Basic Surgical Principles of Amputations and Disarticulations of the Upper and Lower Extremities
Indications to Amputations

1. Trauma and its complications (anaerobic infection, osteomyelitis)

2. Malignant tumors of skeleton and soft tissues of limbs

3. Vascular diseases (thrombosis, diabetic angiopathy, obliterating endarteritis)
Classification of Amputations

- **Primary amputation** (within first 24 hours)
- **Secondary amputation** (7-8 days after injury)
- **Re-amputation** (repeated amputation)
Steps of Amputation

I. Cutting of soft tissue

II. Treatment of periosteum and cutting of bone

III. Stump treatment
Types of Amputations
(according to soft tissues cutting)

1. Flap amputations:
   A - single-flap amputation
   B - double-flap amputation

(A) [Diagram of single-flap amputation]
(B) [Diagram of double-flap amputation]
Single-flap amputation

Bone stump is covered by one flap formed from skin, subcutaneous tissue, superficial and proper fascia. This type of amputation is called as fascioplastic. If a flap contains periosteum, it will be fascioperiosteoplastastic method.

- After creation of a flap a postoperative scar must be located on non-working (unbearing) surface of stump.
Single-flap amputation

*Working surfaces* for:

- Lower extremity: anterior and lower
- Upper extremity: palmar
- I finger – palmar and ulnar surfaces
- II finger – palmar and radial surfaces
- V finger – palmar and ulnar surfaces
- III, IV fingers – palmar surface.
Amputation of the Fingers

Grade 1
Grade 2
Grade 3
Grade 4
Double-flap amputation

- bone stump is covered by two flaps created from opposite limb surfaces. This type of amputation could be fascioplastic and fascioperiosteoplastic.

- It is very important to calculate a length of creating flap. This calculation we can express by the formula of length of circumference:

- $C=2\pi r$ or $C=\pi d$, 

• Where \( C \) – length of circumference
• \( \pi \) – constant value, 3,14
• \( r \) – radius of circumference of limb at level of amputation
• \( d \) – diameter of circumference.
• In case of single-flap amputation length of flap is equal to diameter of a limb at level of amputation.
• \( C=2\pi r=\pi d \)
• \( D=C/\pi=C/3,14\approx C/3. \)
• So, diameter is equal to one third of circumference of limb. A circumference we can measure (evaluate) by any lace (belt).
• As you understand, when we measure the circumference of limb at level of amputation and this number divide by three we will get length of flap in case of single-flap amputation.
• In case of double-flap amputation lengths of both flaps in sum must be equal to diameter of limb at level of amputation. Longer flap is equal to \( \frac{2}{3} \) of diameter, shorter – to \( \frac{1}{3} \) of diameter.

• Except this, it is necessary to take into account a skin contractile (retrench).

• We must add some cm to flap length for calculation of coefficient (factor) of skin contraction.

• Coefficient of skin contraction

• \( K=\frac{1}{6}*C \) or \( K=C/6 \).

• This value is divided by two.
Types of Amputations
(according to soft tissues cutting)

2. Circular amputations:
- one-step (guillotine) amputation
- two-step amputation (variety – “cuff” method of forearm amputation)
- three-step (conical-circular) amputation
• **One-step amputation** (guillotine amputation). All soft tissues (skin, subcutaneous tissue, superficial and proper fasciae, and muscles) are cutted the limb across at the level of amputation. Cutting of a bone on the same level.

• It is an amputation that could be done quickly, and speed of surgery is sometimes very essential (anaerobic infection, for example). **But this type of amputation needs re-amputation in any cases because of faulty stump forming.** After healing of the wound by secondary infection, revision of the stump usually is necessary to make it suitable for wearing a prosthesis comfortably.
• **Two-step amputation.** Soft tissues are cutted in two motions (stages):

  • first – skin, subcutaneous tissue, superficial and proper faciae,

  • second – cutting of muscles at level of contracted skin.

