Institute of Surgical Research

Bio-instrumentation / Monitoring

B 1-2. practicals – Introduction to invasive monitoring
(Tools of volume correction, injections, infusions, intravenous fluids, technique of blood sampling, ex vivo venous cannulation)

B 3-4. practicals – Monitoring of the cardiovascular system

B 5-6. practicals – Complex monitoring

Tools of volume correction 1.

Syringes and hypodermic needles:

- Plastic, sterile and single-use syringes are used (*Luer*)
- The volume ranges from 1,to 2, 5, 10, 20, 25, 50, 60 ml
- Needles are made of stainless steel, size is classified according to a color-coded scale

„Butterfly" needles:

- Needle and cannula
- Flexible plastic wings
- Very useful in case of thinner veins

Tools of volume correction 2.

Peripheral cannulas (Branules):

- Combination of needle and catheter
- Parts: plastic catheter, metal needle, injection port with valve, blood chamber, plastic wings

Tools of volume correction 3.

The 3-way stopcock

Technique of blood sampling 1.

- The patient is lying or sitting, supported by the elbows and
- with arms extended
- Palpate with fingers to identify a vein with a large lumen
- Hanging the arm down and application of muscle pump helps visualizing th vein
- Compress the cuff centrally to the vein
- Disinfect the skin area of the puncture and wait for 15-30 sec
- The skin above the vein should be strained to block the movement of the vessel
- The needle is introduced with face turned upward into the skin, at an angle of 30^{o} to the skin surface, paralell to the axis of the vein
- The patient must not smoke and should be on an empty stomach

Technique of blood sampling 2.

Blood sampling tubes:

- Sample is first taken into the serum (white/yellow) tube
- The second tube serves for the determination of coagulation factors
- Tubes should be filled exactly for correct dilution
- Blood samples should be sent to the laboratory as soon as possible and must not be stored in fridge

The injections 1.

General rules:

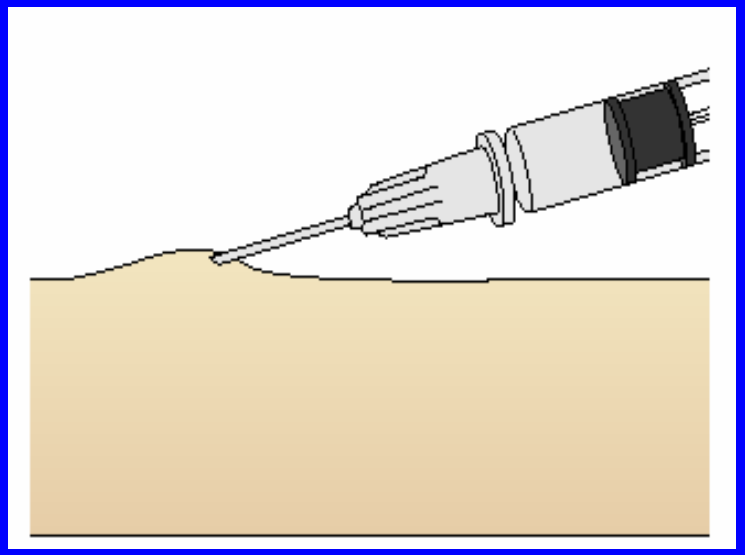
- Before injection the skin must be disinfected carefully
- The air must be removed from the syringe
- After an ampoule is opened, the drug most be utilized in a short time
- When the drug is sucked out, the needle must not touch the outside of the ampoule
- When the drug is sucked out, change the needle before administration
- In case of powder vials the diluent is first added to the vial, the vial is shaken and the solution is sucked into the syringe
- The drug must be checked carefully before administration!

(Once you have injected a solution, it cannot be removed!)

The injections 2.

Intracutaneous injection:

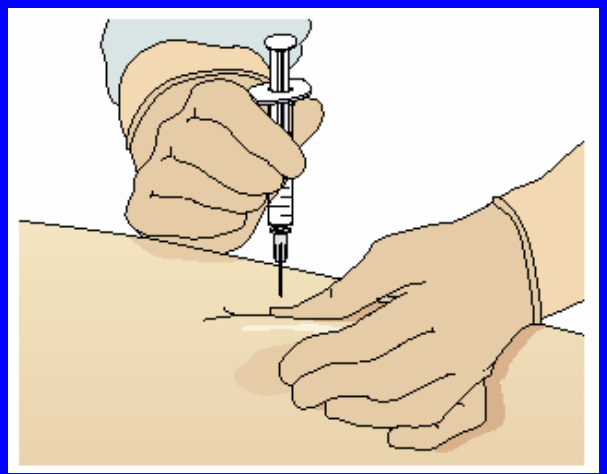
- This is administered to layers of the skin
- Aim: allergy testing, tuberculosis screening
- A tuberculin type syringe and thin needle are used
- The needle should be inserted at an angle of 10-20^{o}
- Sites: inner forearm, posterior of upper arm



The injections 3.

Subcutaneous injection

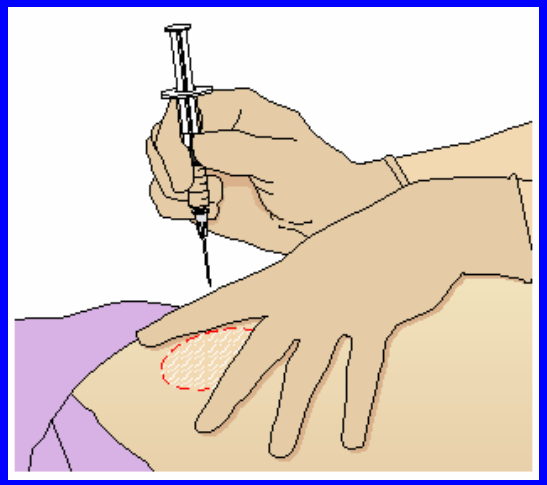
- This is administered into the fat or connective tissue underlying the skin (insulin and heparin)
- Thin needle is applied
- The skin should be gently pinched into a fold to elevate the sc. tissue. The injection should be given at an angle of 45^{o} into the raised skin fold
- Sites: external upper third of the upper arm, abdomen, externa medial area of the thigh

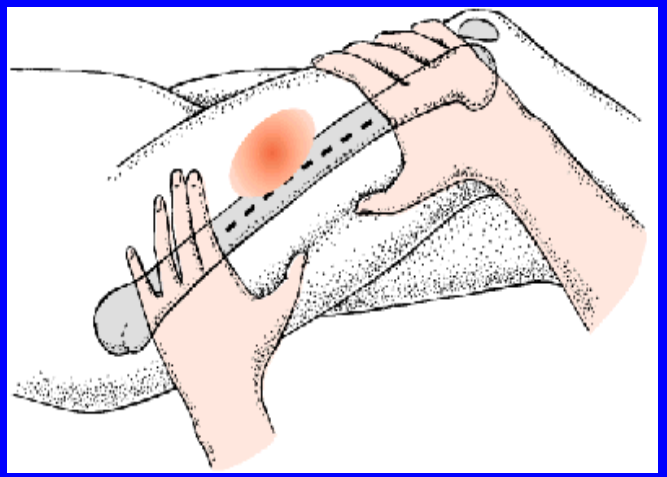


The injections 4.

