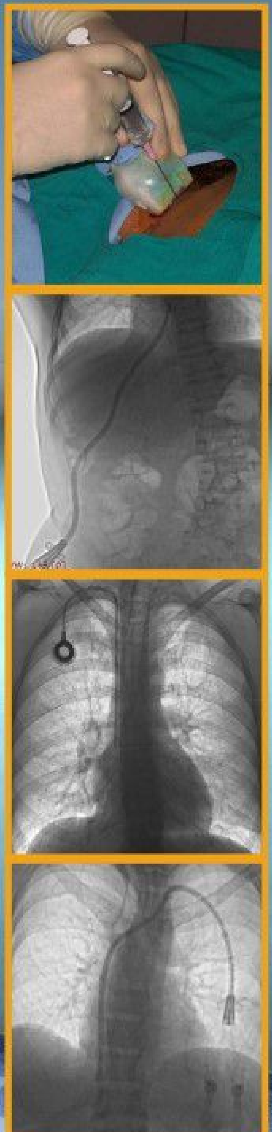
# IMAGE GUIDED CENTRAL VENOUS CATHETER PLACEMENT



**Editor**

Assoc. Prof. Nurullah Dogan, MD.

**Health Sciences**

LIVRE DE LYON

Lyon 2021

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**Editor** • Assoc. Prof. Nurullah Dogan, MD.

**Cover Design** • Clarica Consulting

**Layout** • Clarica Consulting

**First Published** • March 2021, Lyon

**ISBN:** 978-2-38236-133-7



**Publisher** • Livre de Lyon

**Address** • 37 rue marietton, 69009, Lyon France

**website** • http://www.livredelyon.com

LIVRE DE LYON

Lyon 2021

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Assoc. Prof. Nurullah Dogan, MD.
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# CHAPTER 1

# Central Venous Catheter Types and Indications

**Asst. Prof. Mustafa Gok, MD.**
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Central venous catheters (CVCs) have 4 main types according to their intended use and durations; temporary (non-tunneled) catheter (NTC), permanent (tun-neled) catheter (TC), implantable ports (IP) or subcutaneous venous ports (SVP) and peripherally inserted central catheter (PICC). Some authors consider aphesis and hemodialysis catheters as a fifth group, but this categorization is not helpful in practice. Apheresis and hemodialysis catheters can be placed in NTC or TC groups according to their intended use and duration.

## TEMPORARY (NON-TUNNELED) CATHETERS "NTC"

NTC are mostly used in intensive care units (ICU) and emergency rooms (ER) for high flow medical treatments, central venous pressure monitoring or dialysis. They are produced from materials such as polyurethane, polyvinyl, silastic (silicone elastomer) and teflon. Materials such as polythene and polypropylene are not used anymore due to their stiffness and thrombogenic effect.

Polyurethane catheters are structurally stronger and more resistant to chemical disintegration. They are stiff in room temperature and get softer in body temperature. Silastic catheters are softest and least thrombogenic.

There are also heparin, chlorhexidine or anti-biotics (silver sulfadiazine, minocycline, rifampicin and the like) impregnated catheters to reduce throm-

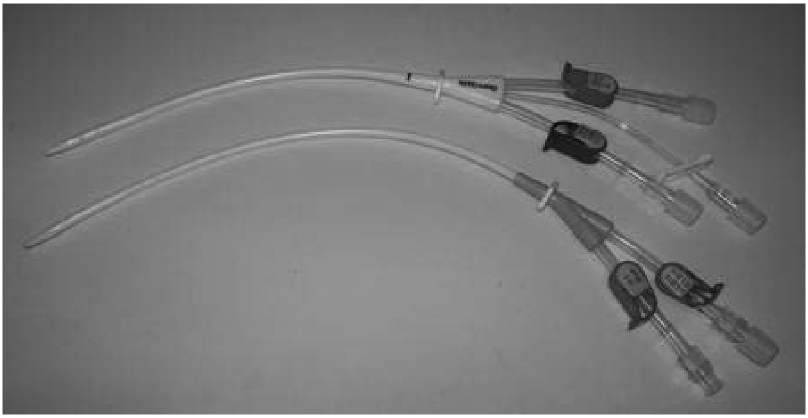

**Figure 1.1:** Bms`jc _lb rpgnjc jskcl rcknmp_pw a_rfcrcpq

`sq _lb gldcargml, ?aampbgle rm rfc nspnmqc md sqc rfcw a_l `c qglejc* bms`jc* rpgnjc* os_bpsnjc mp osglrcr jskcl, Ksjrgnjc jskgl_j ATAq _pc npcdcppcb gl GASq `ca_sqc rfcw _jjmu dmp rfc gldsqgml md bgddcpclr ğsgbq* kcbga_rgmlq mp kmlgrmpgle _r rfc q_kc rgkc, Ml rfc mrfcp f_lb* rfc jskcl lsk`cp qfmsjb `c _q jmu _q nmqqg`jc bsc rm rfc glapc_qcb pgqi md gldcargml, Qrsbgcq qfmuq rf_r mljw mlc jskcl gq sqcb gl n_rgclrq ugrf rpgnjc jskcl a_rfcrcpq &Dgespc /,/',

LRAq _pc _t_gj_`jc gl qgxcq md 4 rm /1D, Dmp GT gldsqgml nspnmqcq 5D jskcl qgxc gq rfc `cqr qgxc* `sr dmp bg_jwqgq mp _nfcpcqgq nspnmqcq rfc a_rfcrcp qgxc qfmsjb `c `geecp rf_l 7,3D, Gr qfmsjb _jjmu dmp _ 03.+1.. kj-kgl ğmu p_rc _lb lmr amjj_nqc,

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Rfcqc a_rfcrcpq _pc qsgr_`jc dmp n_rgclrq rf_r f_tc jgkgrcb ncpgnfcp_j t_q-asj_p _aacqq* lccb dpcosclr ğsgb gldsqgml _lb `jmmb amjjcargml* _lb nj_l rm sqc a_rfcrcp _aacqq jmlecp rf_l mlc ucci _lb jcqq rf_l qgv ucciq, Rfc bgq_b-t_lr_ecq glajsbc rf_r rfcw lccb dpcosclr bpcqqgle* f_tc _ fgef pgqi md bgqnj_ac-kclr _lb mddcp jmu n_rgclr amkdmpr,

## PERMANENT (TUNNELED) CATHETERS “TC”

Ncpk_lclr &Rsllcjcb' A_rfcrcpq bgddcp dpmk LRA ugrf 6+/3ak qfmpr amspqc rsllcj slbcp rfc qigl `cdmpc clrcpgle rfc tcgl, Rfcw _pc k_bc md qgj_qrga mp rfgl nmjwspcrf_lc, Qgj_qrga gq c_qw rm _bt_lac gl qmdr _lr rmprsmsq tcqqcjq, Indications of TC are similar to NTC. However, TCs are suitable for longer use (more than three weeks). The duration of use varies according to the type of catheter, but it is approximately 1 year. There are different types like Hickman, Broviac, Groshong and Leonard and the like.

Groshong catheters end with a blind tip, unlike other TCs. It has a slit-shaped opening just beyond the tip. This structure acts as a valve to prevent back flow and air embolism. Therefore, there is no need for external clamping, which can damage the catheter and shorten its life span. Groshon catheters are more expensive than others and are more likely to loose function than Hickman catheters.

Hickman catheters are available in single, double or triple lumen types with various lengths and diameters. In practice Hickman catheters are the most commonly used.

Broviac and Leonard catheters are a transformed form of Hickman catheter and they are basically very similar.

TCs that will be used for dialysis and apheresis should be produced with a larger diameter and harder materials as in NTC.

The part which is in the tunnel should have at least one or two cuffs (dacron and vita cuff) in TC.

Dacron cuffs stimulate the formation of fibrous tissue within 2-6 weeks and prevent the catheter from moving in the long term (stabilization). The dacron cuff also acts as a barrier for microorganisms (Figure 1.2).

The Vita cuff is antimicrobial and is placed close to the exit of the catheter from the tunnel. It contains collagen and silver ions. Collagen, the basic content of the vita cuff, swells 2-3 times when it comes into contact with the

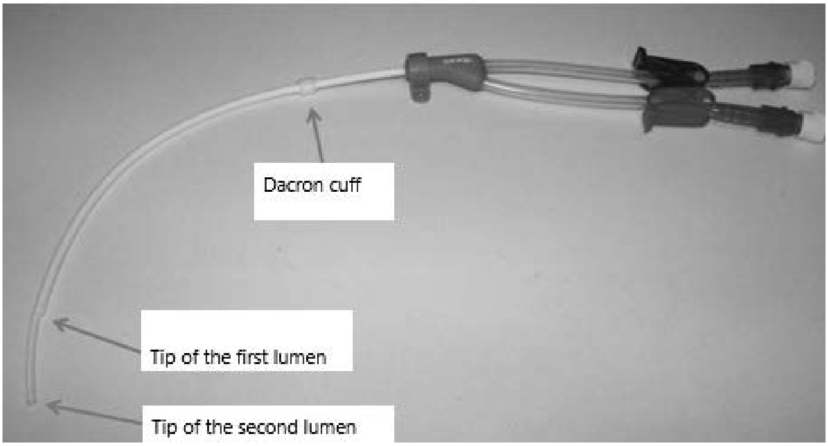


**Figure 1.2:** Double lumen catheter

body, helping it stay temporarily stable during the first 6 weeks. At the end of this period, the collagen is absorbed.

## SUBCUTANEOUS VENOUS PORTS (SVP)

SVPs are a closed system consisting of a reservoir and catheter which is placed under the skin. It is ideal for long-term and intermittent medical treat- ment. It has the lowest risk of infection and highest patient compliance. As it does not contain any part that protrudes outside the body, it is also cosmeti- cally better. It is generally preferred in oncology patients.

Venous ports are also available with double reservoirs and double lumens. Nowadays, double reservoir port catheters developed for dialysis have also been used. The catheters of the venous ports are made of silicone or polyurethane, the reservoir parts are made of titanium or plastic, and the injection membranes are made of silastic. Ports, which are made of both the titanium and plastic, are MR (Magnetic Resonance) compatible (Figures 1.3 and 1.4).

The reservoir section is usually placed subcutaneously on the pectoralis major fascia. However, in slim patients who do not have enough subcutaneous tissue, it is recommended to place the port under the pectoralis major muscle fascia. Placing the reservoir too close to the skin or selecting a large port in slim patients may cause skin necrosis over the reservoir. If there is any con-

**Figure 1.3:** Port catheter

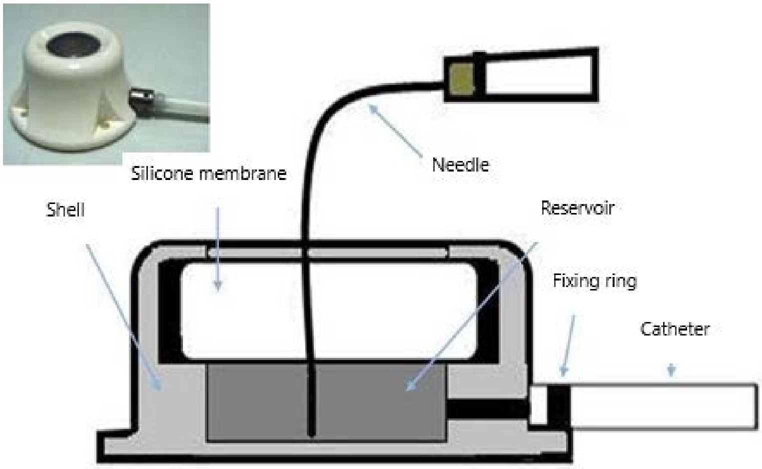


**Figure 1.4:** Sagittal plane of port catheter

traindication due to operation, radiotherapy or any kind of burn in that region, the reservoir may alternatively be placed in the parasternal area on the trapezoidal or deltoid muscle.

## PERIPHERALLY INSERTED CENTRAL CATHETERS (PICC)

PICCs are long catheters with a diameter of 3-7 F (Figure 1.5). They are inserted from the antecubital, basilic and axillary veins by cut-down or percutaneous technique. Basilic veins are preferred because of their straight course. Brachial and cephalic veins are not recommended. There are valves, located at the point where the cephalic vein joins the axillary vein, because of these valves and the sharp angle of the vein, catheter advancement may be problematic. In addition, the incidence of thrombus is more than 50% if placed from the cephalic vein. In young children, the large saphenous vein can also be used as an insertion site.

