>Deep wet wound</td>
<td>Necrotic wound</td>
</tr>
<tr>
<td>Partial thickness wound</td>
<td>Deep dry wound</td>
<td>Sloughing wound</td>
</tr>
<tr>
<td>Full thickness wound</td>
<td>Shallow wet wound</td>
<td>Granulating wound</td>
</tr>
<tr>
<td></td>
<td>Shallow dry wound</td>
<td>Epithelializing wound</td>
</tr>
</tbody>
</table>

8. **What is the principle of wound management and prerequisites for an ideal dressing material?**

   **Ans.** Wound management is based on stepwise approach consisting of:
   a. Assessment of both patient health and wound characteristics
   b. Planning the course of treatment
   c. Cleansing and debridement (establishment of open edge), application of dressing and adjunct therapy.

   The ideal dressing should:
   - Protect from external forces
   - Allow appropriate gaseous exchange
   - Provide moist environment
   - Maintain high humidity
   - Provide optimum pH (slightly acidic)
• Discourage infection
• Provide thermal insulation
• Reduce odour
• Absorb exudates
• Be easy to apply
• Be cost and resource effective.

9. **What is the most accepted dressing method—wet dressing or dry dressing?**

**Ans.** Wet dressing is most accepted method and conversion from wet to moist dressing is ideally suited in most cases:

<table>
<thead>
<tr>
<th>Moist</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced risk of infection</td>
<td>Encourages scab formation</td>
</tr>
<tr>
<td>Reduced healing time</td>
<td>Delays healing</td>
</tr>
<tr>
<td>Faster re-epithelisation</td>
<td>Increases pain</td>
</tr>
<tr>
<td>Better cosmetic result</td>
<td>May produce scar tissue</td>
</tr>
</tbody>
</table>

10. **Classify different dressing materials with examples.**

**Ans.** Classified on the basis of construction and function.

1. **Absorptive**
   a. Gauze
      • Plain
      • Impregnated
      • Foams and polymer dressing
      • Alginites

2. **Oclusive (Moisture maintain) dressing**
   a. Film dressings
   b. Hydrocolloids
   c. Hydrogels

3. **Others**
   a. Oxidized regenerated cellulose and collagen
   b. Silicone skin-substitute dressing
   c. Amnion
   d. Homograft/Xenograft

11. **Where will you use paraffin gauge?**

**Ans.** It is most commonly used in non-infective granulating wounds and on pink epithelializing wounds. Its major
advantage is that it’s non–sticky and can be left for several days.

12. Where will you use iodine or zinc impregnated gauge?

Ans. Skin graft donor site & graft.

13. What is foam dressing?

Ans. It consists of hydrophilic polyurethane open cell sheets and is highly absorptive. It provides moist environment and thermal insulation. It’s useful in exudative wounds and needs to be changed in 3-4 days. No role in dry wound.

14. What are alginates?

Ans. They are calcium, sodium salt of alginic acid. These are highly absorbent and haemostatic in nature and also provide moist environment. Commonly used in highly exudative wounds and infective wounds.

15. What are hydrocolloids?

Ans. It consists of two layers; an inner layer which consists of carboxy methylcellulose polymer absorbs exudates and forms gel. The outer layer which is of polyurethane seals the wound. It allows limited moisture and gas transmission and is impermeable to bacteria. It also has fibrinolytic property and is mainly useful in light to moderate level exudative wounds. E.g. Duoderm, nuderm, comfeel. Mainly used in venous ulcers, pressure ulcers, diabetic ulcers, 1st and 2nd degree burns.

16. What is composition of betadine?

Ans. It is iodine combined with polyvinylpyrrolidone. It is broad spectrum - effective against gram positive negative bacteria, fungi, viruses and protozoa. Its preoperative application before surgical incision reduces colonization. It decreases fibroblast proliferation and neovascularisation in chronic wound.
17. Tell something about hydrogen peroxide?
Ans. It is inexpensive and widely available. It uses free radical oxygen radical which scavenges the infective pathogens. Mainly used for cleaning and removing loose debris. It maintains aseptic environment but decreases neodermal regeneration and fibroblast proliferation.