Intramuscular injection

- This is used for the injection of a larger volume (max. 5 ml)
- The needle should be inserted at an angle of 90^{o}
- The skin should be stretched
- Sites: gluteal muscle, lateral side of the femoral muscle
- Contraindicated for patients treated with anticoagulants

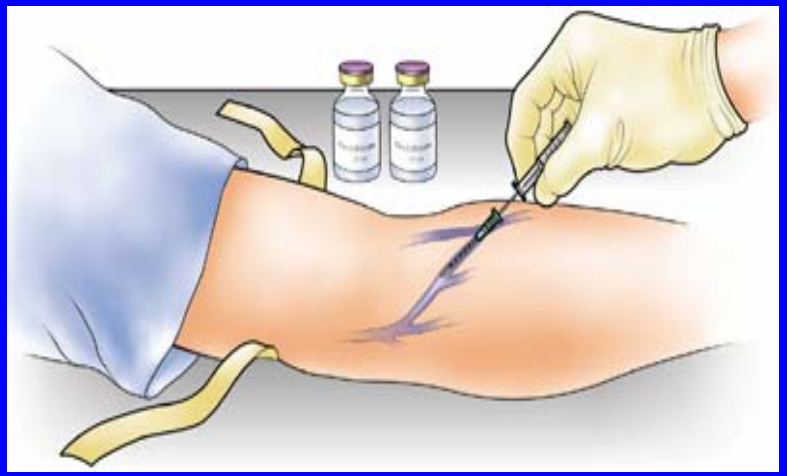




The injections 5.

Intravenous injection:

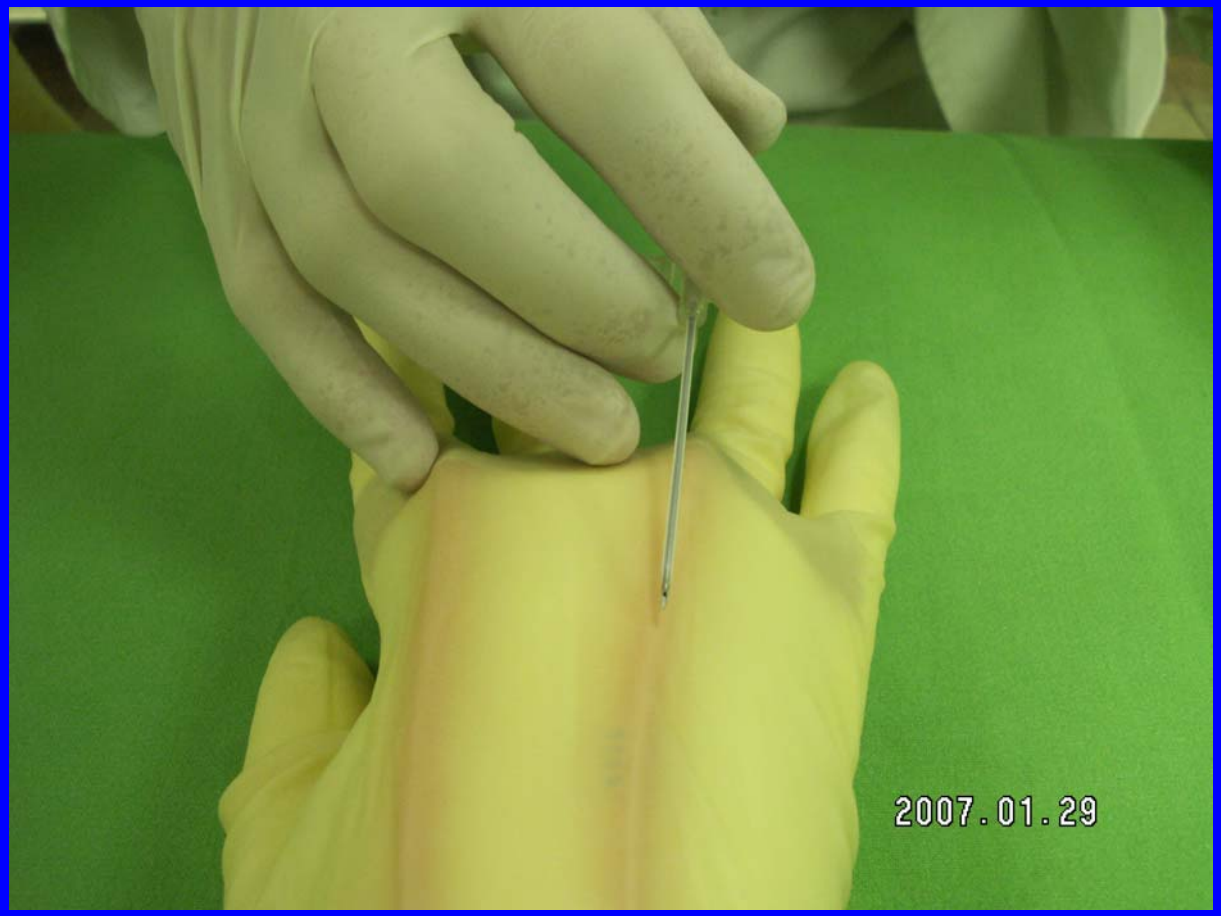
- Fast effect
- Use a tourniquet; the vein must be punctured at an angle of 30-45^{o}
- Once the needle is in place, it is helpful to draw blood
- Torniquet is released and injection is given slowly
- Sites: v. mediana cubiti, v. cephalica, dorsal veins of hand, foo



Introduction of Braunule 1.

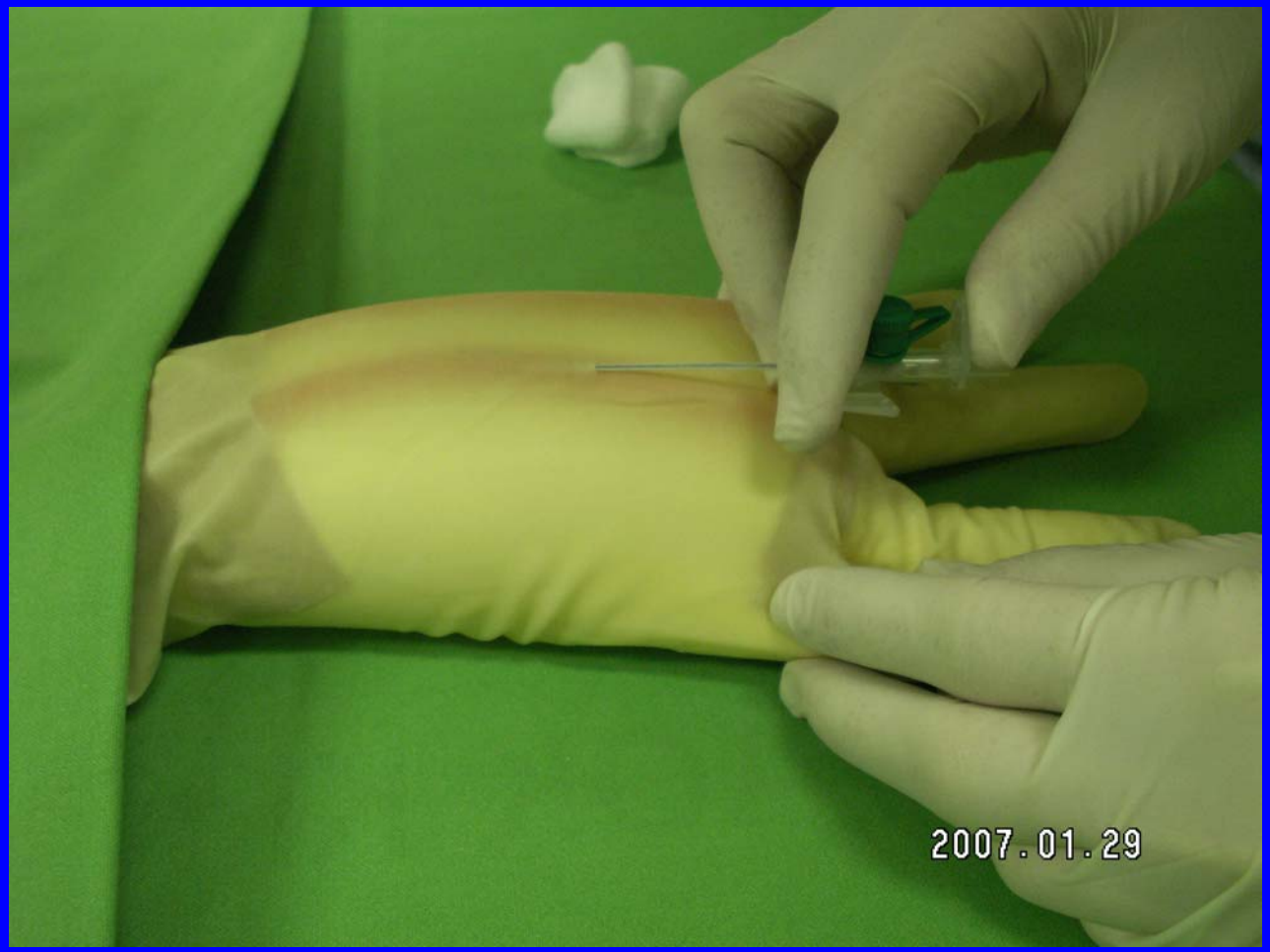
Inection port is grasped with the index and middle fingers; stopper is held with the thumb