PICCs can be single or double lumen. They are generally preferred for low-flow medical treatments. PICCs are suitable for treatments of more than 5 days and less than 6 months. Because of their easy placement and low risk of bleeding, imaging techniques have a limited role in inserting such catheters. However, in cases with difficult vascular access, bedside ultrasound (US)

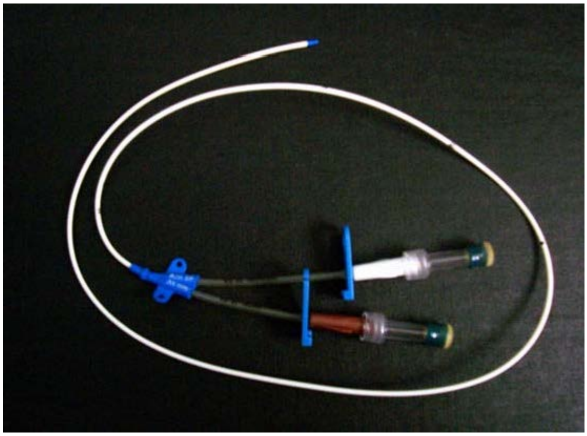

**Figure 1.5:** Bms`jc jskcl NGAA

esgb_lac a_l `c sqcb, N_rgclrq ufm f_tc rfcgp a_rfcrcpq rfpmsef rfcgp _pk* rfcgp a_rfcrcp rgnq qfmsjb rcpkgl_rc /-1 bgqr_jjw md rfc qs`aj_tg_l tcgl, Rm afcai rfgq jma_rgml* p_bgmep_nfga amlrpmj gq pcosgpcb _r rfc clb md rfc npmacbspc,

Rfcqc a_rfcrcpq f_tc _ jmle amspqc gl pcj_rgtcjw qk_jj tcqqcjq* rfgq `cgle rfcgp kmqr gknmpr_lr bgq_bt_lr_ec, ?q rfcw a_l `c c_qgjw maajsbcb mp b_k_ecb `w _pk kmtckclrq* gr gq pcamk kclbcb rm glqcpr rfcqc a_rfcrcpq rm rfc lml+ bmkgl_lr _pk,

Rfc kmqr amk kml amknjga_rgmlq gl mpbcp md dpcosclaw _pc m`qrpsargml* dp_arspc _lb gldcargml. Kmqr amknjga_rgmlq &kmpc rf_l 5.#' maasp _drcp 1. b_wq, Gr gq pcnmprcb rf_r _nnpmvgk_rcjw 2.# md rfc a_rfcrcpq f_tc rm `c pckmtcb `cdmpc rpc_rkclrq _pc amknjcrcb,

Amkn_pcb rm mrfcp ATAq* rfc amqr gq jmucp, Rfcw a_l `c sqcb dmp `jmmb q_knjgle _lb _jj iglbq md ğsgb rpc_rkclrq,

## Midline Catheters

Ctcl rfmsef rfcw _pc lmr ATA* uc ugjj `pgcğw kclrgml kgbbjc a_rfcrcpq _lb ncpgnfcp_j a_llsj_q `ca_sqc md rfcgp dpcosclr sqc,

Kgbjglc a_rfcrcpq _pc 1+6+glaf a_rfcrcpq ufgaf _pc `camkgle glapc_qglejw amk kml _q _l _jrcpl_rgtc rm ncpgnfcp_j tclmsq a_llsj_q _lb ATAq gl n_rgclrq ugrf pcqrpgarcb t_qasj_p _aacqq, Rfcw _pc npcdcppcb dmp sqc dmp _ amsnjc md ucciq, ?jrfmsef rfcpc gq lm amlqclqsq ml rfc mnrgk_j bsp_rgml* gr gq pcnmprcb rf_r qsaf a_rfcrcpq a_l `c sqcb q_dcjw dmp sn rm rum ucciq, Rfcw _pc k_bc md qgjgaml c mp nmjwspcrf_lc,

Rfc pgqi md bctcjmngle nfjc`grgq gl kgbjglc a_rfcrcpq gq jmucp rf_l rf_r md ncpgnfcp_j tclmsq a_llsj_q, Rfcw _pc _jqm jcqq cvnclqgtc rf_l ATAq _lb f_tc _ jmucp pgqi md gldcargml,

?q rfc a_rfcrcp rgn gq lmr rcpkgl_rcb gl _ aclrp_j tcgl* gppgr_lr ğsgbq* qmjs-rgmlq amlr_glgle ejsamqc _`mtc /.# _lb npmrcglq _`mtc 3# a_llmr `c _bkglgqrcpcb,

Rfc glqcprgml _lb _aacqq pmsrcq _pc rfc q_kc _q dmp NGAA* fmuctcp rfc a_rfcrcp rgn clbq gl rfc _vgjj_pw tcgl, P_bgmep_nfga amlrpmj gq lmr pcosgpcb _r rfc clb md rfc npmacbspc,

## Peripheral Venous Cannulas (PVC)/Intracath/Branula

NTAq _pc rfc kmqr amk kml tclmsq t_qasj_p _aacqq, Gr gq eclcp_jjw npcdcppcb dmp qfmpr rcpk sqc, Gppgr_lr djsgbq* total parenteral nutrition (TPN) qmjsrgmlq _lb qmkc _lrg`gmrgaq a_llmr `c egtcl,

Gr qfmsjb `c pcnj_acb ctcpw 50+74 fmspq, Gd gr gq qsqncarcb rf_r glqsdĞagclr _qcnqgq amlbgrgmlq _pgqc bspgle glqcprgml* gr qfmsjb lmr `c icnr dmp kmpc rf_l 26 fmspq,

Rfc _pk _lb jce tcglq _pc glqcprcb _lb rfc kmqr bgqr_j tcgl qfmsjb `c npcdcppcb, Fmuctcp* gd _ npctgmsqjw glqcprcb a_llsj_ gq pcnj_acb* _ lcu mlc qfmsjb `c glqcprcb npmvgk_jjw,

Rfc kmqr amk kml amknjga_rgml qccl gl NTA _nnjga_rgmlq gq nfjc`grgq, Gl NTA _nnjga_rgmlq* rfc bctcjmnkclr md nfjc`grgq gq bsc rm nfwqgamafckga_j mp kcaf_lga_j pc_qmlq p_rfcp rf_l gldcargml,

# CHAPTER 2

## The Histroy of Central Venous Catheter (Brief Chronological History)

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**1900;** In the early 1900s, venous catheters were inserted through the antecubital vein for experimental purposes in Berlin. The first Central venous catheterization (PICC) procedure.

**1952**; Aubaniac published 10 years of experience with IV fluid therapy and subclavian vein catheterization for nutritional purposes.

**1969;** Erben first performed subclavian vein catheterization for dialysis.

**1973;** Broviac used the first tunneled catheter made of silicone for long-term nutritional purposes with a cuff on it.

**1979;** Hickman, an American hematologist, modified the tunneled catheter from Broviac and started to use it for chemotherapy of bone marrow trans-plantation cases.

**1982;** Niederhuber et al. performed the first subcutaneous venous port placement.

**1992;** Morris et al. started the percutaneous port catheter placement procedures with imaging in angiography unit. Since then, the use of port and other CVC with imaging has become an important part of interventional radiological applications.

# CHAPTER 3

## Venous Access Site Selection


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*Aydin Adnan Menderes University, Faculty of Medicine, Department of Radiology, Aydin/TURKEY*
*Orcid GB: 0000-0001-7021-0984*


Rfc gllcp bg_kcrcp md _l gbc_j a_rfcrcp qfmsjb `c ugbc clmsef rm npmtgbc qsddgagclr djmu _lb rfc msrcp bg_kcrcp md rfc a_rfcrcp qfmsjb `c rfgai clmsef lmr rm npctclr djmu gl rfc tcgl ufcpc gr gq nj_acb, Rfcqc apgrcpg_ qfmsjb `c amlqgbcpcb ufcl qcjcargle rfc tcgl* gl ufgaf rfc a_rfcrcp ugjj `c nj_acb, Gl rfgq qcargml* uc ugjj bgqasqq rfc bgddcpclr tclmsq _aacqq qgrcq md ATA _lb amkn_pc rfcgp _bt_lr_ecq _lb bcdgagclagcq rm c_af mrfcp, Gl rfgq af_nrcp uc ugjj _jqm bgqasqq rfc tclmsq _aacqq qgrcq dmp ATA ugrf rfc cvacnrgml md NGAA* ufgaf ugjj `c bgqasqqcb gl af_nrcp 5,

### FREQUENTLY USED VENOUS ACCESS SITES

The most commonly used veins for CVC placement are: internal jugular vein (IJV), subclavian vein (SV), and femoral vein (FV).

#### Venous Access Site selection in CVC

Surgeons and anesthetists usually prefer the SV. When the Landmark technique (based on anatomical markings) is applied; the SV allows safer access than the IJV. However, there are several significant drawbacks of the SV which prevent the SV from becoming a routine venous access site:

- Rfcpc gq _ nmqqg`gjgrw md rfpmk`mqgq gl rfc QT _lb `p_afgmacnf_jga tcgl gd rfc a_rfcrcp gq glqcprcb dpmk QT, Rfgq jma_jgx_rgml gq rfc kmqr amkkml qgrc md rfpmk`mqgq _lb qrclmqgq a_sqcb `w ATA,
- Gl n_rgclrq ugrf arteriovenous (AV) dgqrsj_ dmp bg_jwqgq* qs`aj_tg_l tclmsq a_rfcrcpgx_rgml gq lmr pcamkkclbcb `ca_sqc md rfc nmqqg`gjgrw md qrclmqgq gl rfc qs`aj_tg_l _lb `p_afgm+acnf_jga tcglq* ufgaf dmpkq rfc _prcpg_jgxcb tcgl djmu n_rfu_w,
- Gl QT clrpw* nlcskmrfmp_v _lb fckmrfmp_v _pc kmpc jgicjw rm bctcjmn rf_l GHT _aacqq,
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?jrfmsef `mrf pmsrcq _pc sqcb ufcl glqcprgle tclmsq nmprq* kmqr p_bgmjmegqrq npcdcp GHT* cqncag_jjw rfc pgefr GHT &Dgespc 1,/', Sjrp_qmlmep_nfw &SQ' esgbcb _aacqq rm rfc GHT gq rcaflga_jjw c_qgcp _lb rfcpc gq _ tcpw jmu pgqi md nlcs-kmrfmp_v bctcjmnkclr,

Rfc pgefr GHT gq npcdcppcb mtcp rfc jcdr GHT `ca_sqc gr amlr_glq _ qrp_gefr n_rf rf_r d_agjgr_rcq a_rfcrcpgx_rgml _lb gq j_pecp, Gl _bbgrgml* rfc nmqqg`gjgrw md qwknrmk_rga qrclmqgq _lb rfpmk`sq bctcjmnkclr gq glqgelgĞa_lr* qglac

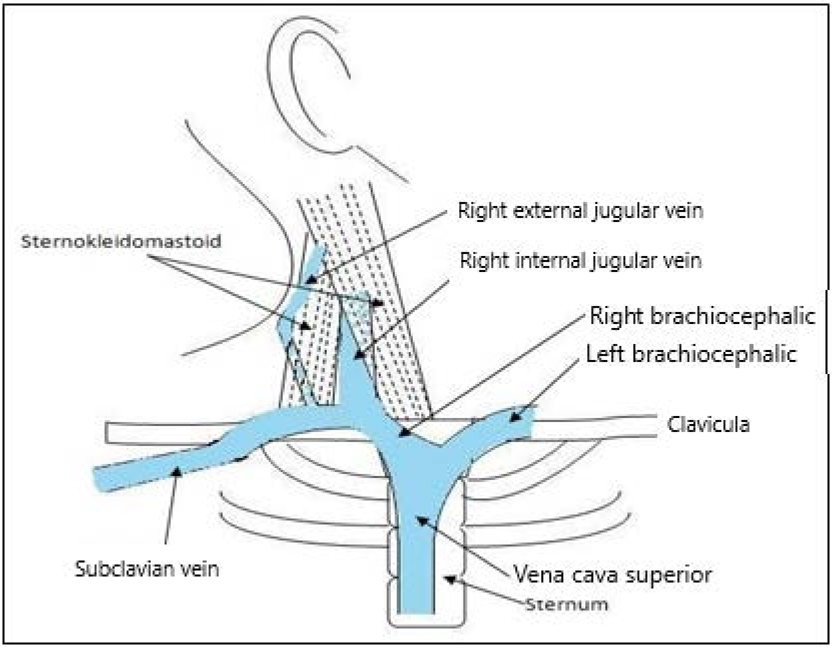


**Figure 3.1:** ?l_rmkw md glrcpl_j hsesj_p &GHT' _lb qs`aj_tg_l tcglq &QT'

**Figure 3.2:** Temporary catheters specificly designed for internal jugular vein entry

access from the right IJV allows the catheter to reach the heart directly without contacting the vessel wall.

The IJV has been reported as the least likely thrombus development site in all venous accesses.

There are also several negative aspects of the IJV site. Temporary catheters (infusion or dialysis) that are inserted in this way cause difficulties in neck movements. Temporary catheters inserted by the subclavian route can be concealed under-garments, while the jugular catheters can not. Furthermore, the risk of infection of temporary jugular catheters is higher than that of temporary subclavian catheters due to excess sweat glands and movements of the neck. To reduce these possibilities, there are commercially available temporary catheters designed for entry into the IJV (Figure 3.2).

When the literature is reviewed, it is clear that IJV (and especially right IJV) is the superior choice for those familiar with US guidance because of low complication rates. Those with more experience in subclavian access may use the subclavian route except in the case of hemodialysis patients.

The femoral vein can also be used in emergencies and short-term catheterization. However, the probability of infection and loss of function is higher than in the subclavian and internal jugular vein. It also restricts the patient's movements and is not cosmetic. For these reasons, the femoral site should not be favored except in emergency situations where there is no experienced team in central venous catheterization. However, when there is a contraindication for subclavian or internal jugular vein access (burn, infection, thrombus, etc.) femoral vein access may be an appropriate choice of site.

## Internal Jugular Vein Access Sites

The sternal head of the sternocleidomastoid muscle (SCM) attaches to the sternum of the manubrium and the clavicular head attaches to the 1/3 medial edge of the clavicle. The triangular area between the two heads and the base of the clavicle is called trigonum jugulare (Figure 3.3). This region corresponds to the last part of the internal jugular vein before joining the brachiocephalic vein. Internal jugular venous accesses occur in this triangular area. There are three basic ways of accessing the jugular vein.

The first is the central high-jugular approach in which the entry is made from the apex of the triangle forming the trigonum jugulare (Figure 3.4). This region is preferred by surgeons who use this landmark technique because of easy compression, especially in the case of arterial injury. In our practice, we use this localization in cases in which we consider catheterization for tempo-rary infusion or temporary dialysis from the IJV.

The second method is the central low-jugular approach in which you pass closely through the clavicle from the base of the trigonum jugulare (Figure 3.5). There are some authors who name this approach the anterior approach.

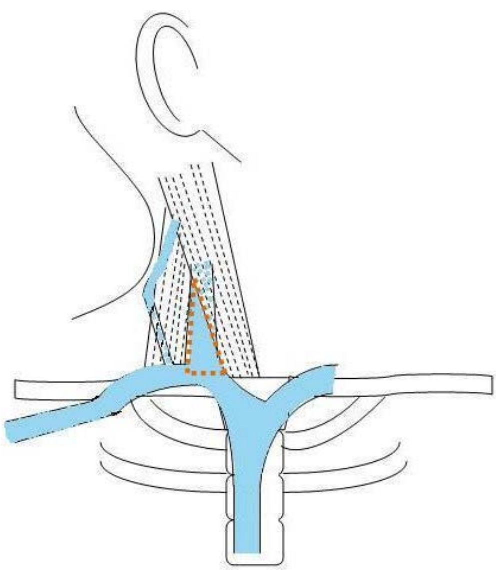

**Figure 3.3:** Trigonum jugulare (dashed line triangle).

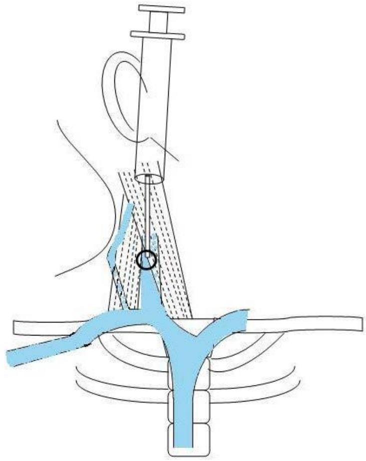

**Figure 3.4:** Venous catheterization with central high-jugular approach.

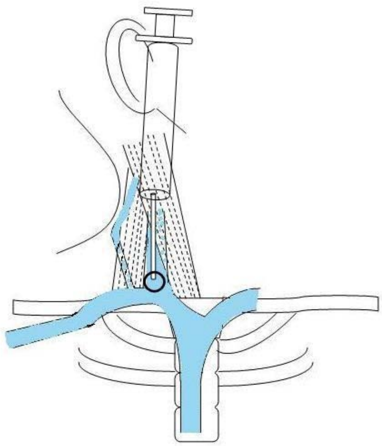

**Figure 3.5:** Venous catheterization with central low-jugular approach.

This approach is the first choice for patients with long-term catheterization (venous port or tunneled catheter), because the catheter is less affected by neck movements. Thus, the risk of catheter rupture or secondary malposition is significantly reduced.