18. What is EUSOL?
Ans. EUSOL stands for Edinburg University Solution. It is basically a Chlorinated lime and boric acid solution 0.25% weight/volume of available chlorine. Better activity with freshly prepared solution.

19. What is oxoferrin?
Ans. It is an aqueous solution which contains bio-catalytically activated oxygen carrier. $O_2$ has good tissue penetration capacity thus promotes phagocytosis. It provides good cleaning and good local defense against infection.

20. What are the properties of silver ointment used for dressing?
Ans. Silver ions destroy bacterial cell wall, enzymes, DNA synthesis. Additional anti-inflammatory properties – reduces TNF-$\alpha$ which is responsible for rapid wound healing. It is useful in infective contaminated wound.

21. What are the constituents of neosporin ointment?
Ans. It is a combination of neomycin, bacitracin and polymyxin-b. It is effective against wide range of gram positive and gram negative bacteria.

22. What is traditionally known as three layer dressing?
Ans. The three layer dressing consists of:
1. Contact layer (non-adherent material)
2. Absorptive layer
3. Binding layer (tape)
23. Enumerate the stages or grades of pressure sore?

**Ans.** Given by Shea, recommended by national pressure ulcer advisory panel.

- **Stage I:** Non-blanching erythema (after 30 sec of pressure) of intact skin (partial thickness wound)
- **Stage II:** Partial thickness skin loss involving epidermis, dermis or both (partial thickness wound)
- **Stage III:** Full-thickness skin involved and extending till fascia (full thickness wound)
- **Stage IV:** Full-thickness skin involved and extending to supporting structures (bones, muscles) (full thickness wound)

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**PRINCIPLES OF FRACTURE FIXATION**

(The topic is added only in part to supplement the answers as the viva may be detailed to include the basics of plating and nailing principles. This makes it imperative to have the basic theoretical knowledge also of these. I fully understand that one has a good practical exposure of the same.

*Read: 2-4 times for MS and DNB candidates*

1. What are the various modes in which a plate can be applied?

**Ans.** The following are the various modes of plate fixation:

1. **Neutralisation:** Used to protect primary fixation from torsion, bending, shear. The longer the plate the greater the neutralization capacity.
2. **Buttressing:** Plate directly counters the bending, compressive and shear forces at # site to the applied axial compressive forces. Often used to stabilize periarticular and intraarticular fractures. Epi-physeal and metaphyseal fractures can displace to produce angular deformity.
3. Compression mode: Reduces, stabilize and compresses the fracture site (transverse and short oblique) when lag screw fixation is not possible.

4. Bridging mode: To maintain length and alignment of a severely comminuted and segmental fracture. The plate goes over the main injury site as 'bridge' without further disturbing the fracture region.

5. Tension band: (Adopted by Pauwels): Plates applied over the tensile surface prevent distraction of fracture fragment and by virtue of eccentric holding, also produces counteractive (compression) forces at the opposite side. Thus the distraction forces are converted into compressive forces due to eccentric hold/fixation.

6. Antiglide: The plate is applied in such a way as to hold the distal fragment indirectly and convert the displacing compression forces into reduction compressive forces, for ex., in Weber type B fractures the proximal spike of distal fragment is caught in the plate, with weight bearing the axial forces are transformed to compression forces at fracture site as the fragment is caught between fracture and plate.

7. Locked plates: Where the internal fixation is actually a type of external fixation with the screws locked to both the plate and bone providing an extremely rigid construct. This is beneficial for treatment of complex metaphyseal fractures and osteoporotic fractures but not simple diaphyseal fractures as the callus response may be suppressed and often compression at fracture site is not deliberately tried.

2. What are the principles of buttress plating?
   Ans. This plating acts as a retaining wall if applied properly:
   - Exactly contour the plate
   - Screws should hold plate from moving with respect to bone
   - Screw applied closest to the fracture through oval hole is said to be in buttress mode, minimizing axial movement at fracture.
3. What is spring plate?
Ans. Plate is affixed to only one of the two fragments such that metallic properties of plate help reduce the fracture and hold it (Buttress mode).

4. How do you achieve compression at fracture site?
Ans. By:
1. Overbending the plate
2. Compression device
3. Using plates with dynamic holes that have two inclined and one horizontal cylinders merged together and leads to production of compression with screw tightening (DCP/ LCDCP).

