

Artery cannulation

Artery cannulation is used primarily for *direct monitoring of arterial blood pressure (BP)*. Different arteries can be cannulated. Preference is given to the distal arteries supplying the region with collateral, alternative vascular equipment: a. radialis, a. tibialis, a. dorsalis pedis. The use of larger arteries is the method of choice where we anticipate a significant disorder of peripheral vascular resistance and cannula insertion in the distal areas is problematic.

Indication

- hemodynamically unstable patient: shock conditions, hypertensive crisis, hypotension
- intracranial hypertension
- necessity to administer vasoactive substances: catecholamines, sodium nitroprusside
- patient with unstable ventilation (need for repeated and frequent examination of blood gases)
- the need for repeated blood sampling
- regular blood sampling
- angiographic examination
- hemofiltration / hemoperfusion
- cardiac output measurement

Direct blood pressure measurement

Measurement of arterial pressure is an essential part of monitoring every acute condition. **Mean Arterial Pressure (MAP)** depends on cardiac output (CO) and systemic resistance (SVR): **$MAP = CO \times SVR$**

The equation itself points to the limits in measuring arterial blood pressure. Blood pressure (BP) does not inform about blood flow. It can therefore be normal even with increasing peripheral resistance and at the same time decreasing cardiac output, and thus with reduced blood flow to the organs. Thus, we consider MAP only as a rough indicator of organ perfusion, especially when many organs have autoregulation, ie. their perfusion is kept constant over a wide range of perfusion pressures through changes in vascular resistance. We measure arterial BP *directly* or *indirectly*. **Indirect methods** are simple and non-invasive. **Direct methods** are invasive, require equipment, and are used only for special or comprehensive monitoring. Differences between indirect and direct blood pressure measurements are particularly evident in shock, hypertension, hypothermia and obesity.

Advantages of direct blood pressure measurement

- continuous monitoring
- continuous measurement accuracy
- rapid recognition of circulatory disorders
- direct monitoring of hemodynamic effects of heart rhythm disorders
- indirect assessment of myocardial contractility from the rate of rise of the arterial pressure curve
- estimate of heart rate volume from the systolic part of the pressure curve
- access to the artery for blood sampling: ABB (Astrup) and other laboratory tests

Arteries suitable for cannulation

- a. radialis
- a. ulnaris
- a. brachialis
- a. femoralis
- a. tibialis posterior
- a. dorsalis pedis

Unless it is necessary, we should not cannulate the a. femoralis. Cannulation a. temporalis is unacceptable due to the high risk of complications.

Procedure

In newborns, we most often choose 24 G i.v. cannulas (for cannulation a. brachialis at this age, **22 G**). In infants approx. 8–10 kg, i.v. cannula **22 G** or possibly the Seldinger technique with **catheter 22 G** can be used. For older children, either **22 or 24 G** catheters are selected.

In general, a poorly palpable artery pulse represents a very small probability of successful cannulation, and conversely, the greatest probability of success is with extremely palpable pulsations. For cannulation, we can use conventional i.v. cannulas or the Seldinger technique. We can catheterize either directly or in children more often by transvascular technique. *We choose an aseptic procedure*: injection site disinfection, sterile gloves, sterile puncture area. In general, it is always advisable to position the limb where we will cannulate the artery in a way in which the pulsation of the artery is best. This will facilitate the cannulation process. We cannulate young children in

deep analgesia; for older ones, a local puncture site anesthetic can be used, eg 1% Mesocaine. The local anesthetic, however, has the disadvantage of infiltrating the cannulation site, which greatly complicates the success of the cannulation.