Introduction of Braunule 2.



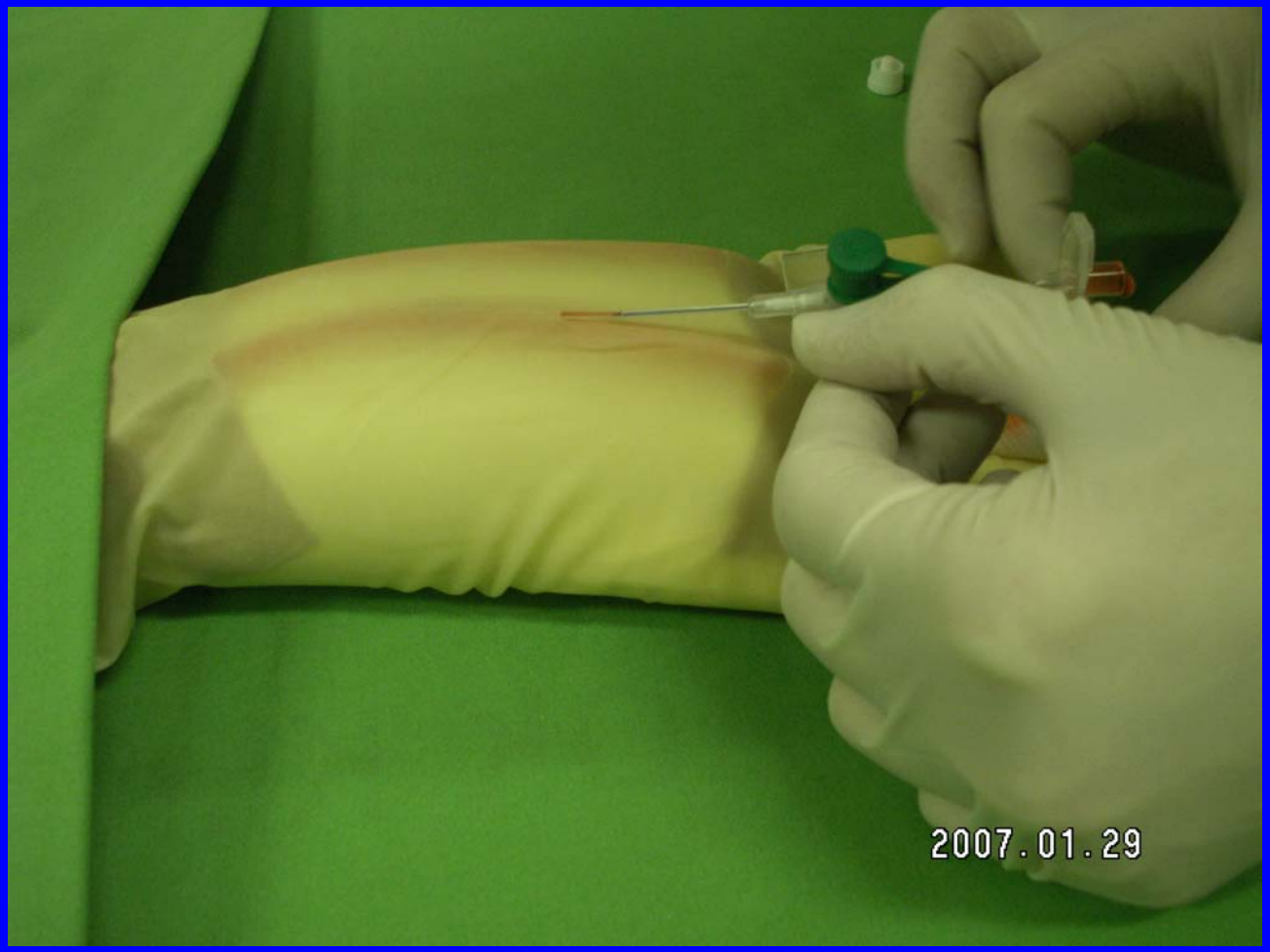
The catheter is pushed into the vein at an angle of 30-45^{o}

Introduction of Braunule 3.



The skin, the sc. tissue and the wall of the vessel should be penetrated in one continuous movement

Introduction of Braunule 4.



The needle is drawn back and catheter is pushed forward

Introduction of Braunule 5.

When the catheter is in the optimal position, the needle is removed and the Braunule is fixed

The infusions 1.

Indications

- Fluid intake
- Electrolyte imbalances
- Parenteral nutrition
- Administration of drugs
- Keeping the intravenous line open

Be careful in case of:

- Decomensated heart insufficiency
- Edema of lung and brain
- Hyperhydration
- Oliguria, anuria

The infusions 2.

Devices for iv. infusion

- Sterile infusion bag
- Sterile administration set
- Hypodermic needle
- Disinfecting solution
- Gauze
- Tapes
- Infusion stand