5. What is a ‘Wave plate’ and what are its uses?
Ans. Similar to bridge plate but the plate is contoured away from fracture site. This gives space to insert bone graft in comminuted fractures and at pseudoarthrosis site. In treating nonunions this plate allows for better in-growth of blood vessels, increases the area for bearing stress (decreasing stress at fracture site), can also act as a tension band by compressing the opposite side.

6. What other modalities (aside from plate) can be used to utilize tension band principle and where all can it be used.
Ans. K-wires with metallic suture wires (encirclage wires), screws with encirclage wiring, simple encirclage wiring can all be used at:
• Greater trochanter (femur)
• Patella
• Olecranon
• Greater tuberosity (humerus)
• Acromio-clavicular joint
7. Where do you apply plate in a bone?

**Ans.** On the tensile surface:
- Humerus – anterior in extension and posterior in flexion. (In elbow stiffness associated with non-union, the posterior surface is the tensile surface)
- Radius – lateral
- Ulna – posterior/posterolateral (actually in proximal third posteromedial is tensile but it is difficult to apply plate there)
- Femur – anterolateral
- Tibia – none specifically!

8. What is the principle of nailing?

**Ans.** Three-point fixation for snugly fitting and elastic nails. The solid unreamed interlocking nail acts as splints only. Nail is a load sharing device so that one does not see stress shielding and resulting osteoporosis. There is transmission of force also through the bone and hence fracture site which helps in bone formation and remodeling at fracture.

9. What is the principle of K-nail?

**Ans.** Kuntsher called the nailing as elastic nailing and described the mode of action of nailing to be elastic impingement or radial compliance to explain the mechanism of fixation. According to him the nail was released from the elastic constraint as soon as it is in the medullary canal and expands to grip the canal from inside. However, the mode of action is now considered to be three-pint fixation only. K-nail provides angular (bending), translational (horizontal displacement) and to some extent torsional (rotatory) stability, provides axial compression facilitating callus response.
10. What are various generations of nailing?
Ans. Nailing has evolved over years and consecutive advancements can be grouped under three generations:
- **1st generation nailing** included K-nail, V-nail, clover-leaf nail, etc. that primarily acted as splints. The rotational stability was minimal and primarily relied on snug fit.
- **2nd generation nailing**: The major advantage was improved rotational stability due to locking screws at either ends. They also relied on snug fit. The proximal femoral entry was piriform fossa in all. Here, the nails were classified into centromedullary (Schneider self broaching nail, Hansen-Street diamond nail, Huskstep nail), cephalomedullary (G-K nail, SUN nail, MDN nail, etc.), caudocephalic nails (distal femoral nails), etc. depending on primary mode of action or technique of insertion. This was the most dynamic phase of nail evolution.
- **3rd generation nailing**: With the aid of CAD various design changes to make the nails as anatomical as possible and to aid the insertion and stability have led to development of multiple curve nails and multiple fixation systems, viz. greater trochanteric entry point for femoral nail with additional lateral curve, femoral nail with femoral neck fixation, tibial nail with malleolar fixation, etc.

11. What do you understand by nail length and working length?
Ans. The nail length is considered from the following viewpoints:
- Total nail length
- Length of nail bone contact
- Working length

Total nail length is primarily an anatomical consideration. Nail-bone contact is difficult to calculate but practically determines the resistance to motion which is directly proportional to length of nail-bone contact.

Working length is the length of nail spanning the fracture site from its distal point of fixation in proximal
fragment to the proximal point of fixation in distal fragment. This represents the part of nail not supported by bone and carries load across the fracture site.

12. **What are the implications of working length?**

**Ans.** Working length determines:

- Bending stiffness – inversely proportional to the square of working length
- Torsional stiffness – inversely proportional to the working length
- Strength of construct – the smaller is the working length the stronger is the construct

{Interlocking screws reduce the working length in torsion by fixing the nail to specific part of bone. This also explains why you should impact the fracture before locking the nail. Similarly reaming the canal improves the working length by enhancing the nail-bone contact towards fracture}.