"Transvascular procedure" means a deep catheter puncture in which we assume "crossing" of the artery. We then pull out the needle and pull the catheter out carefully and slowly (but not extremely slowly). The highest chance of successful insertion is when blood really flows freely. If the blood in the cannula just "appears" during extraction, it is most often an artificial puncture of the vein or the catheter is not ideally in the lumen of the artery and we failed to insert it. If the catheter could not be inserted, the last option is to try to pierce the artery once more, i.e. to "go the same way" and repeat the whole procedure before the next attempt. If we accidentally hit the vein "on the way", it is advantageous to immediately compress the injection site and pull out the cannula. This reduces the outflow of blood into the perivascular space, which would otherwise make the conditions for further punctures more difficult. The second option is to leave the catheter in the lumen of the vein and begin cannulation of the artery with a new catheter. In this way, we also prevent blood from spilling into the environment. A drop of pale blood in the capillary cone can convince us of the correct injection. This finding most likely predicts that we successfully hit and punctured the artery. However, the absence of a drop of blood in the capillary cone does not rule out that it is also a correct puncture. In practice, if the initial puncture is "slower", such as cannulation of the vein, there is a high probability that a drop of pale blood will appear in the cone of the capillary after entering the artery. Of course, if we inject at high speed, the probability is much lower.



I.v. cannula

Using the Seldinger technique, we insert the needle, and if blood begins to flow or splatter freely from the needle, we try to insert a metal wire. Millimeter needle position adjustments are often required to allow the lead to be inserted freely into the artery. After successful insertion, we fix the wire, pull out the needle and wind the catheter over the wire. If we cannulate with a needle, then the difficulties can be brought about by the situation when we repeatedly search for the lumen of the artery, the needle may be clogged and therefore the blood may not start to flow freely after the puncture of the artery. This can be prevented by rinsing the needle occasionally / regularly with saline or, even better, by blowing air. Sometimes the variant is to introduce as i.v. Terumo 22G line and insert a longer arterial catheter through the introducer. Better Arrow 22G (thinner) than Vygon 20G. Problems can occur in the lower limbs (a. dorsalis pedis and a. tibialis posterior), where the skin is thicker and the catheter cannot be inserted into the lumen of the artery.

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Cannulation of the a. radialis

For direct blood pressure measurement, we most often cannulate the **a. radialis**. Its advantages are simplicity, mostly good collateral circulation and good accessibility (eg during the operation).

Note: Some authors recommend *testing the patency of the a. ulnaris with the Allen test* before cannulation: At the same time, we compress the a. radialis and a. ulnaris and the patient clenches his fist to squeeze the blood out of his hand. Then the patient releases the hand grip and releases the pressure on the a. ulnaris. If the hand turns red within 5 seconds, the flow of the a. radialis is sufficient.

To cannulate, we flex the hand in the wrist dorsally by underlaying it with a small curled drape, syringe or placing it on a shaped plate. Positioning is important, the hand should not be curled. The injection site is the area between the *ligamentum carpi* and the distal end of the radius, ie in the area of the *sulcus radialis*. If we inject more proximally, there is a higher risk that the artery will "slide" and our attempts will fail repeatedly. The puncture is made at an angle of about 30 ° (ie a slightly steeper slope than when vein cannulation) above the site of the best palpable pulse and the cannula is inserted parallel to the artery. In newborns and the youngest infants, the course of the artery can be visualized by cold light. The needle hole points upwards. In the transvascular technique, we deliberately pierce the artery with a needle, then remove the mandrel and slowly pull up the catheter until we see free-flowing blood. However, the pulling speed must not be too fast, but also not too slow - it is necessary to get the "adequate speed" in hand (this is generally the case). Then we insert the catheter into the artery. Fading of the injection site after administration of a small amount of 1/1 FR indicates correct, ie intra-arterial catheter insertion. After cannulation of the artery, we put the hand back to the normal position in the wrist so that we do not damage the *n. medianus* by hyperextension. We attach a short rigid tube with a three-way stopcock at the end to the cannula. We do not connect the stopcock directly to the cannula, so that we do not damage the vessel wall by unnecessary movements. Then we fix the cannula firmly and mark it thoroughly. Maximum patience is crucial, especially when retracting a cannula or needle, as it is true: **In the vast majority of cases, we always hit the artery, it's only a matter of time before, and therefore we must be extremely alert during each attempt!**

Usually the artery is located slightly medially from the *sulcus radialis*, ie during its cannulation the needle goes deep into the soft tissues of the wrist. Rarely, however, the artery lies much laterally, ie above the radial bone process. It must then be taken into account that the needle will hit the bone soon after the injection and the subsequent withdrawal of the cannula must therefore be particularly careful, as the artery may lie just below the surface. We flush the arterial line 1/1 FR with heparin (1-2 U.I. per 1 ml of solution) at a rate of 1-3 ml / hour.