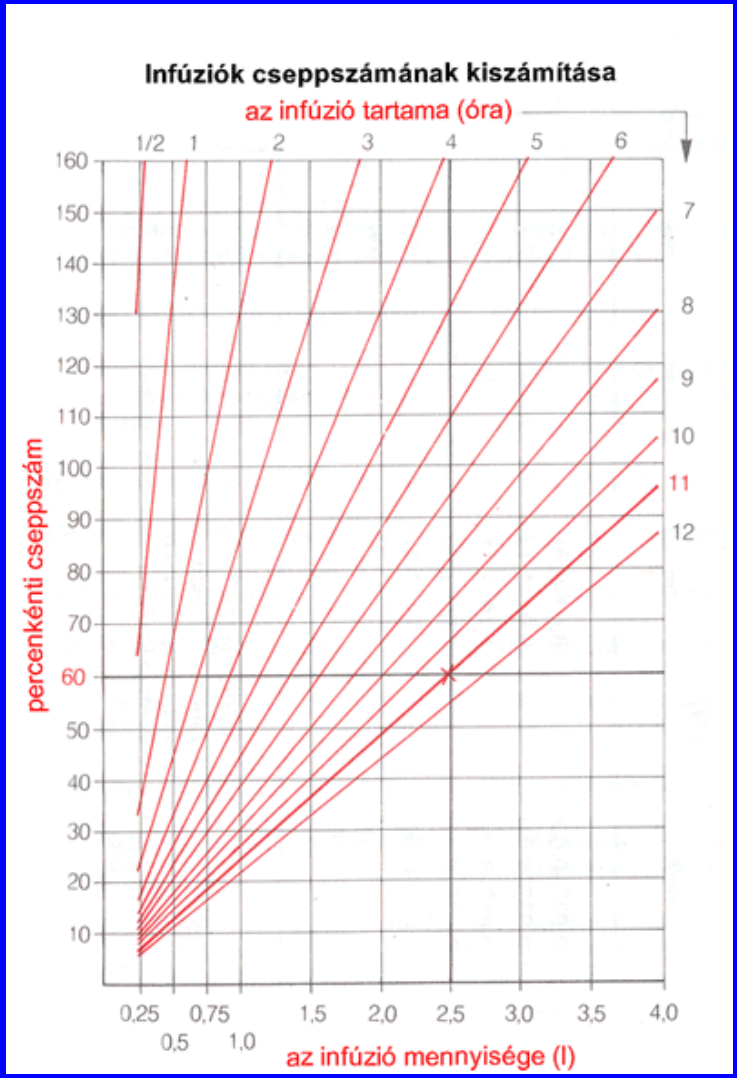
The administration of the infusion

- The spike is inserted into the bag
- The bag is hung on the stand
- The lower part of the drip chamber is squeezed to set the fluid level (one-third full)
- The air should be removed from the tube
- The flow rate is adjusted as desired

The infusions 3.

Dosage of infusion

- Macrodrip:
  10-15 drops/ml
- Microdrip:
  60 drops/ml
- The amount of infusion depends on different factors: age, body surface area physical condition, osmolarity of the infusion fluid



The infusion pumps 1.

Aims

- Slow administration of drugs
- Precise control of flow rate even in case of small volumes

Volumetric infusion pump

- Electric or battery-operated peristaltic mechanism
- The flow rate and volume can be preset

The infusion pumps 2.

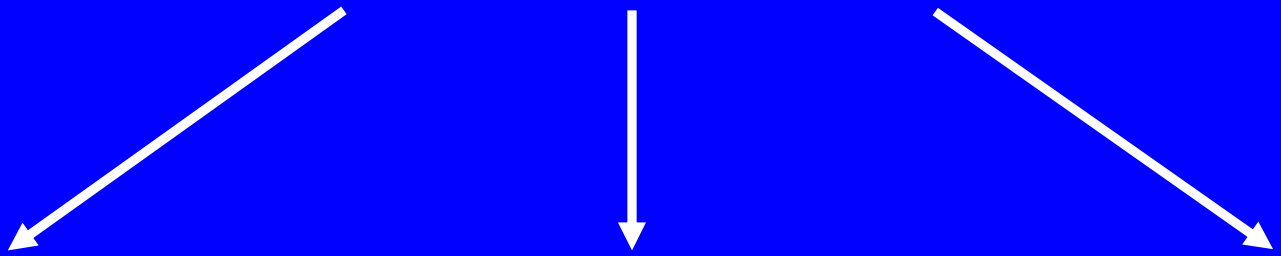
Syringe infusion pump

- Facilitates the long-term continuous delivery of small volume with different type of syringes
- Can be placed on each other like a tower

Patient-controlled analgesia

- Small, battery-operated, portable pump
- The patient administers the pain-killing drug whenever he/she needs it

Intravenous fluids



Crystalloids **Colloids** **Blood products**

Crystalloids 1.

- These are combination of water and electrolytes
- They are appropriate for treatment of hypovolaemia and to initiate the treatment of hypovolaemic shock
- Isotonic crystalloids: electrolyte composition and osmolarity are similar to those of plasma
- They may induce edema
- Large amount may lead to acidosis

Crystalloids 2.

Saline

Composition: Na^+: 154 mmol/l, Cl^-: 154 mmol/l

Indication: bleeding, burning, injuries, hypotonic dehydration, carrier

Contraindications: hypertonic dehydration, edema. hyperchloraemia, metabolic acidosis

Lactated Ringer's solution

Composition: Na^+: 130,2 mmol/l, K^+: 5,4 mmol/l, Ca^{2+}: 0,9 Immol/l, Mg^{2+}: 1,0 mmol/l, Cl^-: 112,2 mmol/l, lactate: 27,2 mmol/l

Indications: acute and chronic loss of extracellular fluid, carrier

Advantage: protects from acidosis

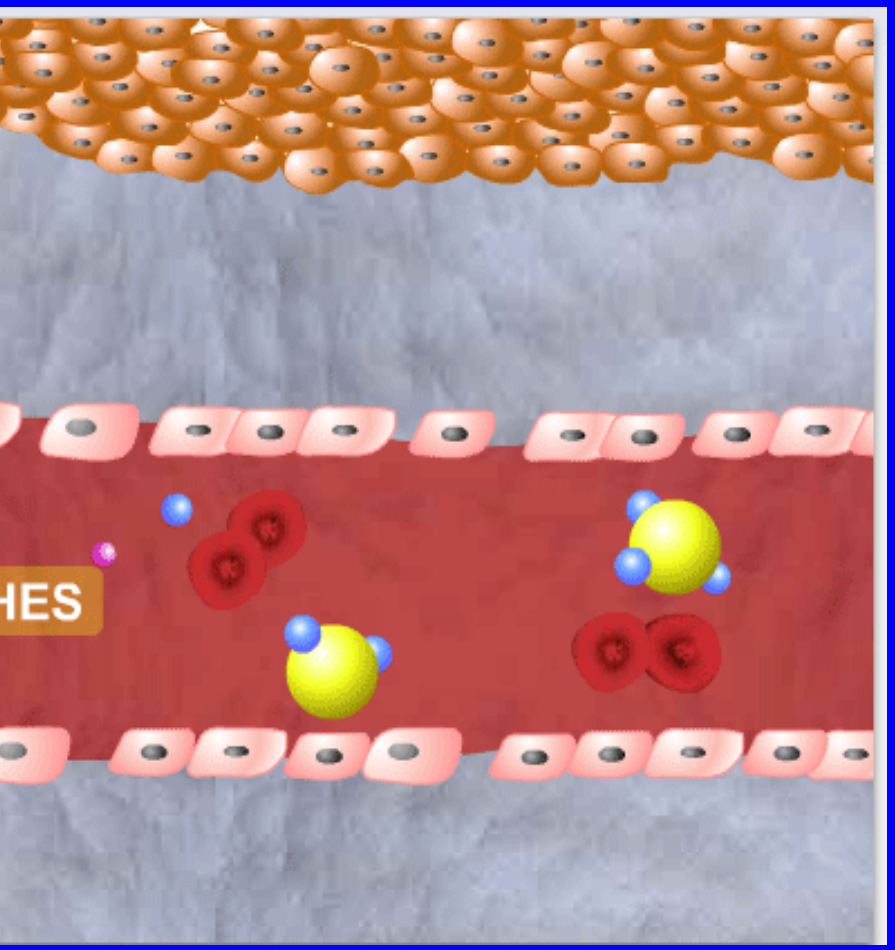
It must not be mixed with solutions containing phosphate or carbonate