13. **What are the methods of reducing ‘Hoop Stresses’ in nailing?**

**Ans.** Hoop stresses (circumferential expanding forces on the bone walls) are generated when nail is inserted into medullary canal. These may rupture the bone and depend on the insertion force (axial forces converted into radial forces) which, in turn depends on the resistance offered by medullary canal. The following can be done to reduce the hoop stresses:

1. Using a flexible nail
2. Over-reaming the canal
3. Selecting proper entry point.

14. **What is dynamisation?**

**Ans.** In general static locking is preferred in comminuted, segmental, long-oblique and spiral fractures. Dynamic locking is otherwise preferable if at least 50% cortical contact is established. Dynamic locking provides in situ dynamisation with weight bearing (some 5 – 10 mm
reserve is offered by most modern nails). Sometimes, however, in delayed union ‘proximal or distal’ screw is removed to allow telescoping and compression at fracture site and aid healing. This allows axial compression but also takes away the rotational stability. Dynamisation is preferably done between 6-10 weeks.

ARTHROPLASTY OF HIP, ELBOW AND SHOULDER

(The basis of writing this chapter is to acquaint the students with the most popular arthroplasty procedures and not at all to detail them! Only those procedures have been dealt that have some significant mention in the book elsewhere – so deliberately quitting knee arthroplasty. It should be remembered however that the hip arthroplasty is so commonly performed now a days that it is a favourite question once you cross the hurdles of examination points and diagnosis.

Read: 3-5 times (MS Orth and DNB candidates))

ARTHROPLASTY OF HIP

1. **What is arthroplasty?**
   **Ans.** Arthroplasty is a joint reconstructive procedure using natural or synthetic substitutes or reduction methods (excisional) that alter the structure and function of the joint.

2. **What is the principle of low friction arthroplasty as propounded by Sir John Charnley?**
   **Ans.** Low friction arthroplasty principles of Sir John Charnley had the following components:
   1. Thick plastic socket of high molecular weight polyethylene – this is more suited than a metal bearing as it wears less and works best at high loads and slow speed. It is able to self lubricate in dry state.
   2. Small diameter femoral head of stainless steel: The smaller the head the less the wear.
   3. Greater trochanter transferred to more lateral position: Increasing offset
4. Fulcrum displaced medially: Centre of artificial joint is more medial than natural joint.

3. What are various types of hip arthroplasty?

Ans.

Resection arthroplasty: Girdle stone type

Interposition arthroplasty: Various natural and synthetic materials interposed between two articulating surfaces. The materials used are muscle, fascia, fat, synthetic membranes (historically – wood! By Carnochan, gold foil by Sir Robert Jones), etc.

Cup arthroplasty: Special interposition arthroplasty in which a cup was used to separate femoral and acetabular surfaces. Smith-Peterson used glass that was then changed to vitallium cup.

Endoprostheses are of following two types:

1. Hemi-arthroplasty:
   - Monoblock non-modular prosthesis like Austin-Moore and Thompson prosthesis
   - Bipolar prosthesis (Bateman’s prototype prosthesis, etc.)
   - Tripolar prosthesis (Jumbo head prosthesis)

2. Total joint replacement arthroplasty:
   - Cemented THR
   - Non-cemented THR
   - Hybrid THR
   - Surface replacement arthroplasty (classically double cup arthroplasty)
   - Custom made THR with variable calcar/ femoral replacing systems.

4. What is cemented THR?

Ans. A cemented THR is one in which both the femoral and acetabular components are fixed to bone with a cement interface.
5. What do you understand by hybrid THR?
Ans. In hybrid system only the femoral component is cemented whereas the acetabular component is used in a non-cemented fashion.

6. Why was the need of this system felt?
Ans. Over the evolution of THR in the past 50 years it was seen that in a cemented system the acetabular component fails more frequently to the femoral component. There were more complications of cement related bone degeneration like osteolysis on the acetabular side so with the development of non-cemented systems acetabulum was fixed to bone without cement interface. However, as regards the femoral component, sturdy fixation of the stem and early mobilisation was possible with the use of cement interface. Also if at all revision would be required it often is limited to changing of acetabular component or liner so cementing of femoral component was retained as a ‘permanent’ stem. The other major rationale emanaates from different mechanisms of failure of cemented acetabular and femoral components (see below).