The disadvantages of this approach for doctors using landmark techniques are severe arterial injury and pneumothorax that can occur if the needle is inserted too deep. Because real-time needle movement is being monitored, such a risk is insignificant in an imaging-guided approach.

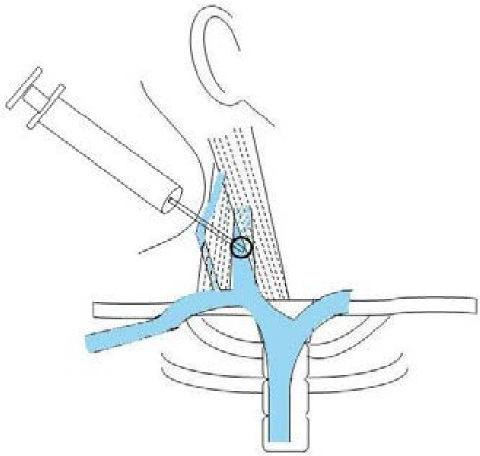

**Figure 3.6:** Venous catheterization with posterior approach

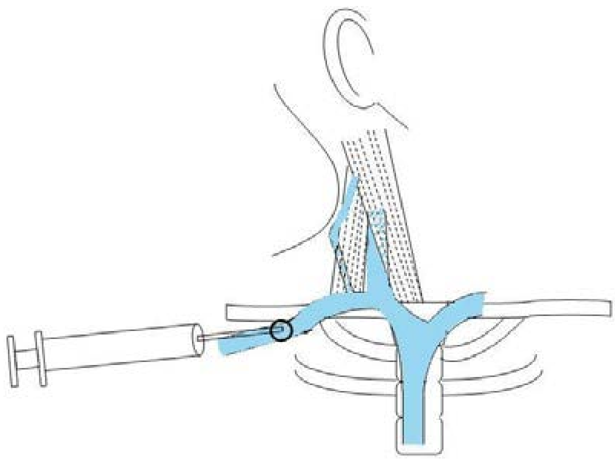

**Figure 3.7:** Subclavian venous catheterization with infraclavicular approach.

The third method of IJV access is known as the "posterior approach" (Figure 3.6). In this approach, the needle enters the skin 0.5 cm above the junction of the external jugular vein with the outer edge of the SCM and proceeds under the skin aiming at the mid jugular region.The aim is to decrease the chance of arterial injury by moving towards the vein which is more superficially placed than the artery. This method, which is primarily used by surgeons, is not a preferred method.

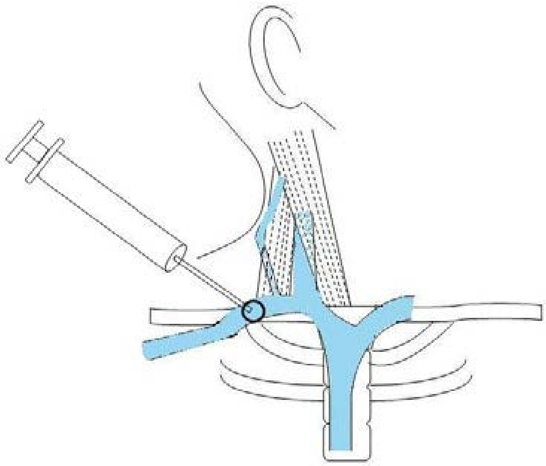

**Figure 3.8:** Subclavian venous catheterization with supraclavicular approach.

The central low jugular approach is the preferred approach in image-guided IJV access interventions in inctances where the high jugular NTC is to be placed (for temporary dialysis or temporary infusion) or TC to be placed (port, tunneled dialysis, tunneled infusion).

## Subclavian Vein Access Sites

There are two basic forms of subclavian venous access. The first is the standard infraclavicular approach (Figure 3.7).

In the infraclavicular approach, ½ middle section of the clavicula is located and the vein is entered in the inferomedial direction at an angle of 30-45 degrees from 1 cm below the clavicle.

In the supraclavicular approach, the mid-point of the clavicle is found and the vein is entered in an inferomedial direction at an angle of 10-20 degrees from the 1 cm upper and 1 cm outer part of the clavicle (Figure 3.8). It is a less preferred route than the infraclavicular approach.

Infraclavicular access is preferred for imaging-guided interventions, however, in long-term catheterization, the supraclavicular approach should be kept in mind as an alternative.

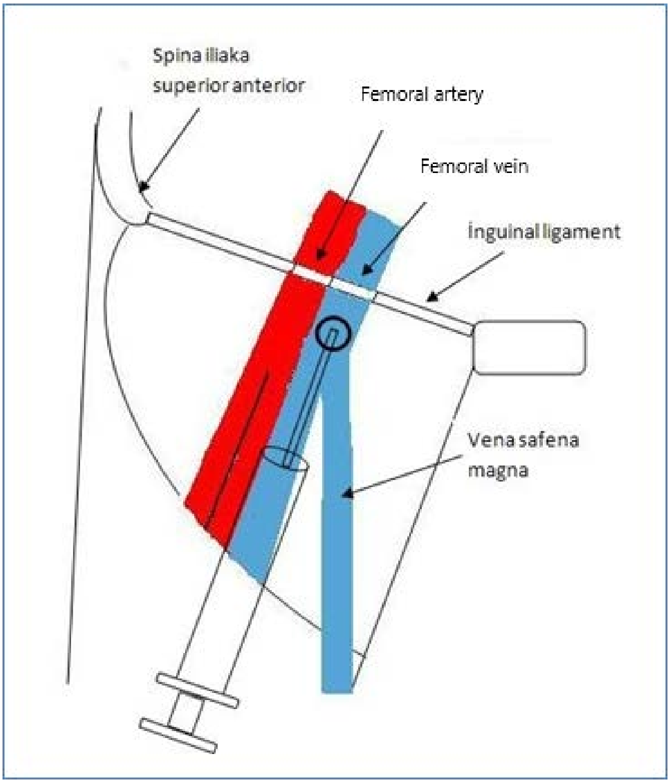


**Figure 3.9:** Femoral venous catheterization.

## Femoral Vein Access Sites

Technically, the femoral vein is the most straight forward site and has the lowest risk of complications. For these reasons, imaging guidance is not needed for this approach. However, this site is not recommended except in emergencies since the risk of infection is significantly higher than other sites and restricts patient movement. US-guided cases may be performed in patients for whom it is difficult to obtain a femoral artery pulse due to overweight, requirement for urgent vascular access or for those who are not suitable for subclavian and internal jugular venous access.

The entry site is 1-2 cm below the inguinal ligament. If US will not be used, it is appropriate to enter the femoral vein 1 cm medial of the arterial pulse location (Figure 3.9).

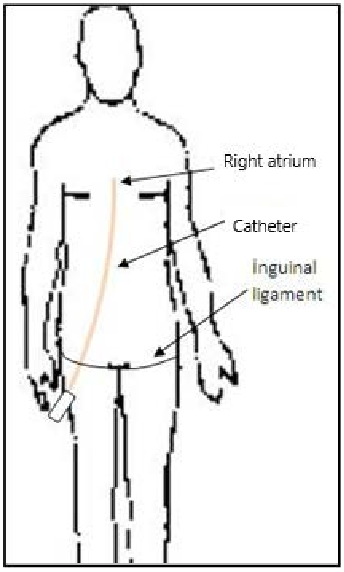


**Figure 3.10:** View of a catheter pathway from the right femoral vein to the right atrium.

Today, especially for dialysis patients, there are various sized catheters (up to 55cm) designed to reach from femoral vein to right atrium level (Figure 3.10).

## INFREQUENT VENOUS ACCESS SITES

These sites are alternative access routes in patients who require long-term catheterization (for hemodialysis or TPN) and can not use conventional routes due to contraindications such as stenosis, occlusion, thrombus, anatomical variations, infection, or burns at the entrance site.

Translumbar inferior vena cava, external jugular vein, hepatic veins, renal vein, internal mammary vein, scalp veins, cephalic vein, pudendal vein, gonadal vein, inferior epigastric vein, azygos vein and intercostal veins can be used for these purposes. The catheter tip should be terminated in the superior vena cava, right atrium, or inferior vena cava near the right atrium.

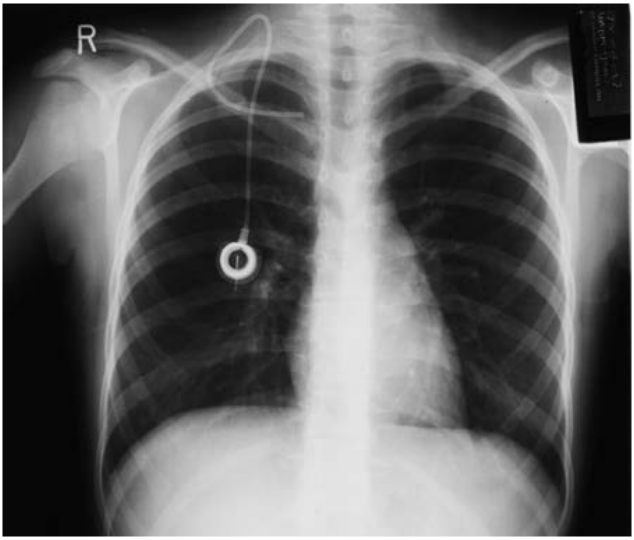

**Figure 3.11:** A case in which a subcutaneous venous port was performed by pediatric surgeons using the cut-down method from the right external jugular vein. Since the catheter length is left short, the tip ends in the right brachiocephalic vein (Primary malposition).

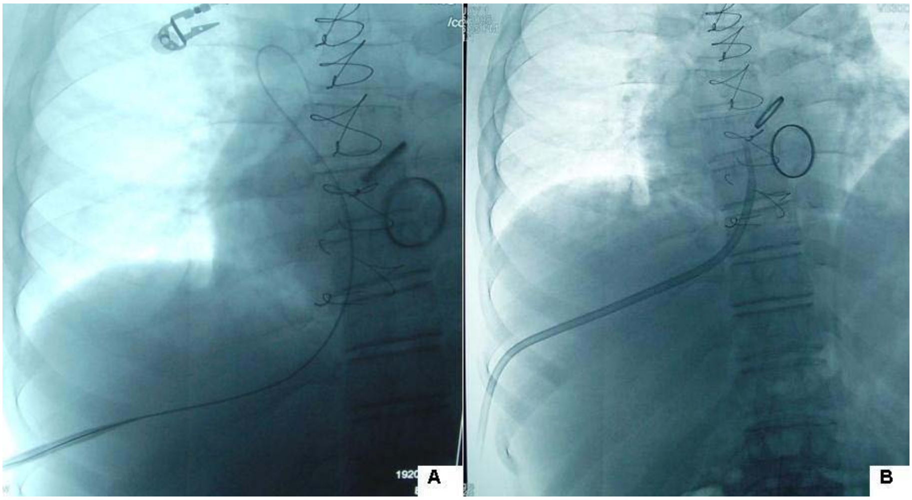


**Figure 3.12:** A 14-year-old male patient with chronic renal failure who underwent aortic and mitral valve replacement. Due to recurrent venous catheterizations, there is stenosis in superior vena cava and thrombus in both femoral veins. The left image depicts a peel-away sheath that is advanced over the guide wire inserted through the middle hepatic vein (A). At the end of the procedure, the tip of the double lumen dialysis catheter ends in the right atrium (B).

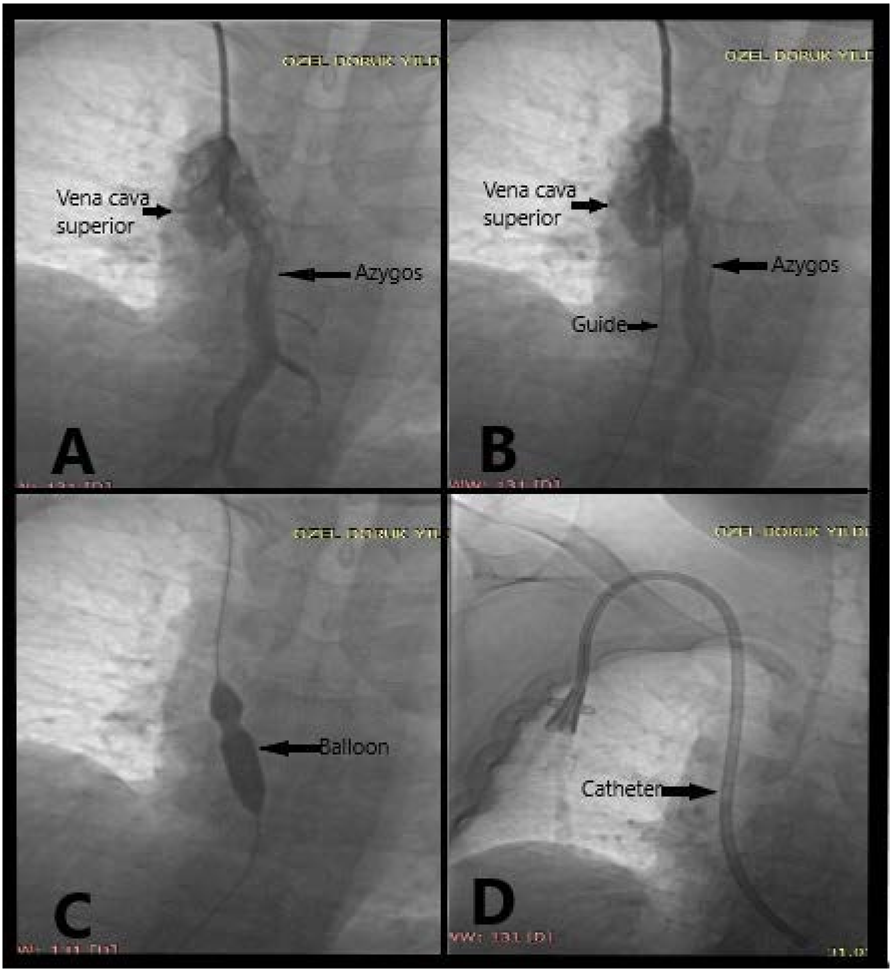


**Figure 3.13:** There were no vascular structures suitable for atriovenous fistula or graft in either arm of a patient who had been on dialysis for many years. A tunneled dialysis catheter placement was planned for the patient with vena cava superior syndrome (VCSS). The patient also had a history of many CVC placements spanning years. First, vena cavagraphy was obtained by entering through the internal jugular vein (A). The superior vena cava was observed to be completely blocked just before joining the right atrium. The drainage in the proximal part of the vena cava superior directed to the azygos vein. By conducting appropriate maneuvers, the guide wire was passed through the congested segment and delivered to the inferior vena cava (B). Consecutive dilatations were performed with larger-sized balloons starting from a small diameter (C). When the diameter of the clogged segment reached a normal width, a permanent dialysis catheter was placed in the tunnel and the procedure was completed (D)

## External Jugular Venous Catheterization

This technique is generally used by pediatric surgeons, especially for long-term catheterization. Because it is superficial and can be seen even on the sternocleidomastoid muscle (SCM) with the naked eye, US guidance is not needed. However, fluoroscopic guidance during the advancement of the guide wire reduces the risk of primary malposition (Figure 3.11).