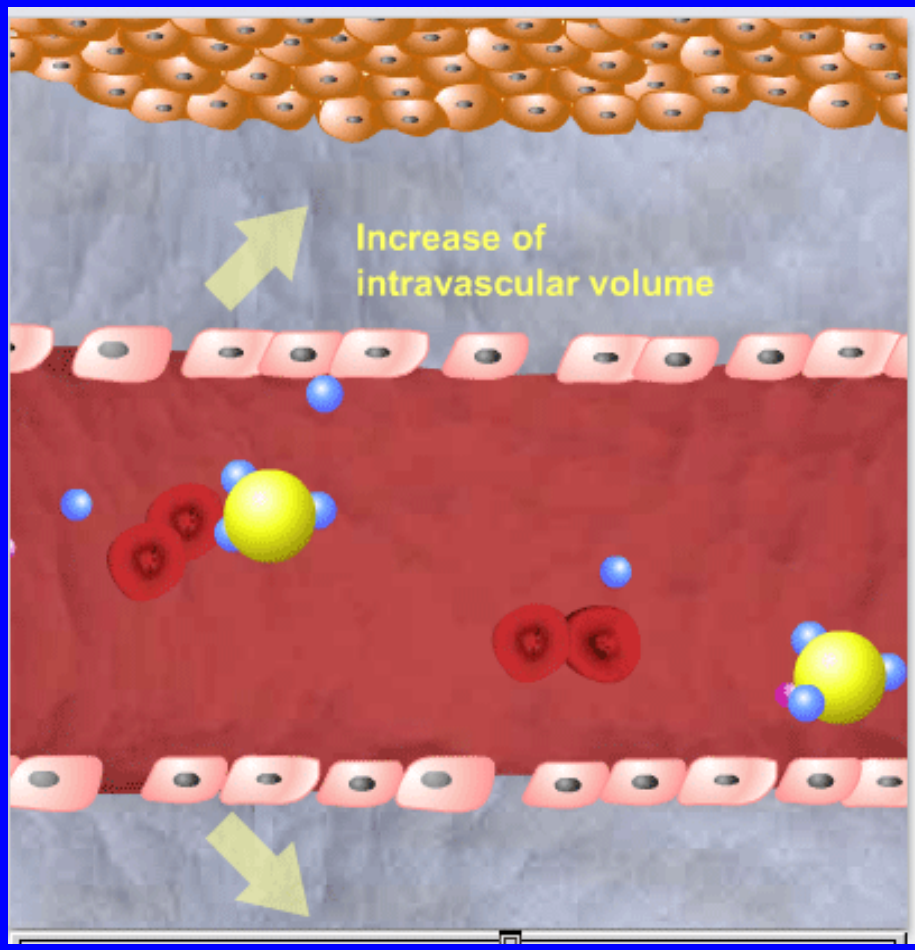
Colloids 1.

- Solutions which contain macromolecules
- They remain in the intravascular space and bind water
- Their volume-expanding effect is more significant than that of crystalloids

Colloids 2.

Volume-expanding effect





Colloids 3.

Albumin:
- Natural colloid
- Effects last for 4-6 h
- Septic patients respond well to albumin treatment

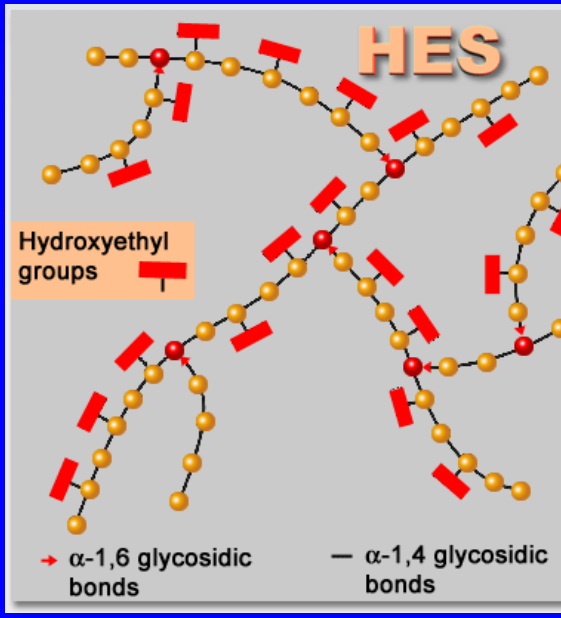
Gelatin:
- Bovine origine
- Relatively few side effects
- Its use in Europe is declining

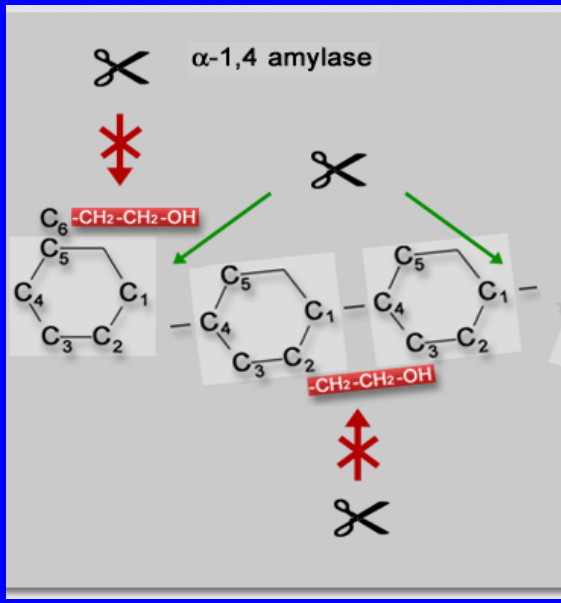
Dextran:
- 70.000 D és 40.000 D average MW
- Positively affects leukocyte- és thrombocyte adhesion
- Severe side-effects

Colloids 4.

Hydroxi-ethyl starch:

- Corn-derived modified amylopectine
- Effect lasts for 4 h
- 6 and 10% solutions
- Second and third generation HES eliminated the side-effects of earlier HES solutions