7. What are the various mechanisms of failure of cemented acetabular and femoral components, can you correlate these to development of hybrid system?
Ans. Acetabular (cemented) component predominantly fails due to immunological induced bone lysis destroying the fixation ultimately. This induction is done by wear particles.

Femoral (cemented) component whereas loosens predominantly for mechanical reasons. Early failure is related to thin cement mantle whereas long term failure is due to loosening at cement metal interface at the tip and higher up seen more frequently with first-generation cementing techniques.

Cementless fixation of femoral stem developed with the hope of reducing above however fared poorly and on the contrary more frequent and progressive lysis was
observed seen in anatomic modular locking (AML), Allopro prosthesis (APR), Harris-Galante prosthesis (HGP) and porous coated anatomic (PCA) systems.

Considering the above results one would naturally be intended to use a cemented femoral and cementless acetabular component (hybrid system).

(Philosophies and schools differ and may continue to do so endlessly – may be till total robotic age comes up! When there will be no ‘soft tissue’ and only metal prevails)

8. What decides the use of a cemented or noncemented or a hybrid THR?

**Ans.** Primarily the decision is based upon the age of patient and bone stock (Dorr classification type A – complete funnelisation (ideal for cementless stem) type C – No funnel, B – intermediate). Requirement for mobility and disease condition for which replacement has been planned are also important while deciding type of prosthesis to use. Elderly patients with poor bone stalk are better dealt with cement augmentation of bone and hence cemented THR. Also for patients requiring early mobilisation and those with limited longevity (viz. tumour patients) cemented components are preferred. Non-cemented prostheses are preferred for younger patients.

9. Can you name some cemented femoral and acetabular components that have evolved over time?

**Ans.**

Cemented acetabular cups:
- Charnley’s plastic cup
- Modified Charnley’s cup
- Buchholtz cup
- Peg cups, etc

Cemented femoral stems (these may be curved/straight, collared/collarless, textured/smooth, bowed/straight):
- McKee-Farrar (metal on metal)
- Charnley femoral stem (metal on plastic) with 22.25 mm head
Muller femoral stem with 32 mm head (medial ridge - 'saber') and with a curve to ease insertion

Harris femoral component (HD-2): 32 mm head with moderate undercut and oval neck around 3 cm of proximal stem was precoated with PMMA for better fixation.

Amstutz femoral component (TR-28): Modified Charnley component to a head size of 28 mm and a thicker stem (but not wider).

Aufranc-Turner component: Similar to Muller cup but the head is more undercut.
(A collarless, polished, straight stem subsides well into the cement and converts load into hoop stresses)

10. What are the various cementing techniques?

**Ans.** Over a time refinements in the way cement was applied to the components have led to developments into generations in cementing:

- **First generation:** Finger packing, no distal plug.
- **Second generation:** Distal plug of canal, ‘preparation’ of canal with pulsed lavage, distal centraliser and use of cement gun to insert the cement in a retrograde fashion.
- **Third generation:** Precooling of cement, vacuum mixing and centrifugation, pressurization of cement by use of proximal seal.
- **Fourth generation:** In addition, this uses a proximal centralizer to ensure symmetric cement mantle.

During the same periods there were some ‘implant characteristics’ that improved however they are not grouped into generations. In the first generation the implants had ‘sharp’ borders that used to split the mantle and were prone to ‘mid-stem pivot effect’ whereby there was excessive medial pressure in the proximal portion and lateral pressure distally. In the second generation the implants were made of superalloys and sharp corners were removed. During third generation the surface characteristics were improved to increase bonding.
11. How much cement mantle is considered adequate?
Ans. 2-5 mm. The place where cement is missing or very thin is called ‘mantle defect’ and is often the site of failure.

12. What is cement disease?
Ans. “Cement disease” applies to the previously prevailing concept of ill effects on the body and local bone due to leakage of hot monomer, thermal injury during curing phase, degradation and release of particles including contrast. Seemingly there is no strong biological backing for this mundane term.

13. What are the various types of cements available?
Ans. There is no standard classification but the available types of cements evolved on the needs of different types of procedures:
• **High viscosity cements**: Standard arthroplasty procedures now not preferred.
• **Low viscosity cements**: The most commonly used cement, surface replacement and vertebroplasty (very low viscosity cement).
• **Antibiotic impregnated cements**: Revision and infection in arthroplasty, spacer, cement beads for defect management in chronic osteomyelitis.
• **Cold curing cements (Mjoberg)** using butyl methacrylate.
• **Biodegradable aqueous gel phase cement**.