External jugular venous access is not preferred by interventional radiologists. It should be kept in mind that it can rarely be used.

## Transhepatic Venous Catheterization

When conventional venous access sites cannot be utilized by interventional radiologists, particularly if long-term catheterization is required (e.g., dialysis), it is the most preferred alternative site (Figure 3.12).

The middle or right hepatic veins can be used for the access site. This procedure is performed with US-guidance in accordance with the angle of the entry vein, either subcostally or intercostally. Ensure that the tip of the guide wire is advanced to the superior vena cava during the procedure (with fluo-roscopic guidance). The subsequent steps are the same as for other venous access sites.

## Translumbar Inferior Vena Cava Catheterization

Translumbar catheterization is the most common form of non-traditional catheterization, which was preferred mostly by interventional radiologists before transhepatic catheterization became outdated. This procedure usually requires a marker for the entry of the venous needle. A guidewire or pig-tail catheter may be used as a marker. At the beginning of the procedure, the introducer and marker are placed from the femoral vein while the patient is lying in the supine position. The patient is then returned to the prone position. The oblique position is given with the right side 15 degrees above. The vein is entered with a 21 or 22G Chiba needle from the right outer part of the midline through the line passing through the crista iliaca. The needle is advanced to the marker with fluoroscopic guidance. If necessary, the safety of the entry process can be increased by the cavogram obtained by introducing a contrast agent through the introducer.

Once the catheter path is provided with guide wire and expanders, the usual catheter placement is performed.

Usually a TC is inserted and the tunnel exit area is the right lumbar region.

## Recanalized Vein Catheterization

Narrowed vein catheterization may be attempted when other routes cannot be used. To do this, it is necessary to recanalize the narrowed part with a series of expansion or balloon angioplasty by passing through the guide-wire (Figure 3.13).

This technique is the most frequently used for subclavian vein stenosis. Catheterization from the external jugular or collateral veins can also be attempted, however, it should be kept in mind that the procedure time and technical difficulty will increase.

Depending on the site of the vein, there are different approaches such as axillary approach, subclavian approach, and main femoral approach.

# CHAPTER 4

# Temporary (Non-Tunneled) Catheter "NTC"

**Asst. Prof. Mustafa Gok, MD.**

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*Mrcid GD8 ....+.../+5.0/+.762*

## (NON-TUNNELED) CATHETER PLACEMENT

### Preparation

All patients must be informed about the procedure and consent should be obtained prior to commencement.

Then, bleeding tests and complete blood counts should be performed.

For the procedure, it is recommended that the INR value should be below 1.5 and the platelet count should be above 50.000 to reduce the risk of bleeding. However, for patients that can not have vascular access with con-ventional methods and need urgent vascular access, platelet count above 25.000/$mm^3$ is acceptable.

When the patient is taken to the interventional room, the vascular access should be prepared and the patient monitored. Venous anatomy should be examined with US (Ultrasonography) and intervention should be planned. It should be determined which venous structure is going to be used for the access.

After the team is wearing masks, caps and wearing lead aprons, appropriate sterile aprons and gloves can be worn.

In our experience, performing the procedure under local anesthesia is sufficient for adults. However, it can be applied under IV sedation or general anesthesia in children and adults who have intense anxiety or low pain threshold.

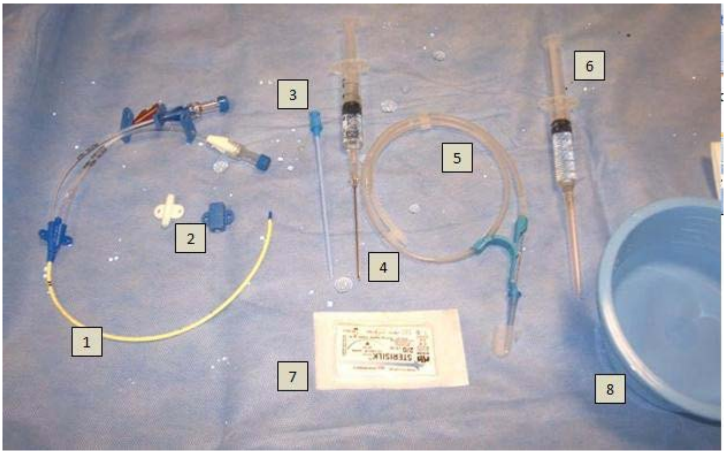


**Figure 4.1:** Materials needed for NTC insertion. 1. Triple lumen temporary infusion catheter, 2. Replacement wing set, 3. Dilatator, 4. Vein needle (with injector contains saline), 5. Guide wire, 6. Injector (for local anesthetic application), 7. 2/0 Silk suture, 8. Washing bowl.

The materials used during NTC insertion are shown in Figure 4.1.

## NTC Placement Procedure

An elevation is placed on the interscapular region of the patient to slightly extend the neck (such as a folded towel or patient pad). The patient's head is then turned to the opposite side of the procedure.

Surgical skin preparation is performed by wiping at least 3 times with povidone-iodine (Batticon™) from the center to the edges where venous access is to be applied (Figure 4.2). Alternatively 2% chlorhexidine or 70% alcohol can be used.

After the intervention site is covered with a sterile drape, the US probe should be prepared in a sterile fashion.

Entrance site should be detected with US. A high jugular approach is the most suitable approach for internal jugular vein entry. For subclavian access, the infraclavicular approach is the most appropriate one.

The local anesthetic (e.g. prilocaine or bupivacaine for infants) is administered with dental syringe using US guidance. Then a 0.5 cm incision is made at the entry site of the vein, which contains the skin subcutaneous tissues.

**Resim 4.2:** Surgical skin cleaning in a patient that was planned to have right internal jugular vein approach.

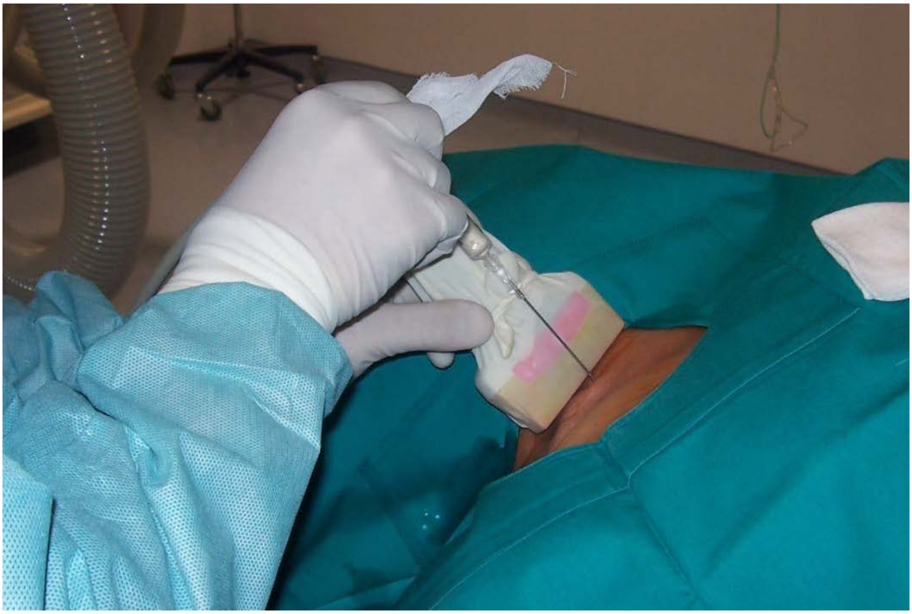

**Figure 4.3:** Right internal jugular vein approach with US guidance

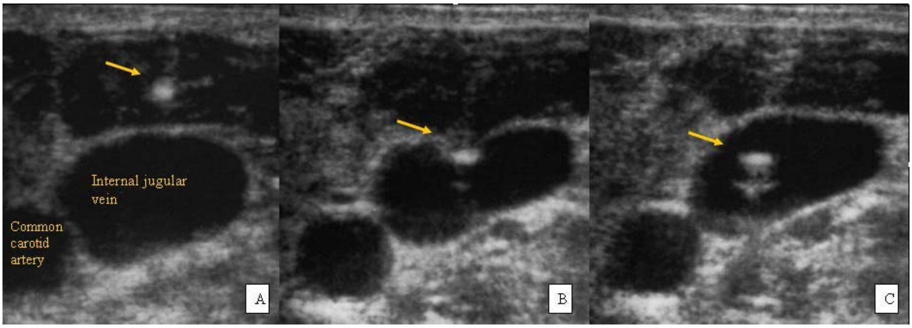


**Figure 4.4:** US-guided needle (yellow arrow) entering the internal jugular vein (successive images)


**Figure 4.5:** Advancing the guide wire towards the inferior vena cava

Under the guidance of the US, the venous entry needle is inserted with an 18 G venous needle (Figures 4.3 and 4.4).

The 0.035 inch guide wire through the vein needle is advanced to the inferior vena cava (Figure 4.5).

**Figure 4.6:** Dilatation with vascular dilator over the guide wire

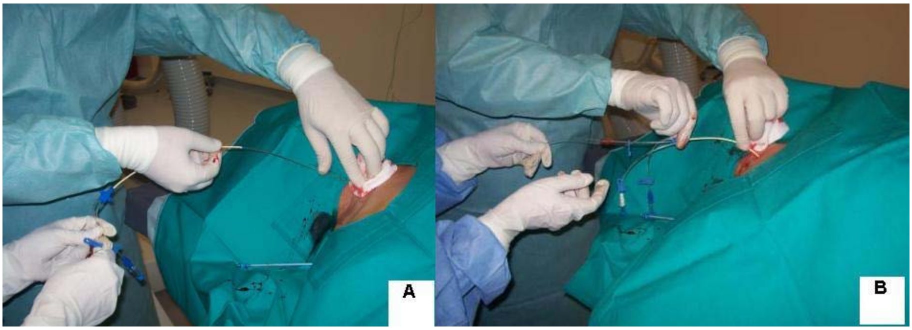


**Figure 4.7:** Placement of the catheter over the guide wire. If it is noted, in figure A, the intervention radiologist applies pressure to the venous access site to prevent bleeding after widening the left hand. This pressure application should be performed until the catheter enters the vein (B).

The needle is then removed. The access path is provided with the dilatator (Figure 4.6). Depending on the diameter of the catheter, one or more expanders of suitable diameter are used. Some prefer not to make the incision at the beginning, but over the guide wire before using the dilatators. These different applications have no superiority to each other.

When the expander is removed, gentle compression should be applied to the venous access location. Bleeding occurs if pressure is not applied because

**Figure 4.8:** Measuring catheter length with fluroscopic guidance.

**Figure 4.9:** Catheter lumens are checked for functionality.

a catheter tract is formed in this region due to dilation. After dilation, the catheter is placed into the vessel through the guide wire (Figure 4.7).

The length of the catheter is measured with fluroscopic guidance (Figure 4.8).

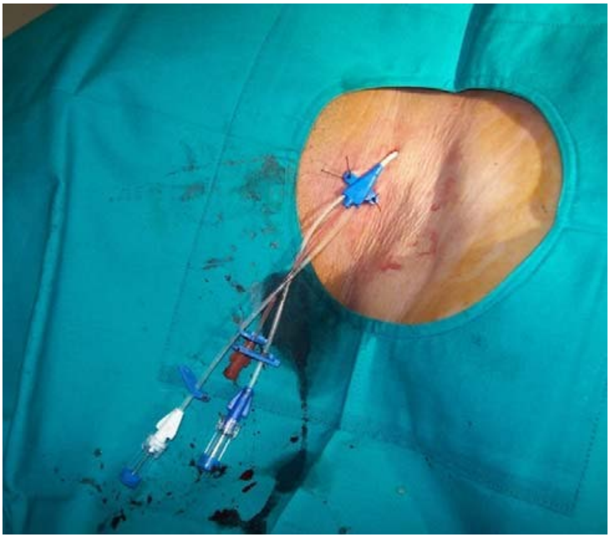

**Figure 4.10:** Triple-lumen temporary infusion catheter sutured to the skin (with 2/0 silk)

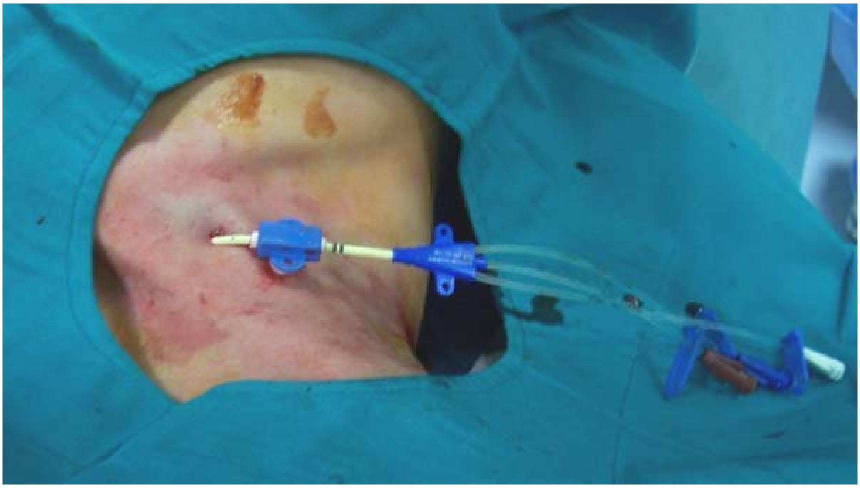

**Figure 4.11:** Since the part outside of the skin is long, the spare wings are attached to the catheter close to the skin outlet (another patient).