The most common complications of a. radialis cannulation are circulatory disorders, abnormal pulsations, hematomas. A large blood loss with unrecognized disconnection, infections, abnormal skin discoloration and disorders of thumb sensitivity, embolism, finger necrosis and AV fistula are very rare. Some authors point to a clear relationship between the frequency of thrombosis of the a. radialis and the duration of cannulation.

Artery cannulation is used **only to measure blood pressure and take blood samples**. Administration of drugs, blood derivatives and hypertonic solutions is contraindicated for the possibility of severe arterial spasm with consequent hand damage, therefore all arterial lines must be clearly marked!

Puncture of the a. radialis

The injection is made so that the needle with the skin forms an angle of 30-60 ° (so we choose a larger angle = less tangential inclination of the needle). Thin needles are suitable because they do not trauma the artery as much. After collection, the area should be firmly compressed by compression for about 5 minutes (we prevent the formation of a hematoma), but the pressure must not cause occlusion of the artery.

Cannulation of the a. ulnaris

We rarely cannulate the **a. ulnaris**. We prick above the place of the best tactile pulse. There are no "tweaks".

Cannulation of the a. brachialis

The **a. brachialis** is chosen especially with reduced quality of peripheral pulsations. We prefer the *left a. brachialis* to reduce the risk of catheter embolization into the brain. The main complication here is the closure of the artery by a thrombus, but the risk is not great.

Practical procedure

The injection site is the cubital area, the inclination of the needle is about 30 degrees. The pulsation of the a. brachialis is located on the ulnar side of the cubital area, the course of the artery in this area leading somewhat obliquely to the medial.

Cannulation of the a. femoralis

The **a. femoralis** is cannulated "in the highest emergency," in poorly palpable peripheral pulsations, or in situations where the patient requires invasive hemodynamic monitoring (femoral arterial catheters for the PICCO method). The main risk is the formation of hematomas, the risk of infection. Far more often, the femoral artery is used to perform arterial blood sampling for more accurate ABB testing. The procedure is as follows: the injection is performed with the thinnest needle attached to a 2 ml syringe in which is written about **0.5-1 ml** of air (→ when penetrating the artery, this will cause a gentle negative pressure and allow the suction of arterial blood), we prick above the place of the best tactile pulse perpendicular to the artery. The most important thing for the technique is to inject very gently, because the needle easily penetrates deeper structures and deep penetration or too high a speed means a loss of the lumen of the artery and the impossibility of taking blood.

Cannulation of the a. tibialis posterior and the a. dorsalis pedis

We cannulate the **a. tibialis posterior** in the space behind the inner ankle. The cannula needle is inserted at a 30 ° angle proximal to the center between the posterior edge of the medial malleolus and the Achilles tendon at the site of the best tactile pulsation. We choose the position of the foot in a slight dorsal flexion to "level" the area at the injection site behind the inner ankle. The optimal position is always the one in which the best tactile pulsation is. We often succeed when we inject from a point below the inner ankle and point a little obliquely towards the Achilles tendon. But we must always respect the course of artery, so too sloping a direction does not lead to success. We cannulate the **a. dorsalis pedis** in the dorsum of the foot, in the middle of the back of the foot between the first and second metatarsus, we also insert the needle with the cannula at an angle of about 30 ° (practically at an angle slightly larger than during peripheral vein cannulation). We hold the child's leg in mild plantar flexion. In particular, it is appropriate to position the dorsum of the foot in the position in which the pulsation of the artery is best palpable. This will facilitate the cannulation process. The pressure curve on the lower limbs is usually of poorer quality than in more centrally located arteries: there is no incision, transmission is delayed, systolic blood pressure is slightly higher, diastolic blood pressure is slightly lower.