14. What are the components of standard cement?
Ans. Cement is provided as biphasic module (2-3 parts powder and one part monomer liquid). The solid phase comprises powder form microbeads (1-100μm) of polymerized component (PMMA) with opacifier (barium sulfate or zirconium oxide) and initiator (benzoyl peroxide). The liquid phase consists of monomer methyl methacrylate and co-initiator (aka activator – Dimethyl-p-Toulidine, DMPT) along with stabilizers to prevent autopolymerisation (hydroquinone and /or ascorbic acid).
colouring agents like chlorophyllin can be added to any phase while antibiotics are added only to solid (powder) phase.

15. **What are the various antibiotics that can be used?**

   **Ans.** Most commonly used are aminoglycosides, vancomycin. However, the β-lactams, cephalosporins, macrolides, quinolones, doxycycline can all be used. Basically the antibiotic should be heat stable, water soluble, hypoallergic, bactericidal and available as a powder.

16. **What are the various phases of polymerization?**

   **Ans.**
   1. Mixing phase: Wetting
   2. Waiting phase: Swelling + polymerization, ↓ viscosity, sticky dough
   4. Setting phase: chain growth finished, no movability, high temperature
      There is shrinkage of the mix finally and the whole process is exothermic (heat of polymerization = 43-46°C).

17. **What is the effect of precooling/ warming of prosthesis?**

   **Ans.** Both are deleterious. Precooling leads to shrinkage of the material at cement-prosthesis interphase – early loosening. Prewarming leads to ↓ conductive capacity of prosthesis → heat necrosis → early loosening. (So warm prosthesis till body temperature)

18. **What are the effects of vacuum mixing and centrifugation?**

   **Ans.** Vacuum mixing results in ↑ in bending strength by 15-30%.
   
   Centrifugation improves the fatigue strength by ≈ 9%.
   
   Precooling of monomer, polymer and mixing vessels ↓ number and volume of pores.
19. **What are the various bearing surfaces?**

**Ans.** The most popular one is metal (cobalt-chrome alloy) on UHMWPE (ultra high molecular weight polyethylene). The others are:
- Metal on metal
- Ceramic on UHMWPE
- Ceramic on ceramic (alumina on alumina third generation bearings)
- Failed bearing surfaces:
  - Ceramic on metal: High frictional torque and wear
  - Titanium on polyethylene: High wear typically third body wear.

20. **What are the various types of cementless stems?**

**Ans.** There are three methods of cementless stem fixation:
1. **Press-fit:** Moore and Thompson prototype stems, Lord and Sivash femoral stems. These rely on the development of bone ‘around’ stem to give a tight fit.
2. **Macro-interlock:** Here the press-fit is supplemented by mechanically carving out ribs, threads, steps, etc. in the stem.
3. **Porous coated stems (modern stems):** The porous coating could be of hydroxyapatite (ceramic pore size ≈ 50 μm) or spongy metal porous coating in the form of small spherical beads (cobalt-chrome/ titanium, pore size of 50-400μm) or mesh applied by sintering or diffusion bonding. Bone ‘ingrowth’ is considered optimal if micromotion is <20μm at bone-implant interface. Some examples are AML, HGP, PCA stems. For porous coated ceramic stems; the cells migrate into the pores (osteo-conduction) and bone may form from the coating itself! The following characteristics are found:
   a. **Diaphyseal (distal) fit or metaphyseal (proximal) fit:** Latter is preferred. In the former one there is complete porosity over the surface that may stress shield the metaphysis due to early distal fit and lead to metaphyseal bone loss and are also prone to cause thigh pain. The metaphyseal fit stems to have only proximal porous coating.
b. **Anatomical or straight stems**: The former have proximal posterior bow and a variable distal anterior bow (only for revision long stems). This mandates side determination for prosthesis as anteversion is also additionally built into the neck.

c. **Circumferential or patchy porous coating**: Newer designs have circumferential coating earlier designs had patchy coating that served to circulate particulate debris around the stem – “effective joint space”.

d. **Collared or a collarless stem**: Collar in a cementless stem is useless! As if collar fits before stem fit – stability is compromised, if stem fits before collar is seated it is ineffectual.