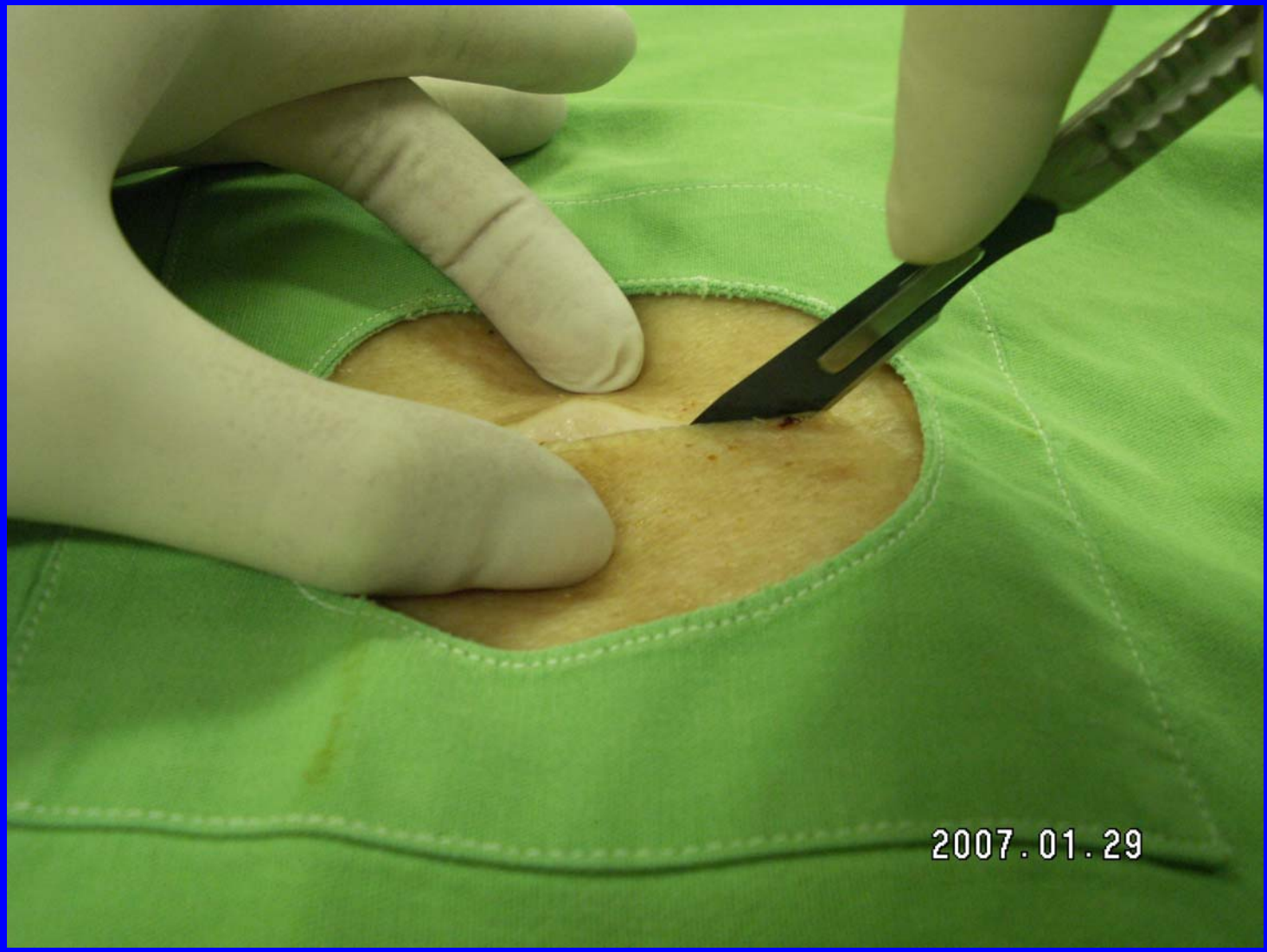


Preparing for invasive monitoring:

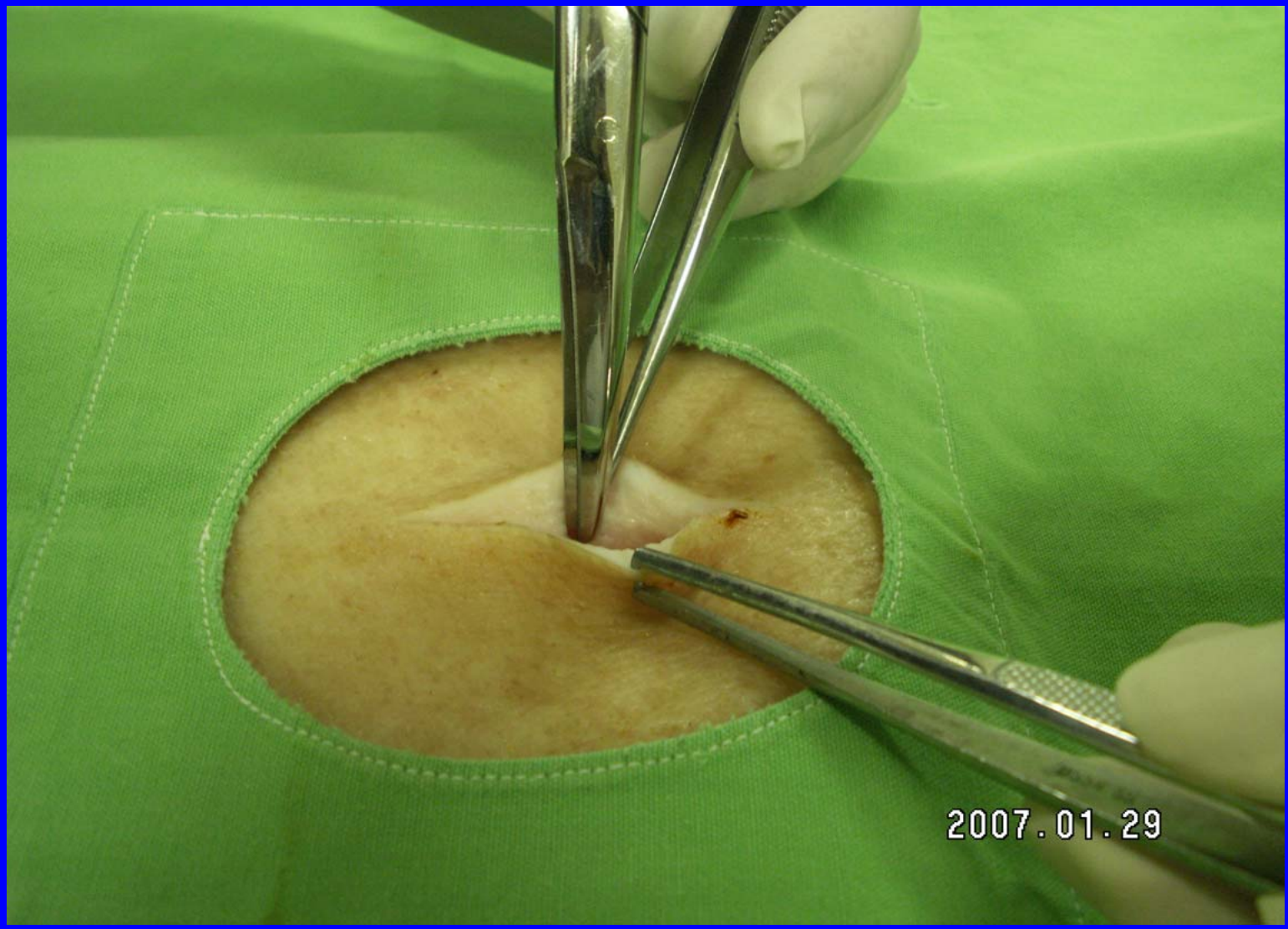
1. Venasection e*x vivo*

2. Seldinger technique

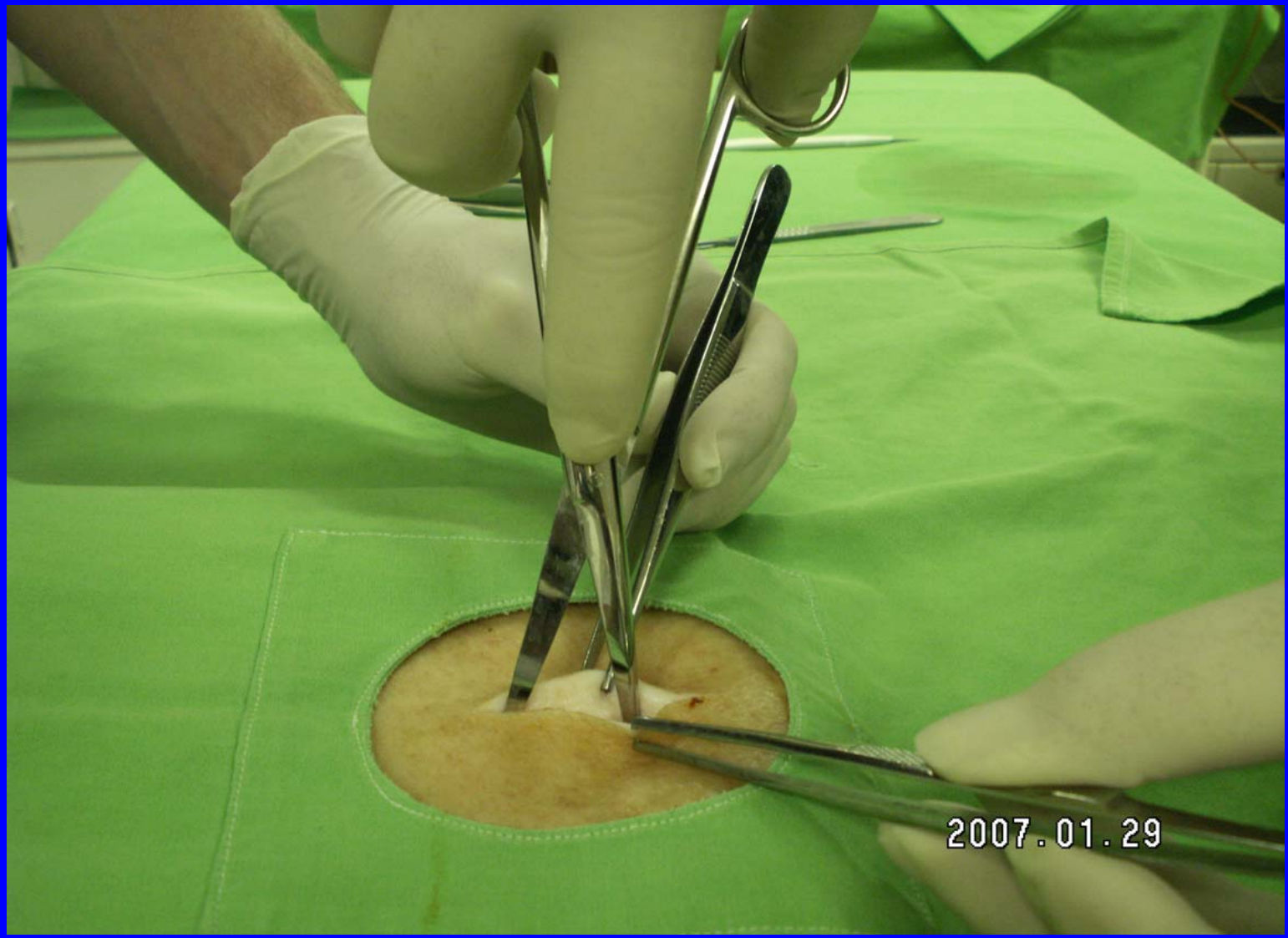
Incision



Blunt preparation 1.

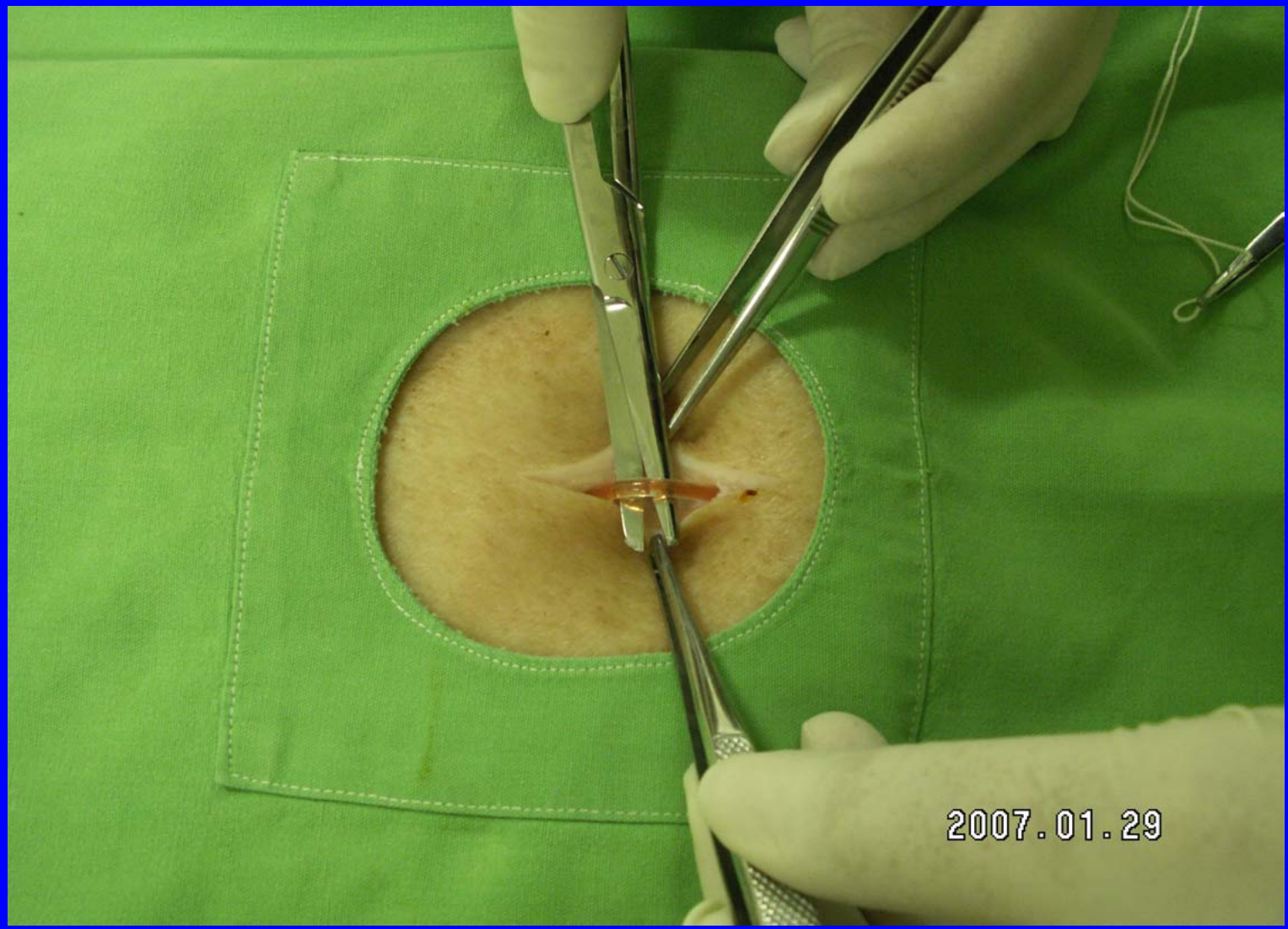


Blunt preparation 2.