It is necessary to check whether all the lumens of the catheter are functional or not after the catheter placement with fluroscopic guidance (Figure 4.9). After application of aspiration and infusion in all the lumens of the catheter, all lumens should be filled with saline solution and cleaned.

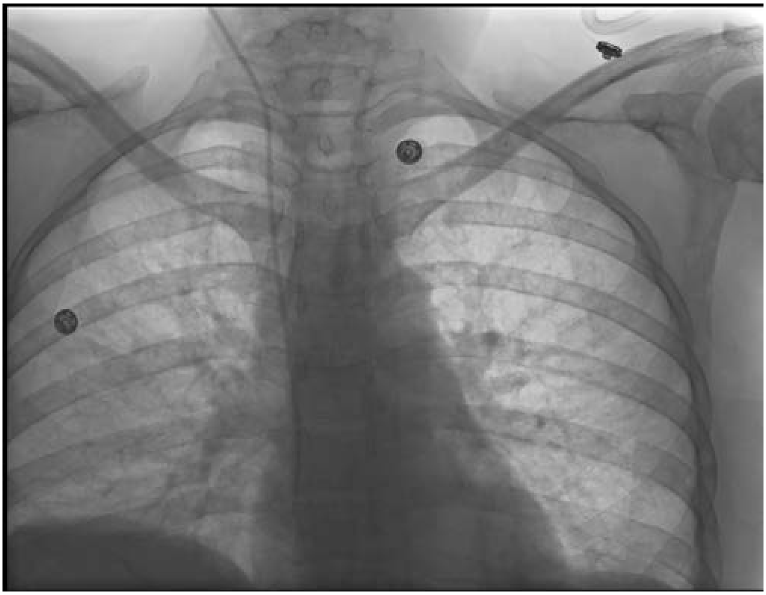

**Figure 4.12:** Digital radiogram shows a temporary infusion catheter which was inserted from the right internal jugular vein.

There are wings which have side holes for the fixation sutures, on the outer part of the catheter. With these holes, the catheter is fixed to the skin (Figure 4.10).

In general, NTC have many size options, so the most appropriate one should be chosen for the patient. However, sometimes, if there is no appropriate catheter size available, the outer part of the inserted catheter may remain too long. In this way, fixation the catheter to the skin will make maintenance difficult so this increases the risk of fracture. To prevent this, the catheter sets are usually provided with spare wings which can be attached to the desired site of the catheter (Figure 4.11)

After the procedure (Figures 4.12 and 4.13), the patient should be observed for half an hour for the possibility of bleeding or slow developing pneumothorax.

NTC can be used immediately after the procedure.

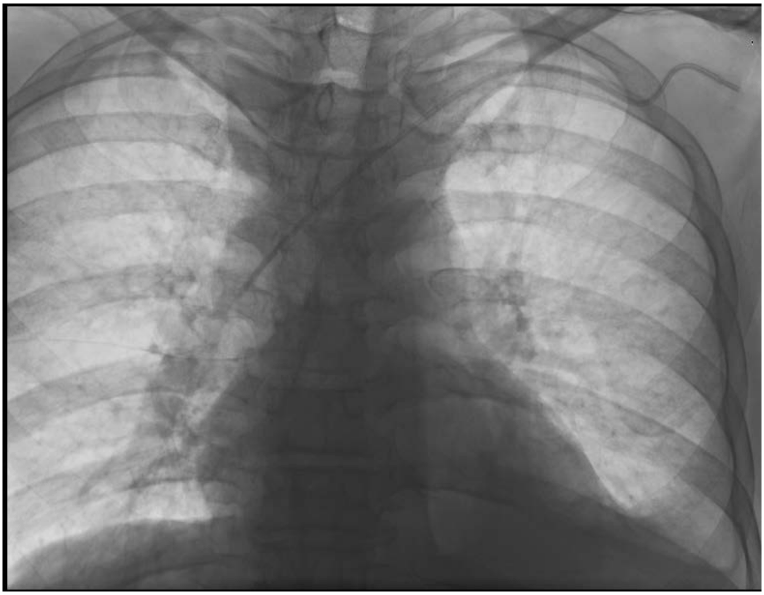

**Figure 4.13:** Digital radiogram shows a temporary infusion catheter which was inserted from the left subclavian vein. The tip remained 2 cm higher than it should be due to the insufficient length of the catheter.

## TEMPORARY (NON-TUNNELED) CATHETER REMOVAL

### Preparation

Catheters that have lost their functionality due to the end of treatment or complication cannot be reused. Catheters that are decided to be removed due to complications can be replaced with a new catheter over the guide wire if there is no contraindication to venous catheterization in the same way.

Patients who have been decided to remove the catheter should be informed about the procedure and their consent should be obtained. Then bleeding tests and complete blood counts should be performed.

For the procedure, the INR value should be below 1.5 and the platelet count should be over 25.000/mm$^3$.

Anesthesia is not required during the procedure. It is important to obey asepsis-antisepsis rules. The procedure can also be performed in the patient's room. No lead gowns or sterile gowns are required. It is enough to use sterile gloves.

## NTC Removal Procedure

The vein entry site is cleaned from the center to the edges with povidone-iodine (Batticon™). Alternatively 2% chlorhexidine or 70% alcohol can be used.

The fixation sutures in the catheter wings should be removed then the catheter is slowly withdrawn. After removing the catheter from the vein, compression should be applied for 5-10 minutes to the venous access site.

Venous entry site should be closed sterile and then 5 cm sized catheter tip should be cut and sent to the microbiology laboratory.

If the procedure is performed in the interventional radiology unit, the patient can be referred to his clinic or home after the procedure.

# CHAPTER 5

## Permanent (Tunneled) Catheter "TC"

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### PERMANENT (TUNNELED) CATHETER PLACEMENT

#### Preparation

Permanent tunneled catheter (TC) placement is similar to venous port implantation except that the port pocket is not prepared. Patients for whom TC is indicated should first be informed about the procedure and their consent obtained. Then, bleeding tests and complete blood counts should be performed.

For this procedure, it is recommended that the INR value should be below 1.5 and the platelet count should be above 50.000/$mm^3$. However, for patients who can not have vascular access with conventional methods and need urgent vascular access, a platelet count above 30.000/$mm^3$ is acceptable. Six hours fasting is recommended before the procedure in case of emergency or to give anesthesia when needed.

When the patient is taken to the intervention room, vascular access should be prepared and the patient should be monitored. Venous anatomy should be examined with Ultrasonography (US) and intervention should be planned. It should be determined which venous structure is going to be used as an access.

After the team is wearing masks and gowns and wearing lead aprons, appropriate sterile gowns and gloves can be worn.

In our experience, performing the procedure only under local anesthesia is sufficient for adults. However, IV sedation or general anesthesia may be applied for children and adults who have intense anxiety or low pain threshold.

Before the procedure, the chest should be shaved to remove bodily hairs and the procedure area should be cleaned.

## TC Placement Procedure

An elevation is placed below the interscapular region of the patient to slightly extend the neck (such as a folded towel, patient pillow, etc.). The patient's body is then turned to the opposite side of the procedure side. Since the patient's face will be covered during the procedure, wearing an oxygen mask is beneficial for the patient to breathe comfortably.

Surgical skin cleansing is performed by wiping at least three times with povidone-iodine (Batticon™), from the mandible to the breast subfold, from the sternum to the midaxillary line, and from the center to the edges (alternatively 2% chlorhexidine or 70% alcohol can be used) (Figure 5.1).

After the patient's entire body is covered with at least 2 layers of waterproof fabric, except the procedure site, the US probe should be prepared sterilely.

**Figure 5.1:** Surgical skin cleaning before the procedure

The entrance site should be detected with US. The ideal area for internal jugular vein entry is just above the clavicle. For subclavian access, the infraclavicular approach is appropriate.

A local anesthetic agent (eg prilocaine / bupivacaine for infants) is injected between the vein and the skin using a US-guided dental syringe (Figure 5.2). The aim here is not just to provide local anesthesia but also to open the space between the vein and the skin, to prevent vascular injury during the skin inci-

**Figure 5.2:** Local anesthesia application to the venous entrance site

**Figure 5.3:** Making a skin incision at the venous entrance site.

sion. Then, a 1 cm incision through subcutaneous tissue is made at the entrance site (Figure 5.3). With the help of a clamp subcutaneous tissues are separated from each other (Figure 5.4) then a US-guided 18 G venous access needle is inserted into the vein. The 0.035-inch guide wire is then advanced through the needle to the inferior vena cava (Figure 5.5).

The needle is then removed. The input path is provided with the dilator. Depending on the diameter of the catheter, one or more expanders of suitable diameter are used. A fluoroscopy-guided, peel-away sheath is placed over the

**Figure 5.4:** Separation of subcutaneous tissues in the incision area with the help of clamps.

**Figure 5.5:** Advancing the guide wire through the puncture needle (following images).

**Figure 5.6:** Placing the peel away sheat over the guide wire.

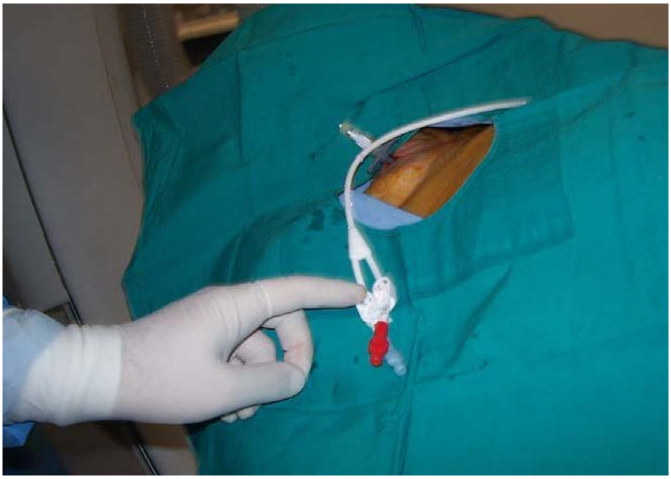

**Figure 5.7:** Determination of the possible path by placing the catheter on the body.

guide wire (Figure 5.6). After the guide wire is removed, the lid of the peel-away sheath is closed to prevent bleeding or air embolism, and the first stage of the process is completed.

In the second stage, the catheter size is calculated with fluoroscopy and the entrance of the tunnel to the skin is determined (Figure 5.7). To calculate the size of the catheter the part outside the vessel can be folded when the guide wire is retracted to the appropriate position.

**Figure 5.8:** Local anesthetic application from the incision site to the area to be tunneled.

**Figure 5.9:** Local anesthetic application from venous entry area to tunnel area.

Subsequently, local anesthesia is applied to the subcutaneous tissues at the entrance of the catheter to the tunnel. A skin-subcutaneous incision (usually a 1 cm incision is sufficient) is made. Subcutaneous tissues are separated up to fascia with the help of a clamp; then, a venous needle is inserted through the incision side and a local anesthetic is applied to the area up to the venous entry side (Figure 5.8). If local anesthetics cannot be applied to the entire tunnel area from the incision side, the procedure can be repeated by entering the vein needle under the skin through the venous entry site (Figure 5.9).

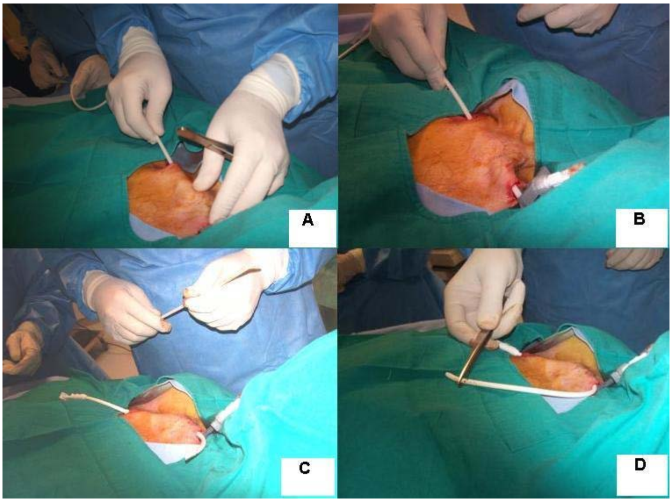


**Figure 5.10:** Creation of tunnel with tunnel opener (following images).

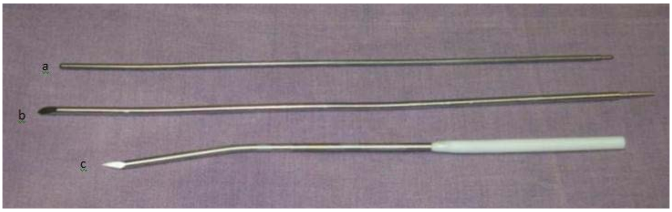


**Figure 5.11:** Examples of (a) blunt-tipped, (b)-(c) sharp-tip tunnel opener (trocar). The tunnel marked with (c) has a curved tip and a protective cover to prevent the catheter from separating during tunnel formation. Apart from these examples, tunnel opener types made of other materials such as plastic are also available and should be chosen according to the characteristics of the process.

Then, the tunnel is created using the trocar (tunnel opener). The catheter which is inserted behind the trocar is also passed through the tunnel (Figures 5.10 and 5.11).

After confirming that the catheter is not folded, the soft tissues between the sheath and the catheter are separated by a clamp in the venous access region. The peel-away sheath expander is then removed and pushed into the catheter sheath (Figure 5.12). The sheath is broken and slowly removed by taking care of the catheter not to come back (Figure 5.13).