Complications and their prevention

The most common disorders of direct blood pressure measurement include an insufficiently or excessively damped curve. An insufficiently damped curve usually occurs when the cannula in the a. radialis is connected with a tube that is too long. For an excessively damped curve, we obtain a low value of systolic and a too high value of diastolic pressure. The most common causes are air bubbles in the system or a clot in the cannula or in the system. Air bubbles must be removed from the system by three-way stopcocks (never flush towards the artery). The formation of clots can not always be prevented even by continuous flushing of the system. We always aspirate the already formed clot, never flush it under pressure into the artery. The functionality is confirmed by trouble-free blood suction during the sampling and a well-plotted pulse curve on the monitor. When taking blood or taking care of the cannula patency, we take care that there is no artificial application of air to the system → microembolization of air into the artery is manifested primarily by skin changes (maculosis fading or rash on the forearm), possibly up to necrotic lesions of the upper limb skin. Areas perfused with the cannulated artery must always be accessible to the nurse. We reduce the risk of thrombosis and embolism by continuous flushing of the arterial cannula and, of course, by a short insertion time. The thrombotic closure of the vessel is usually temporary. Blood backflow can be prevented by flushing and the correct positioning of the three-way stopcocks and inlets. When taking blood, we always develop a minimum negative pressure, as high negative pressure causes spasm and consequent damage to the artery intima → shortened life of the arterial line. We pay attention to thorough sterility of the collection, first we take about 2 ml of blood into a syringe and after that the next blood is suitable for the appropriate examination. After the end of the blood sampling, the catheter is flushed to prevent a thrombus from forming in the cannula. We

immediately remove the cannula at signs of artery occlusion → edema, extreme pallor, cold hand, difference in O₂ saturation compared to the other hand. When canceling the cannula, it is necessary to ensure consistent hemostasis → 5-10 minute compression of the injection site with a sterile swab, but so as not to cause complete occlusion of the artery.

Complication

- hematoma
- infection
- thrombosis
- cannula occlusion by a clot in case of insufficient heparin lavage

Practical notes

- if it fails and the cannulation site is totally disturbed, sometimes positioning the limb to another position in which the pulsation will be more palpable will help
- if it fails and the cannulation site is totally disturbed, then the site where we hit the artery is usually somewhere other than the center of our futile attempts
- if we accidentally hit the artery but fail to cannulate, it is necessary to take into account that its pulsations may disappear (both due to blood flow and vasoconstriction of the vessel)
- The following procedure seems to be a good option: for children where a Terumo 22 G cannula can already be used - lead the punctures to the artery area slowly, do not pull the needle out immediately, try to back up and slightly change the tendency of the puncture. It seems that in this way, when the artery is successfully punctured, there is an almost 100% a light drop of blood should appears in the cone of the capillary. However, it is better to rinse the cannula and tap the water out after 3-4 "turns", as there is a real possibility that the needle will become clogged.
- if we want to subsequently insert a longer arterial catheter, it is better to insert the catheter guide into the fully inserted cannula. So far, during cannulation, the success of inserting your own cannula into the artery appears to be higher than inserting a conductor through the cannula. When inserting the cannula itself, the following applies: in the area of the wrist the Teruma is introduced without flushing, in the area of the a. brachialis and a. dorsalis pedis, preferably with flushing (other places have not been studied yet)
- in newborns count on very peripheral artery placement. Therefore, great care is important when pulling out the cannula, because the lumen of the artery is often located just below the surface, where we usually do not anticipate the course of the artery, and when pulling out the cannula, we often come out from under the skin.

Links

Related articles

- Central vein cannulation, Peripheral vein cannulation
- Seldinger technique

External link

- HAVRÁNEK, Jiří: *Kanylace arterie*.