21. **What is the rationale for using recently launched large head bearings?**

   **Ans.** Large head with limited endoprosthetic components that waste a very limited amount of patients bone has been popularized as surface replacement arthroplasty. Also there are various modular components which can fit large metal bearings on standard endoprosthetic components. The highly polished surfaces provide very limited wear and improved stability and range of motion as compared to the conventional arthroplasty.

22. **What are various types of wear seen in THR?**

   **Ans.** Wear is the loss of rubbing surfaces due to repetitive motion and friction.

   1. **Abrasive**: Due to rubbing of two hard surfaces
   2. **Adhesive**: Rubbing of a soft surface onto a hard one in which the former is transferred as a thin film over the latter.
   3. **Fatigue**: Due to repetitive loading
   4. **Corrosive wear**: Due to different types of metals (Galvanic), etc.

   **Linear wear**: With linear wear the head penetrates into the acetabulum due to high contact pressure (linear distance travelled by head). This wear is more common with smaller heads (say 22 mm). *(The smaller heads may also*
penetrate the acetabulum due to ‘cold flow’ of plastic — plastic deformation).

Volumetric wear: This is due to frictional torque and is more with larger (say 32 mm) heads! (You see why we use 28 mm heads. The larger heads have again come in vogue due to improvement in plastic characteristics – the highly cross-linked polyethylene)

23. What are the indications of total hip arthroplasty?
Ans. Primary and secondary osteoarthritis, osteonecrosis, inflammatory arthritis, dysplastic hip, PFFD, pathological fracture of proximal femur, conversion of arthrodesis into arthroplasty, etc.

24. What are the contraindications of hip arthroplasty?
Ans. Absolute: Active or latent infection at local/ distant site, medically unfit patient with a high risk to benefit ratio. Relative: Neuropathic arthropathy, rapid bone destruction, insufficiency of abductor mechanism, rapidly progressive neurological disease.

25. What are the complications of THR?
Ans. Various complications are seen; all related to major surgical procedure and to prosthesis fixation itself:
Early: Fat embolism, deep vein thrombosis, thromboembolism, dislocation, infection. Renal failure.
Late: Loosening and osteolysis, wear, thigh pain, lurch, protrusion, heterotopic ossification, peri-prosthetic fractures.

ELBOW ARTHROPLASTY

1. What are the indications of elbow arthroplasty?
Ans. Age >60 years, advanced arthritis or post-traumatic destruction of joint in a low demand patient.
2. What are the various types of elbow prosthesis?
Ans. Semi-constrained (linked prosthesis) like GBS III elbow and Coonard-Morrey prosthesis and unconstrained or unlinked prosthesis like Kudo and IBP elbow.

3. What are the prerequisites for unconstrained prosthesis?
Ans. There should be good bone stock, little deformity, stable capsuloligamentous support.

4. What are the indications for unconstrained prosthesis?
Ans. Elderly patients with rheumatoid arthritis, painless ankylosed elbow, e.g. Juvenile rheumatoid arthritis.

5. What is the prosthetic choice for post traumatic elbow?
Ans. Constrained (linked) prosthesis as the capsuloligamentous structures are damaged.

6. What are the indications for constrained elbow prosthesis?
Ans. Deficient bone stock, unstable capsuloligamentous support, deformed joint.

7. What is Bakshi's sloppy hinge prosthesis?
Ans. It is a type of semi-constrained linked prosthesis with a loose hinge (sloppy) to partially compensate for the rotational stress on the prosthesis hinge.

8. What are the limitations after total elbow arthroplasty?
Ans. The person cannot lift weight >5 Kg and should avoid contact sports for life time.

SHOULDER ARTHROPLASTY

1. What are the indications of shoulder arthroplasty?
Ans. In general shoulder arthroplasty is recommended for patients with symptomatic gleno humeral arthritis (osteoarthritis, rheumatoid arthritis), traumatic arthritis, osteonecrosis, rotator cuff arthropathy and four part non-reconstructible proximal humerus fractures.
2. What are the various options available?