After it is observed under fluoroscopy that the catheter is in the proper position, it is necessary to check whether the lumens of the catheter are functional (Figure 5.14). The functional catheter to be used for dialysis should


**Figure 5.12:** The structure of the peel-away sheat (A) consisting of the expander (dilator) and the sheath (B).

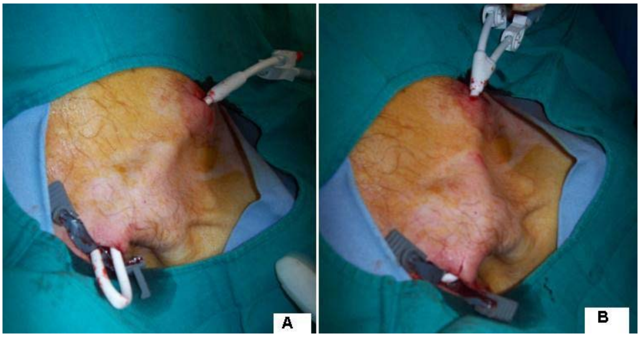


**Figure 5.13:** Advancing the catheter through the peel-away sheath.

allow a 300 cc/min flow rate. To control this, a 10 cc syringe is taken and connected to the catheter, and pulled rapidly. If 10 cc can be withdrawn in 2 seconds (300 cc per minute), the catheter can be used for dialysis.

After checking all the lumens are easily aspirated and infused, the lumens should be cleaned by filling with saline. There are also authors who recommend the use of heparinized saline (100 units heparin per ml) instead of just saline. However, in our experience, cleaning the catheter just with saline and to prevent blood remains is sufficent.

**Figure 5.14:** Functional check of catheter lumens.

Catheters to be used for dialysis should be filled with heparin (5000 units/cc) after the first dialysis procedure. It should be remembered that heparin greater than lumen volume increases the risk of bleeding by prolonging bleeding time.

Because of the prolonging bleeding time with heparin usage, alternative solutions have been tested. As a result of these trials, locking solutions containing sodium citrate was introduced to the market (Figure 5.15). Initial studies have shown that these solutions not only prevent fibrin sheath and thrombus formation, but also reduce catheter-related infection rates. However, these results need to be confirmed by new controlled trials.

Once the catheter is confirmed to be functional, the venous access incision is sutured (Figure 5.16). In general, there are wings and holes within these wings for the fixation sutures on the part of the catheter outside the skin. Models without wings should be fixated to the skin with the knotting method (Figure 5.17).

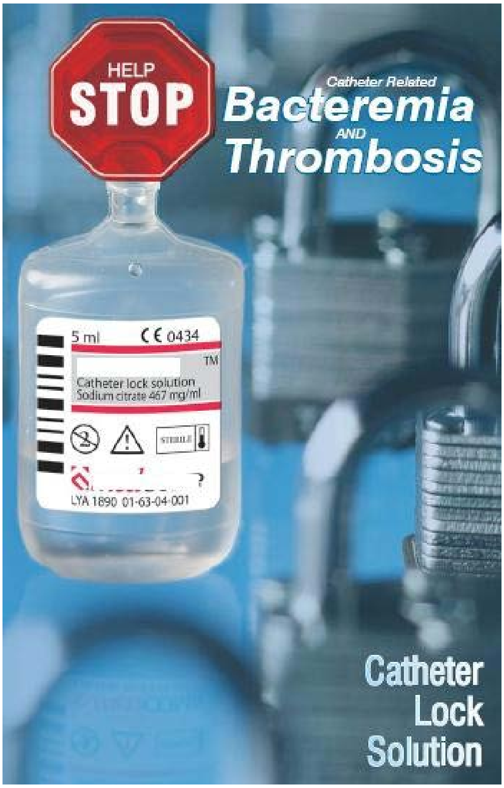


**Figure 5.15:** Brochure of catheter locking solution (brand and company name has been covered).

**Figure 5.16:** Suture of the incision in the venous access site with 2/0 silk.

After the procedure (Figure 5.18), the patient should be observed for at least 1-2 hours to monitor possible bleeding or slow development of a pneumothorax. The patient is then called back to evaluate wound after 72 hours.

The TC can be used immediately after the procedure (Figures 5.19 and 5.20).

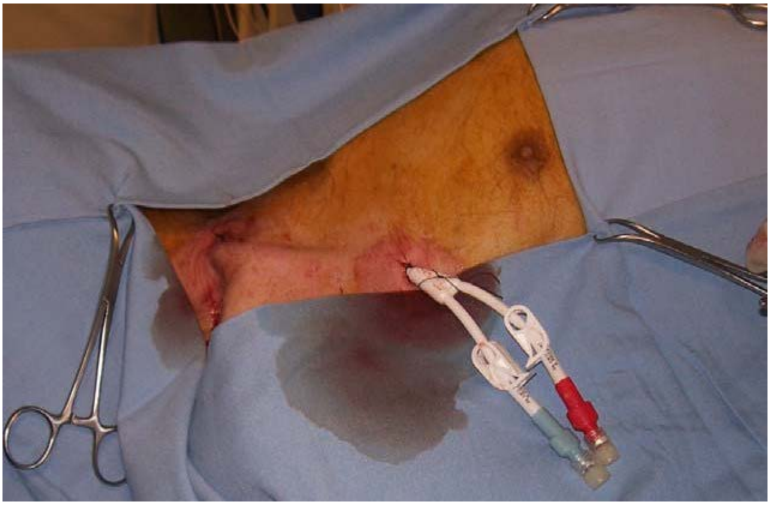

**Figure 5.17:** Fixing the catheter without wings to the skin with knotting suture.

**Figure 5.18:** View of the patient after the procedure.

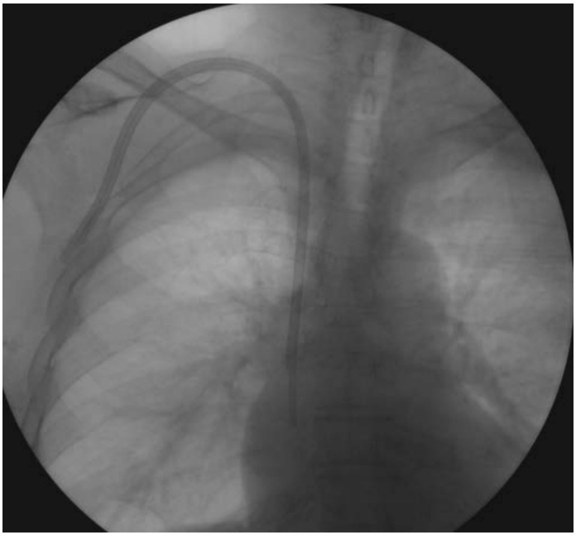

**Figure 5.19:** Digital radiogram shows a tunnel catheter inserted from the right internal jugular vein.

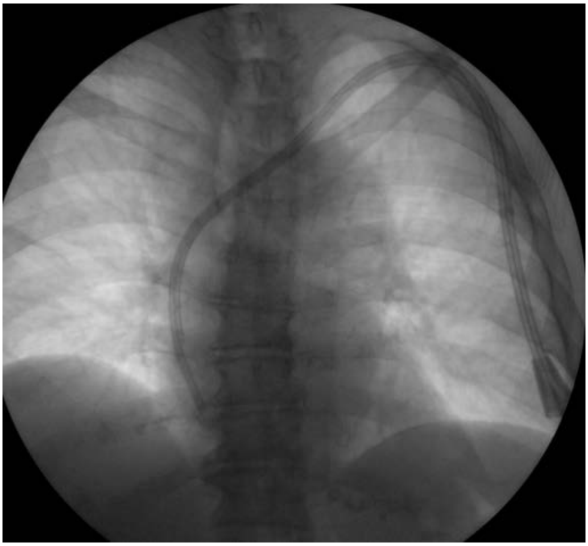

**Figure 5.20:** Digital radiogram shows a tunneled catheter placed through the left internal jugular vein.

## PERMANENT (TUNNELED) CATHETER REMOVAL

### Preparation

TC can be removed, if no recurrence is detected at the 6-month follow-up after completion of chemotherapy, if there is no more need for chemotherapy, or if another route such as an AV fistula is used for patients who are having hemodialysis.

In the case of catheters that have lost their functionality, first, the methods described in the complications section (Chapter 9) should be implemented. If it is unsuccessful, the catheter can be replaced with a new catheter over the guide wire if there is no obstacle to catheterization by the same venous route.

Patients for whom catheter removal has been decided, should be informed about the procedure and their consent should be obtained in the first place; then, bleeding tests and complete blood counts should then be performed.

For the procedure, the INR value should be less than 1.5 and the platelet count should be over 30,000/mm$^3$.

According to our experiences, prophylactic antibiotic use is not required if the necessary asepsis-antisepsis rules are followed during the procedure.

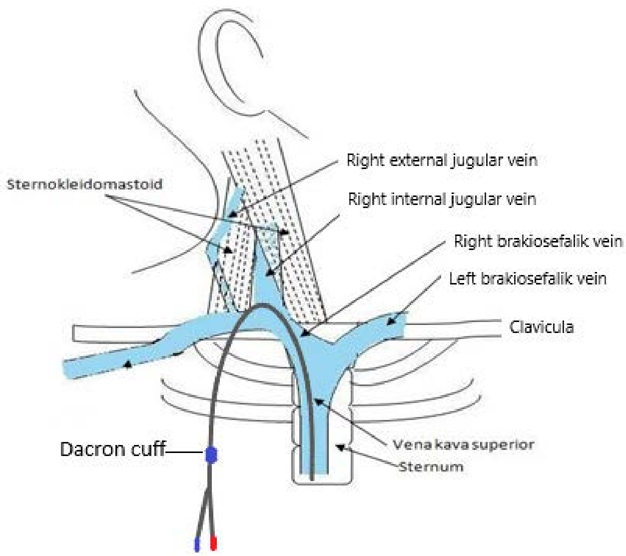


**Figure 5.21:** Schematic view of the tunneled catheter inserted through the right internal jugular vein.

Performing the procedure just with local anesthesia is sufficient for adults. However, IV sedation or general anesthesia may be needed in children or adults who are intensely worried about the procedure or those with a low pain threshold.

Once the patient is admitted to the procedure room, the vascular access should be opened and the patient should be monitored. The team should wear a mask and cap and wear sterile gowns and gloves. There is no need to wear a lead apron as fluoroscopy will not be used during the procedure.

## TC Removal Procedure

First, the fibrous ring formed around the cuff is palpated preventing easy removal of the tunnel. A decision can then be made about where to perform

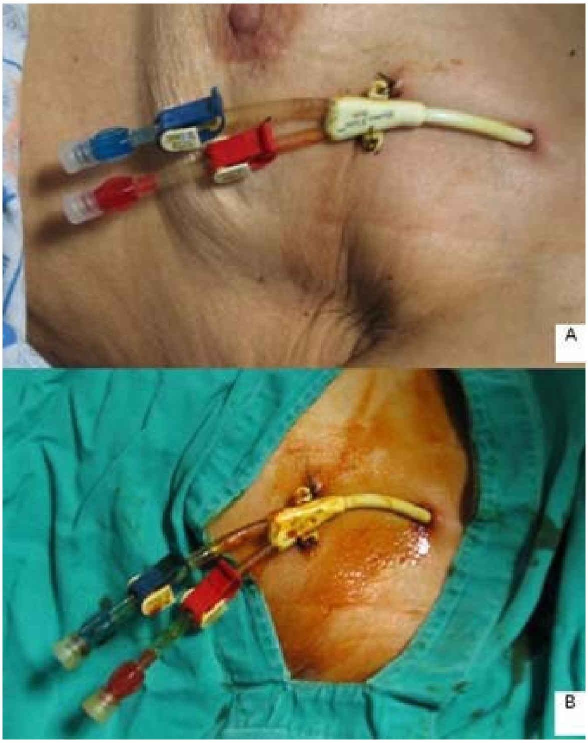


**Figure 5.22:** The catheter section outside the skin (A), covering with single hole cover following the skin cleaning (B).

the incision (Figure 5.21). If a local anesthetic is applied first, it may be difficult to feel the cuff.

If the catheter insertion time is less than 3 weeks, there will be little fibrotic tissue around the cuff and it can easily be removed without any dissection. In longer insertion time, attempts to pull the catheter out without dissection may cause the catheter to break or even cause embolization.

Surgical skin cleaning is necessary after the fibrous ring is felt by hand. For this, povidone-iodine (Batticon™) (Alternatively 2% chlorhexidine or 70% alcohol) can be used. Tunnel localization should be wiped 3 times from the center to the edges. The outer parts of the catheter are also dipped into a container containing liquid povidone-iodine followed by wrapping with a sterile gauze pad, then use of a sterile cover with one-hole (Figure 5.22).

It is necessary to drain the catheter lumen contents with a syringe before performing the catheter removal procedure.

A local anesthetic is applied to the catheter entry site (Figure 5.23). If the cuff is in close proximity to the exit of the tunnel, extend the tunnel entry site with the help of a clamp and reached to the cuff, and try to separate it from the fibrous tissue (Figure 5.24). Since this procedure will be very painful, adequate local anesthesia should be provided.

If fibrous tissues cannot be separated by blunt dissection, a scalpel may be used without damaging the catheter. The use of a scalpel for sharp dissection makes the procedure faster and easier to complete. However, it is recom-mended that this is performed by an experienced interventional radiologist due to the risk of catheter damage and embolism (air, catheter tip). If the

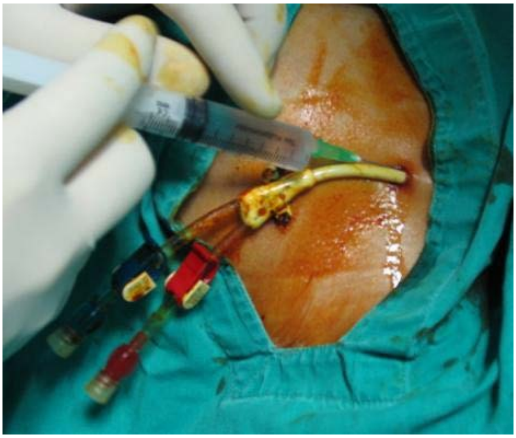

**Figure 5.23:** Local anesthetic application instead of catheter access.

interventional radiologist does not have sufficient experience, he/she should separate the fibrous tissue from the cuff by blunt dissection only.

If the cuff is located far from the tunnel exit, after a local anesthetic is applied to the tunnel entry site, a local anesthetic should also be applied to the area where the fibrous tissue is felt. Following incision in this area, fibrous tissue is reached by blunt dissection and separated from the cuff.