• Deficiency of this method is forming of a scar at bearing or working surface of the stump.

• Variety of two-step circular amputation is forearm amputation by “cuff” method.

• First step – cutting of skin, subcutaneous tissue, superficial and proper faciae. Then all these layers are separated and tucked up like a cuff of sleeve in proximal direction of a limb. Length of a cuff is calculated like in case of double-flap amputation. But use smaller diameter of forearm at level of amputation (because it has ellipse-shaped form). Second step – muscle cutting until the bone at level of turned cuff.
• **Three-step amputation.**

• As usual, this type of amputation is performed on thigh or arm (where just one bone is present). In this case soft tissues are cutted in three motions on different levels.

• First step – cutting of skin, subcutaneous tissue, superficial and proper faciae.

• Second step – cutting of superficial muscles at level of contracted skin.

• Third step – cutting of deep muscles.

• Another name of three-step amputation is conico-circular amputation because soft tissues are cutted by circular method. As result of different levels cutting we’ll have cone-shaped stump with apex situated on bone-stump.

• Merit: three-step circular amputation is easy to perform.
• Deficiency: 1) this method is uneconomical. In the same time flap amputations use tissues more economical but it is difficult to perform.

• 2) forming of central postoperative scar that situated on bearing surface of stump.

• Conico-circular amputation is indicated in case of gas infection.

• So, guillotine amputation (one-step) and conico-circular amputation (three-step) are preliminary and need re-amputation for prosthetics.
Standard Above-knee Amputation (AKA)
Stages of Transfemoral Amputation
Transfemoral amputation – Above-knee Amputation: marking-out of skin flaps
Creating of Flaps and Cutting of Soft Tissues
Methods of Periosteum Treatment

1. Periosteal

2. Aperiosteal
   Amputation with removal of periosteum from bone at the site of amputation.

3. Subperiosteal
Treatment of Periosteum and Cutting of Bone
Exposure and Ligation of Main Vessels
Arrest of Bleeding from Small Vessels by Electro coagulation after Removing of Tourniquet
Exposure and Cutting of Nervous Trunks
Stitching of Soft Tissues above Bone Stump and Draining of Wound
Aseptic Bandage and Immobilization of the Limb Stump
The most common complications of amputation are:

- massive haemorrhage that occurs when a suture becomes loose
- infection
- rash, blisters, and skin breakdown caused by immobility, pressure, and other sources of irritation
- pneumonia, blood clots, and breathing problems associated with immobility
- formation of nerve cell tumors (neuromas) at severed nerve endings
Complications of Amputation

- **Mistakes of I step of amputation:**
  1. conical stump
  2. mace-shaped stump

- **Mistakes of II step of amputation:**
  3. terminal necrosis of bone
  4. forming of large osteophytes

- **Mistakes of III step of amputation:**
  5. forming of trophic ulcers
  6. phantom pain

- 7. **Chronic osteomyelitis** caused by secondary infection inside a wound
Osteo-plastic Amputations
(Gritti-Stokes and Sabanajeff amputations)
Pirogoff Amputation
Callander Amputation
(this gives an excellent end-bearing stump)
Below-knee Amputation
Amputation in Middle Third of Leg
Schemes of Foot Amputations

Disarticulation at metatarsophalangeal joints

Long plantar flap for toe amputation

Long dorsal flap for toe amputation

Amputation of lateral toes & rays
3rd, 4th & 5th
2nd, 3rd, 4th & 5th

Chopart

Lisfranc

Transmetatarsal

Syme

Metatarsophalangeal disarticulation

Toe amputation disarticulation
Syme Amputation
Sites of Election for Amputations of Upper Extremity
Finger Amputation

A. Awkward stump.
B. Better amputation than A.
C. Most satisfactory type.

Finger amputation

Poor type amputation. Better to remove entire 3rd metacarpal
Different Types of Prosthesis
Thank You for Attention!