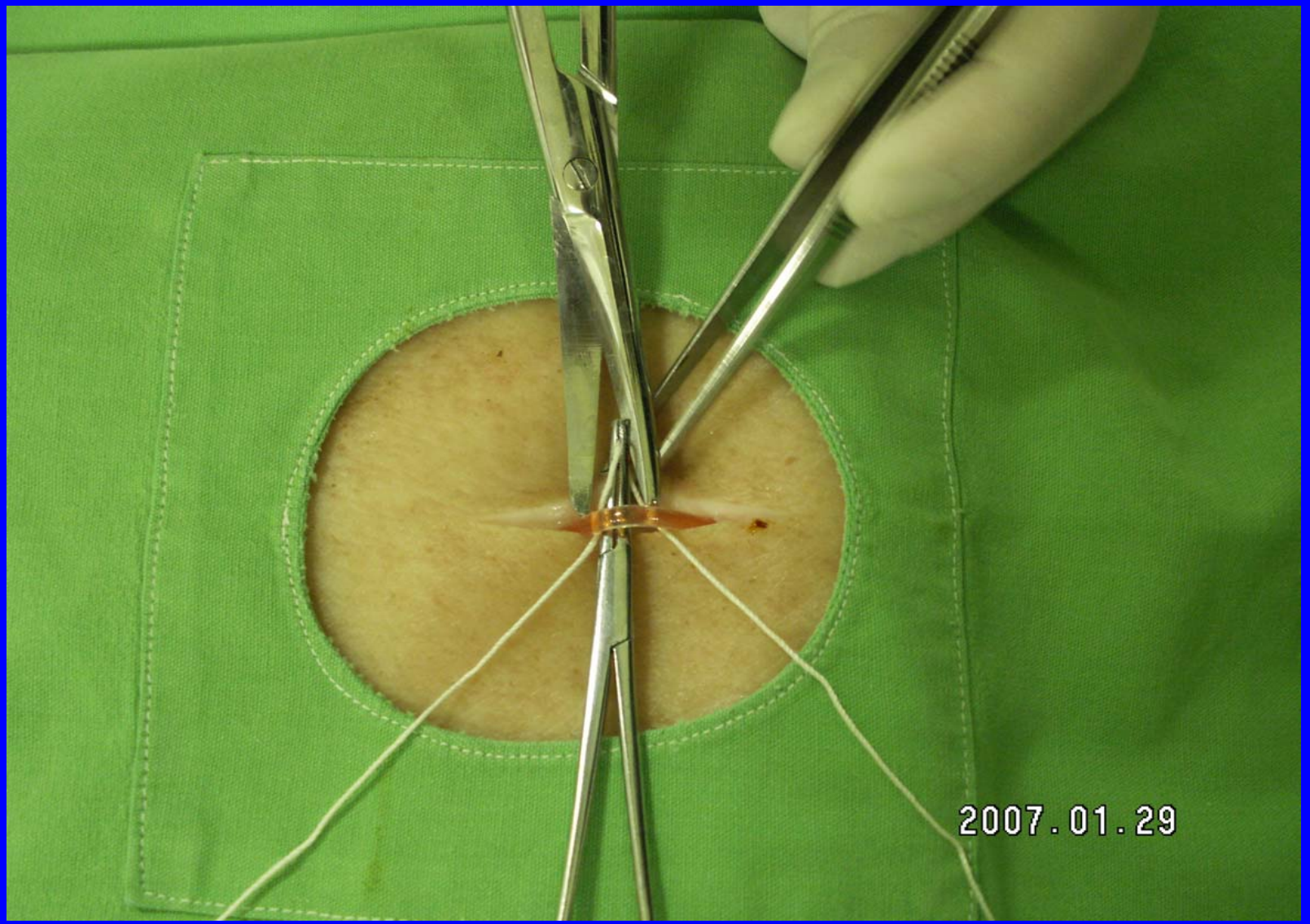


Dissection of the vein 1.

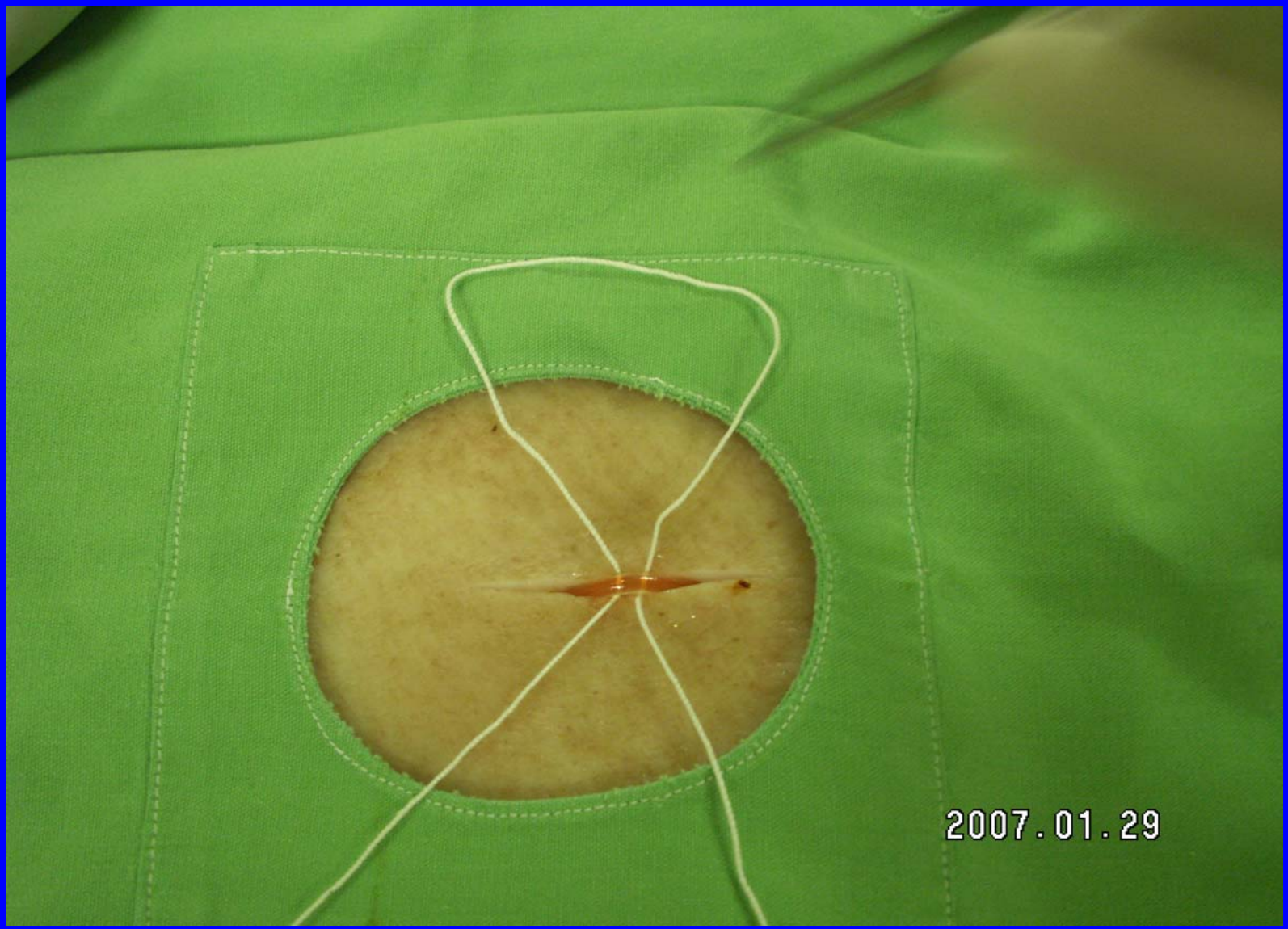
Dissection of the vein 2.



Introduction of double thread 1.



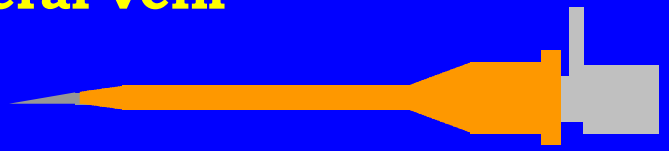
Introduction of double thread 2.



Gentle elevation of the vein

1. Introduce a Braunüle into a peripheral vein

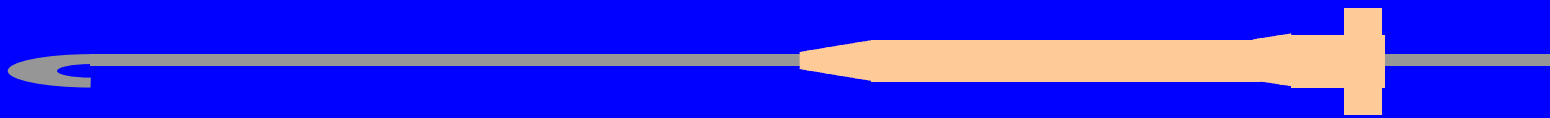
2. Remove the needle



3. Insert a flexible guide-wire into the central vein

4. Remove the Braunüle cannula

5. Insert – then remove the dilator cannula



6. Insert the central venous cannula

7. Remove the guide-wir

Practicals

Working in groups of 4 under the guidance of a tutor;

Entering the operating room: take caps and masks;

1. Administration of i.c., s.c., i.v. és i.m. injections after disinfection on a practice pad
2. Introduction of Braunule and butterfly needle on a plastic hand; giving infusions; use of infusion pump.
3. Taking blood samples;
4. Venasection *ex vivo*:
5. Seldinger technique;