After the cuff is separated from the fibrous tissue, the catheter should be pulled out slowly (Figure 5.25). If the fibrous tissue is completely separated,

**Figure 5.24:** Removal of fibrous tissue around the catheter with blunt dissection.

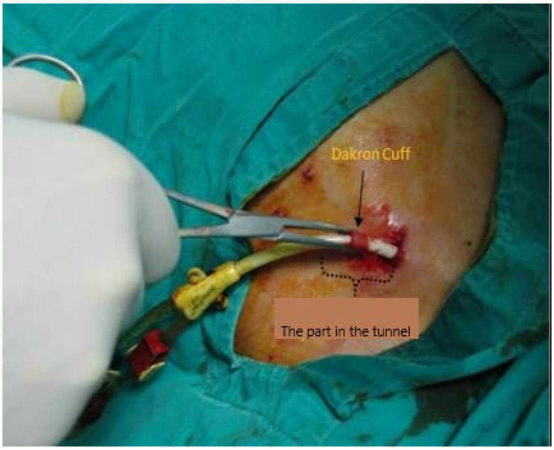


**Figure 5.25:** Withdrawal of the catheter after getting rid of the fibrous sheath.

the catheter can be easily delivered. After the catheter is removed, pressure should be applied for 5-10 min. Usually, there is no need to stitch the tunnel exit. However, if the tunnel outlet has to be widened during catheter removal, the skin can be closed with primary sutures.

Cover the tunnel outlet with a sterile sponge. Cut the catheter into 5 cm pieces and send it to the microbiology laboratory in different containers. After 1-hour of observation, the patient may be discharged home or to the inpatient clinic.

The patient should be called back for evaluation after 48 hours for wound control.

## PERMANENT (TUNNELED) CATHETER REPLACEMENT

### Preparation

The catheter may be replaced over the guide wire in cases with catheter dysfunction, where attempts to rescue the catheter have failed (fibrin sheath, a clot in the lumen, drug precipitation, etc.) and if there is no contraindication (infection, thrombus) to use the same venous access route. Replacement of Groshong catheters is not recommended because the tips of the catheters are blunt. In general, catheters placed for dialysis are replaced.

Patients, with catheter removal indications, should be informed about the procedure and their consent should be obtained first. Bleeding tests and complete blood counts should then be performed.

There are authors who recommend prophylactic antibiotic use such as 1 g IV cefazolin. However, antibiotic use is not necessary according to our experience.

For the procedure, the INR value should be below 1.5 and the platelet count should be over 50,000/mm$^3$. Once the patient is admitted to the procedure room, the vascular access should be opened and monitored. The team should wear a mask and cap and wear sterile gowns and gloves.

### TC Replacement Procedure

First, the catheter should be evaluated for curl, length, position and end point, with fluroscopic-guidance.

Surgical skin cleaning is performed after the fibrous ring around the cuff is felt by hand. For this, povidone-iodine (Batticon™) (Alternatively 2% chlorhexidine or 70% alcohol) can be used. The entrance of the tunnel to the skin should be wiped 3 times, from the center to the periphery. The outer parts of the catheter are also immersed in a sterile container of liquid povidone-iodine and then wrapped sterile. The sterile one-hole cover is then covered.

It is necessary to drain the catheter lumen with a syringe before catheter removal is initiated. The sterile dressing of the catheter should not be opened and contact with parts other than the caps should be avoided.

A local anesthetic is applied around the catheter entrance side. If the cuff is close to the tunnel outlet, widening should be performed with the help of a clamp, and the cuff is reached and separated from the fibrous tissue.

If the cuff is located far from the tunnel exit, after a local anesthetic is applied to the tunnel entrance side, a local anesthetic is applied on the area where fibrous tissue is felt. Following incision in this area, fibrous tissue is reached by blunt dissection and separated from the cuff.

Following the release of the cuff from the fibrous tissue, a 0.035-inch J-tipped guide wire is routed through the venous lumen (blue) to guide it into the inferior vena cava (Figure 5.26). Usually, a single guide wire is sufficient. However, a second guide wire can be placed in the same way to increase propulsion in cases that are thought to have difficulty in catheter placement. The

**Figure 5.26:** In the case where the tunneled dialysis catheter which was inserted through the left internal jugular vein is planned to be replaced, a fluoroscopic view when the guide wire is sent through the catheter.

catheter is then slowly and steadily pulled over the guide wire. The catheter can be removed easily if the fibrous tissue is completely separated.

The new catheter is pushed through the guide wire to the desired section with the correct end orientation. The guide wire is then pulled.

The venous access incision is sutured after the catheter appears to be functional as described in the procedure of inserting the TC.

After the procedure, the patient should be observed for 1 hour. The patient should be called in evaluation after 72 hours for wound control. The removed catheter is cut into 5 cm pieces and transferred to microbiology in separate culture dishes.

A catheter can be used immediately after the procedure.

## TRANSHEPATIC VENOUS CATHETERIZATION

At present, transhepatic venous catheterization is the first preferred alternative route for patients who can-not have conventional routes due to stenosis (occlusion), thrombus (clot), anatomic variations, infection or burns at the entrance site, or who require long-term catheterization (for hemodialysis or TPN).

The risks of transhepatic catheter insertion, removal, and replacement are similar to those of conventional procedures. The only important difference is that the catheter is constantly exposed to movement due to the displacement of the diaphragm and the skin and this can cause pain and secondary malposition of the catheter over time if perpendicular access to the vein is inserted during catheter insertion. In order to prevent this, the hepatic vein should be entered as parallel as possible.

### Preparation

Patients with transhepatic tunneled catheter indication should first be informed about the procedure and their consent should be obtained. Bleeding tests and complete blood counts should then be performed.

For the procedure, it is recommended that the INR value should be below 1.5 and the platelet count should be above 75,000/mm$^3$. However, in patients who can not have venous access from classical routes and need urgent vascular access, a platelet count over 50,000/mm$^3$ is sufficient. Fasting for 6 hours is recommended before the procedure in order to facilitate emergency anesthesia should the need arise due to any complication.

Once the patient is admitted to the intervention room, the vascular access should be opened and the patient should be monitored. Venous anatomy is then examined by doppler (US). An operation plan should then be obtained and venous access route determined.

Sterile gowns and gloves should be worn appropriately after donning masks, bonnets, and lead aprons.

In our experience, performing the procedure under local anesthesia is sufficient for adults. However, IV sedation or general anesthesia may be used in children and adults who have intense anxiety or low pain threshold.

## Transhepatic Tunneled Catheter Placement Procedure

Surgical skin cleaning is performed by wiping the right abdomen half with povidone-iodine (Batticon™) at least three times from the lower breast fold to the iliac bone to the midline to the posterior axillary line (alternatively 2% chlorhexidine or 70% alcohol may be used).

After the patient's entire body is covered with at least two layers of waterproof fabric, (with the exception of the treatment site), the US probe is prepared for use in a sterile manner.

Hepatic veins are examined by US to select the most appropriate input vein (Figure 5.27), however catheters can be inserted from all hepatic veins. It is important to ensure that the catheter follows a straight path through which it can travel both at the entrance to the skin and within the vein without folding (Figure 5.28).

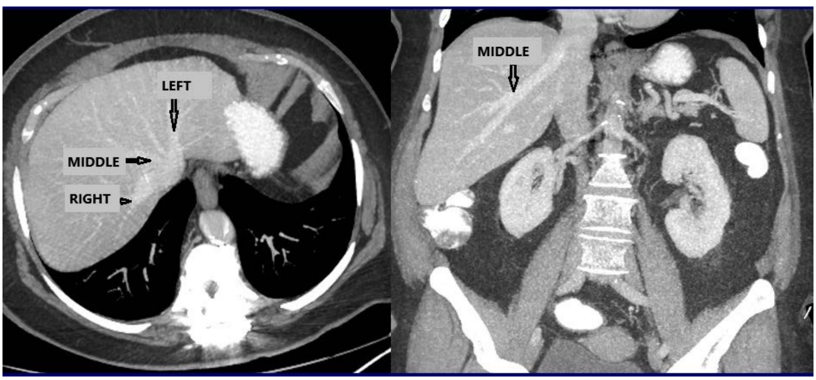


**Figure 5.27:** Computed tomographic view of hepatic veins.

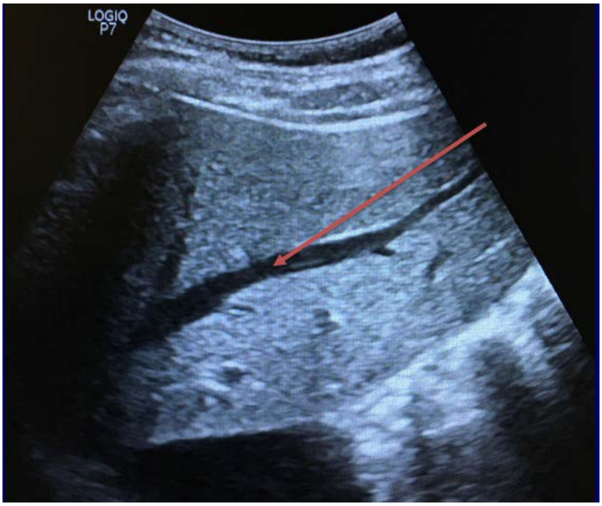


**Figure 5.28:** Roadmap to follow for transhepatic puncture to the hepatic vein (red arrow).

**Figure 5.29:** Biliary tract access set.

The experienced interventional radiologist can directly access the hepatic vein with an 18 G Chiba needle, however, multiple entries with Chiba needles will increase the risk of bleeding. Because of that, it is recommended that a bile set is used for those less experienced. These sets consist of a 21G Chiba needle, a 0.018-inch nitinol guide wire and a 6F coaxial dilator (Figure 5.29).

**Figure 5.30:** Advancing the 0.018inch guide wire through the Chiba needle towards the right atrium.

**Figure 5.31:** Coaxial system placement over the guide wire.

US-guided local anesthetic (eg prilocaine) is injected into the skin and subcutaneous tissues and the liver capsule. The incision is then made at approximately 1 cm in length, containing the skin-subcutaneous tissues. With the help of a clamp, subcutaneous tissues are separated. The selected hepatic vein is then entered with a 21 G chiba needle under the guidance of the US.

**Figure 5.32:** 0.035 wire guided through the sheath.

**Figure 5.33:** Peel away sheath in intrahepatic vein.

The 0.018 inch guide wire through the Chiba needle is advanced into the right atrium (Figure 5.30). The coaxial system is installed over the guide wire (Figure 5.31).

The dilator and stiffener of the coaxial system is removed and 0.035 or 0.038 stiff wire is sent through the remaining sheath (Figure 5.32).

The sheath is then removed. The peel-away sheath is placed over the guide wire under scopic observation (Figure 5.33). After the guide wire is removed, the lid of the peel-away sheath is closed to prevent bleeding or air embolism. This completes the first stage of the process.

The second step is the same as routine TC insertion. The catheter size is calculated, with fluoroscopic guidance, from the site of entry of the tunnel to the skin. Subsequently, local anesthesia is applied to the subcutaneous tissues at the entrance of the catheter to the tunnel then a subcutaneous incision is made. Usually, a 1 cm incision is sufficient. With the help of a clamp, subcutaneous tissues are separated first up to the fascia, then a venous needle is inserted through the incision site and a local anesthetic is applied to the area up to the venous access site. The tunnel is created using the trocar (tunneler). The catheter inserted behind the tunneler is also passed through the tunnel. After observing that the catheter is not folded, the soft tissues between the sheath and the catheter are separated by a clamp in the venous access region.

The peel-away sheath extender is then removed and pushed into the catheter sheath. The sheath is broken and slowly removed ensuring the cathether

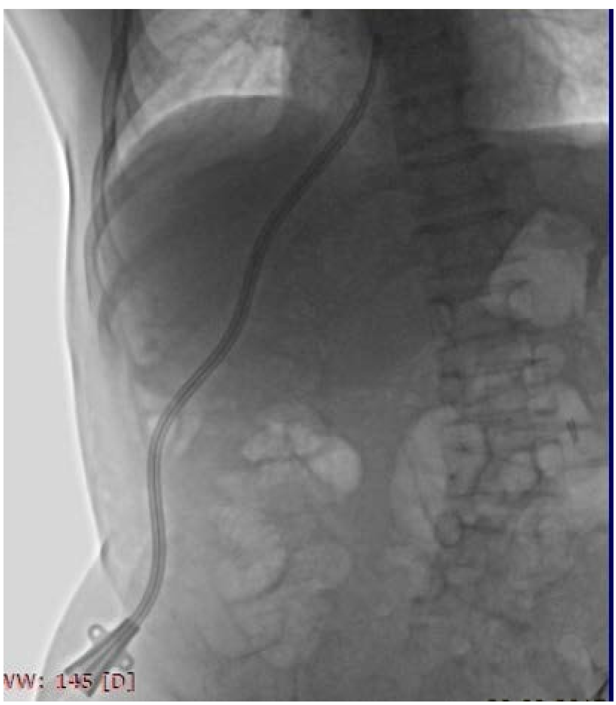


**Figure 5.34:** Permanent dialysis catheter placed transhepathically.

does not come back. After it is confirmed that the catheter is in the proper position with fluoroscopy, it is necessary to check whether all lumens of the catheter are functional. Once the catheter is found to be functional, the catheter is secured with a suture. The TC can be used immediately after the procedure (Figure 5.34).

## Transhepatic Tunneled Catheter Removal Procedure

In the case of catheters that have lost their functionality, the catheter is first repaired by using the methods described in the complications section. If unsuccessful, the catheter can be replaced with a new catheter over the guide wire given there is no obstacle to catheterization by the same venous route.

Patients suitable for catheter removal should initially be informed about the procedure and their consent obtained. Bleeding tests and complete blood counts should then be performed.

For the procedure, the INR value should be less than 1.5 and the platelet count should be over 75,000/mm$^3$.

According to our experience, prophylactic antibiotic use is not required if the necessary asepsis-antisepsis rules are followed during the procedure. It is sufficient for adults to perform the procedure only under local anesthesia. However, IV sedation or general anesthesia may be used in children and adults who have intense anxiety or low pain threshold.

Once the patient is admitted to the intervention room, the vascular access should be opened and monitored. The team should wear a mask and cap and wear sterile gowns and gloves. There is no need to wear a lead apron as the procedure is not conducted under fluoroscopic guidance.

First, the fibrous ring formed around the Dacron cuff is palpated to deter-mine, the location of the incision site if it will be challenging to remove the catheter from the tunnel exit site. If a local anesthetic is applied first, it may be difficult to feel the ring by hand.