Ans.
- Hemiarthroplasty
- Total shoulder arthroplasty
- Reverse shoulder arthroplasty

3. When do you decide between hemi and total shoulder replacements?

Ans. The demarcation is vague and controversial but the following guidelines are generally followed: Always first look at two crucial components to be restore – arthritis and instability.

**Hemiarthroplasty (HSA):**
- Rough and destroyed humeral articular surface with intact glenoid cartilage with enough glenoid to stabilize the humeral prosthetic head
- There is insufficient bone to support glenoid component with irreparable cuff tears
- Fixed upward displacement of humeral head relative to glenoid
- History of remote joint infection
- Heavy demands anticipated for the joint
- Four-part non-reconstructable fracture of humeral head.

**Total shoulder arthroplasty (TSA)**
- Incongruent joint surfaces
- Normal or repairable cuff tears
- Loss of articular cartilage on both surfaces

**Reverse total shoulder arthroplasty (rTSA)**
- Arthritis and/or instability from non-reconstructable soft tissue or osseous defects
- Posterior aspect of capsule and rotator cuff have been lost.
- ‘Antero-superior escape’ due to coracoacromial arch deficiency (wear, fracture, acromioplasty!)
- Slackened deltoid unable to lift the humerus for abduction ‘pseudoparalysis’.
- Failed previous conventional arthroplasty.
4. **What is reverse total shoulder prosthesis?**

**Ans.** This prosthesis involves making glenoid ‘ball’ that articulates with concave humeral trumpet shaped component, in effect it is reversal of the normal anatomical joint.

5. **What are the prerequisites for hemiarthroplasty?**

**Ans.** (This is the most popular procedure world over. Total shoulder needs expertise and overall the indications are not very clear. Reverse total shoulder is mentioned only for candidate to have an idea that this relatively new system exists. The experience is very limited and results not extensively quantified or qualified. So at the summit it becomes clear that if asked about shoulder arthroplasty then hemiarthroplasty will be the choice- unless furiously refrained to by an occasional examiner)

- Concentric glenoid consisting of eburnated bone
- Non-concentric glenoid that can be converted to a smooth concentric surface by reaming
- The humeral head can be centered in the glenoid by soft tissue balancing and glenoid preparation
- The surgeon is proficient with soft tissue and osseous procedures!

6. **What is the rationale for development of reverse total shoulder arthroplasty?**

**Ans.** There are various limitations for conventional shoulder arthroplasty that could be addressed by reverse total shoulder arthroplasty as follows:

- Limitation of TSA/HSA to manage glenohumeral translation: For the exquisite ROM of a normal shoulder there is translation of humeral head especially at the ends. This is limited in perfectly conforming joint surfaces of TSA/ HSA.
- Limited fixation of glenoid component to bone in TSA
- Limited intrinsic stability of TSA/ HSA: (See above for indications of rTSA). The TSA/ HSA can be done for the following conditions:
  - Arthritis/instability due to deficiency of humeral head (HSA)
- Arthritis/instability due to deficient glenoid that can be reconstructed (TSA)
- Arthritis + acute reparable rotator cuff tears (HSA/TSA)
- Arthritis + excessive capsular laxity: Tightening + large head HSA/TSA with increased lateral offset and tissue balancing
- Arthritis + upward displacement of humeral head (intact coraco-acromial arch) (HSA/TSA)

• Limited ability for compensation of deltoïd dysfunction

*These are the most preferred explanations for development and use of rTSA, results are beginning to come and have been satisfactory*

7. **What are the limitations of shoulder arthroplasty?**

**Ans.**
- Skin, vascular, osseous deficiency
- Infection
- Deltoid deficiency, limited scapular mobility
- Unfit patients (medical, emotional, motivational issues)

8. **What are the differences of shoulder arthroplasty as compared to hip arthroplasty?**

**Ans.**
- Shoulder arthroplasty depends upon soft tissue balancing primarily
- The humeral head is in retroversion (femoral head is anteverted)
- Glenoid is in minimal retroversion (acetabulum is anteverted)
- The approach to shoulder is anterior (hip is posterior/lateral)
- The glenoid surface (concave surface) is small and humeral surface (convex surface) is larger (in THR femoral head is smaller than acetabulum) *(This ‘issue’ is also resolved by reverse shoulder!!).*