If the catheter insertion time is less than 3 weeks, there will not be enough fibrosis around the cuff and it can easily be removed without any dissection. At longer catheterizations, attempts to pull the catheter out without dissection may cause the catheter to break or even embolize.

Surgical skin cleaning is necessary after the fibrous ring is felt by hand. For this, povidone-iodine (Batticon™) (Alternatively 2% chlorhexidine or 70% alcohol) can be used. Tunnel localization should be wiped 3 times from the center to the edges. The outer parts of the catheter are also dipped into a container containing liquid povidone-iodine (Batticon™) followed by wrapping with sterile gauze. The sterile one-hole cover is then covered.

It is necessary to drain the catheter lumen contents with the syringe before catheter removal is initiated.

A local anesthetic is applied around the catheter port. If the cuff is close to the tunnel exit, the cuff is extended with the help of the clamp to reach the cuff, with an attempt to separate it from the fibrous tissue. Since this procedure will be very painful, adequate local anesthesia should be provided.

If fibrous tissues cannot be separated by blunt dissection, a scalpel may be used without damaging the catheter. The use of a scalpel for sharp dissection makes the procedure faster and easier to complete. However, it is not recommended that this technique be performed by inexperienced persons due to the risk of catheter damage and embolism (air, catheter tip). If the person undertaking the procedure has insufficient experience, the fibrous tissue then need to be separated by blunt dissection only.

If the cuff is located far from the tunnel exit, after local anesthetic is applied to the tunnel entrance, local anesthetic should also be applied in the area where the fibrous tissue is felt by hand. Following incision in this area, fibrous tissue is reached by blunt dissection and separated from the cuff.

After the cuff is released from the fibrous tissue, the catheter is withdrawn slowly and steadily. If the fibrous tissue is completely separated, the catheter can be easily delivered. After the catheter is withdrawn, pressure is applied to the area where the catheter comes out of the vein for 10 min. Usually there is no need to stitch the tunnel exit. However, if the tunnel outlet has to be widened during catheter removal, the skin can be closed with sutures. The patient can be discharged after 3 hours of observation and with control US examination.

The spongy structure of the liver is highly absorbant and prevents bleeding. Bleeding is not expected after removal of the transhepatic catheter in patients with normal bleeding parameters.

For more information about transhepatic catheter, please refer to the publication of Şanal et al. (Şanal B, Nas OF, Doğan N, Korkmaz M, Hacikurt K, Yildiz A, Aytac IK, Hakyemez B, Erdogan C. Diagnostic and Interventional Radiology, 2016; 22 (6): 560-565, doi: 10.5152 / dir.2016.16043).

# CHAPTER 6

# Subcutaneous Venous Port

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## SUBCUTANEOUS VENOUS PORT IMPLANTATION

### Preparation

Patients planned for venous port placement should first be informed about the procedure and their consent should be obtained. Bleeding tests and complete blood counts should then be performed.

For the procedure, the international normalized ratio (INR) should be below 1.5 and the platelet count should be above 75,000/mm$^3$. A total of 6 hours of fasting is recommended before the procedure to lessen the risk of developing a life threatening complication.

There are different opinions regarding the use of prophylactic antibiotics. Some publications suggest that all patients should be given antibiotics (1 g IV cefazolin 30 minutes before the procedure), in some publications it is suggested that only neutropenic patients should receive antibiotics. However, many publications indicate that prophylactic antibiotic use is not necessary. In our experience, the prophylactic antibiotic application is unnecessary if the necessary asepsis-antisepsis rules are followed during the procedure.

When the patient is taken to the intervention room, the vascular access should be prepared and the patient should be monitored. Venous anatomy should be examined with US and intervention should be planned. It should be determined which venous structure is going to be used as an access and where the port reservoir will be placed.

The team should perform surgical hand washing after wearing a mask and cap, and wear lead aprons. Sterile gowns and gloves should then be worn in accordance with operating room conditions.

It is sufficient to perform the procedure on adults only under local anesthesia. However, IV sedation or general anesthesia can be used in children and adults who have intense anxiety or low pain threshold.

Before the procedure, the patient's chest hairs (if any) should be shaved and cleaned. The instruments used for subcutaneous venous port placement are shown in Figure 6.1.

## Venous Port Implantation Procedure

An elevation is placed under the interscapular region of the patient to slightly extend the neck (such as a folded towel, patient pad, etc). The patient's head is then turned to the opposite side of the procedural site. Since the patient's face will be covered during the procedure, wearing an oxygen mask is beneficial for the patient to breathe comfortably. Surgical skin cleansing is per-formed by wiping at least three times with povidone-iodine (Batticon™) from the mandible to the sub-nipple folding, from the sternum to the midaxillary line, from the center to the edges (alternatively 2% chlorhexidine or 70% alcohol can be used) (Figure 6.2).


**Figure 6.1:** Tools used to place subcutaneous venous port 1.Painting forceps, 2. Portege, 3. Surgical scissors, 4. Small clamp, 5. Large clamp, 6. Collet, 7. Scalpel tip and handle, 8. Dental tip injector (For local anesthetic injection), 9. Washing tray (inside a standard port set content appears).

**Figure 6.2:** Surgical skin cleaning before the procedure.

**Figure 6.3:** Covering the patient before the procedure.

After the patient's entire body is covered with at least 2 layers of waterproof fabric (except the procedural site) the US probe is prepared for use in a sterile manner (Figures 6.3 and 6.4).

The entrance vein is detected with US. The ideal location for internal jugular vein entry is just above the clavicle. For subclavian access, the infraclavicular approach is appropriate. Currently, the supraclavicular approach is not preferred for subclavian vein access.

**Figure 6.4:** Preparation of the US probe for procedure in sterile manner.

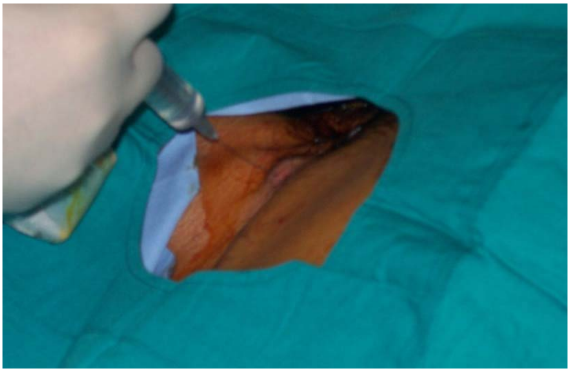

**Figure 6.5:** Local anesthesia application to the venous entrance area

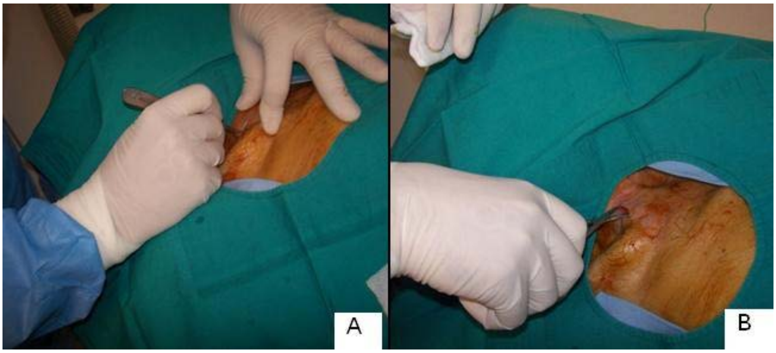


**Figure 6.6:** Cutting the subcutaneous tissues in the entrance area (A) and separating them with a clamp (B).

Using a US guided dental syringe, a local anesthetic (eg prilocaine / bupivacaine for infants) is injected between the vein and the skin. The aim

**Figure 6.7:** After the necessary asepsis conditions are provided, entry into the internal jugular vein with US guidance

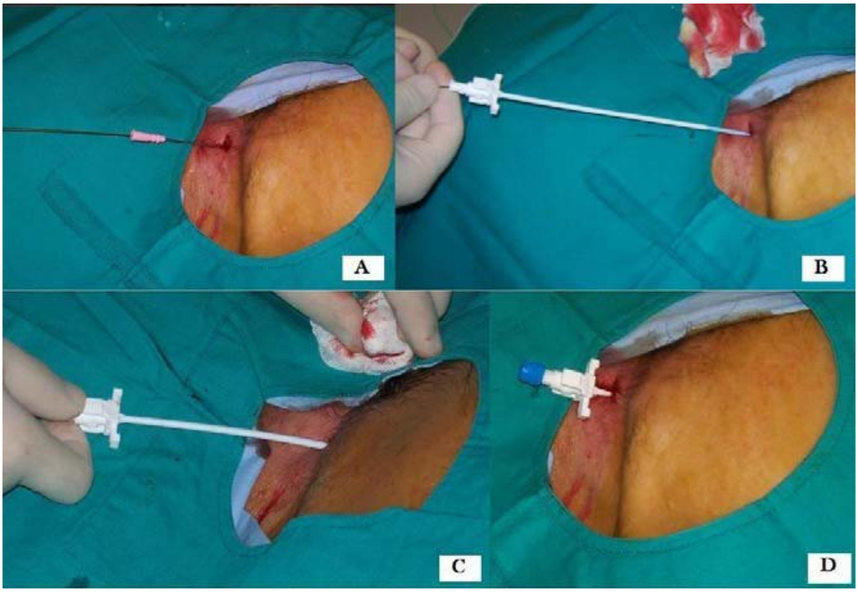


**Figure 6.8:** After the needle on the guide wire is removed (A), the peel-away sheath is placed over the guide wire (B, C). After insertion of the peel-away sheath, the guide wire is removed and tip is closed with cap.

here is not only to provide local anesthesia, but also to open a space between the vein and the skin to prevent vascular injury during skin incision (Figure 6.5).

A 1 cm incision is made at the entry site of the vein, which contains skin-subcutaneous tissues. With the help of a clamp, subcutaneous tissues are separated from each other (Figure 6.6).

Under the guidance of the US, an 18 G venous entry needle is inserted into the vein (Figure 6.7). The 0.035-inch guide wire through the vein needle is advanced into the inferior vena cava. The needle is then removed. A fluo-roscopy-guided, peel-away sheath is then placed over the guide wire (Figures 6.8 and 6.9).

After removal of the guide wire, the peel-away sheath lid is closed to prevent bleeding or air embolism. This completes the first stage of the process.

In the second stage, a local anesthetic is applied to the subcutaneous tissues in the area where the port pocket will be formed. A skin-subcutaneous incision is made according to the port size to be used (usually 2-3 cm incision is sufficient). With the help of a clamp, subcutaneous tissues are separated first up to fascia then the port pocket is created with the help of a clamp (Figure 6.10). The size of the port pocket should be adjusted so that the reservoir can snungly enter it (Figure 6.11).

There are holes in the sides of the reservoirs (fixing seam). However, there is no need to stitch if the port pocket tightly wraps the reservoir. Attempting to stitch unnecessarily leads to the need for a larger incision and a larger port pocket. However, if obese patients are thought to have a risk of rotating the port reservoir due to excess fat tissue, fixation sutures may be performed.

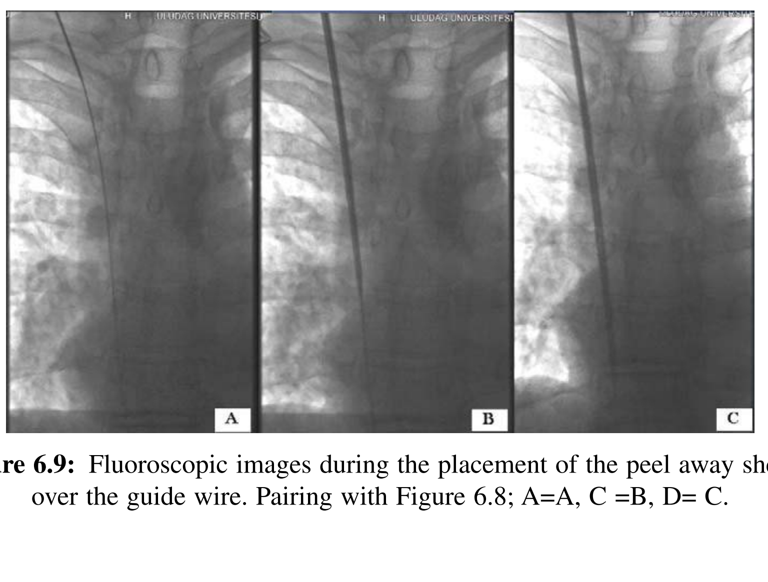


**Figure 6.9:** Fluoroscopic images during the placement of the peel away sheath over the guide wire. Pairing with Figure 6.8; A=A, C =B, D= C.

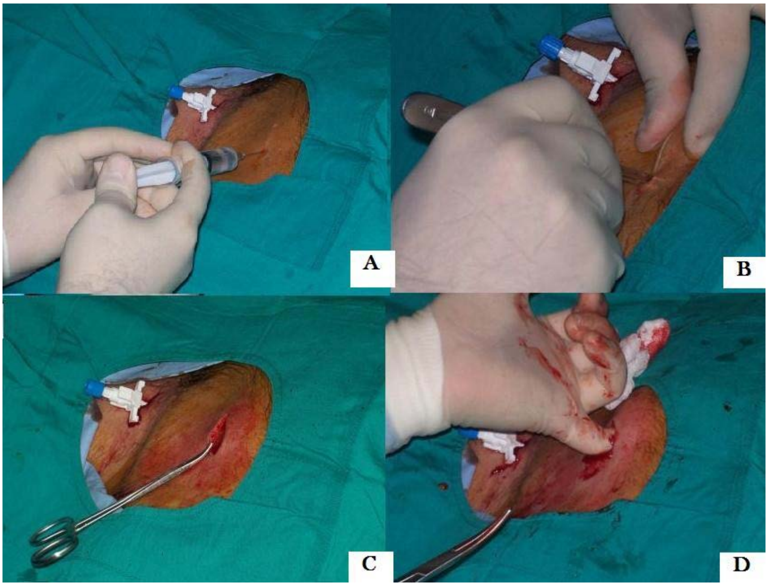


**Figure 6.10:** Performing the port pocket; local anesthesia is applied first (A). A skin incision is made with scalpel (B). A pocket is created by separating subcutaneous tissues with a clamp (C). Blunt dissection is performed with the fingertip (D).

**Figure 6.11:** Checking the port pocket size.

After opening the port pocket, the venous needle and the port pocket are entered through the incision site and local anesthetics are applied to the area up to the venous entry site (Figure 6.12). Then the tunnel is created using the trocar (tunneler). The catheter inserted behind the tunneler is also passed through the tunnel (Figure 6.13).

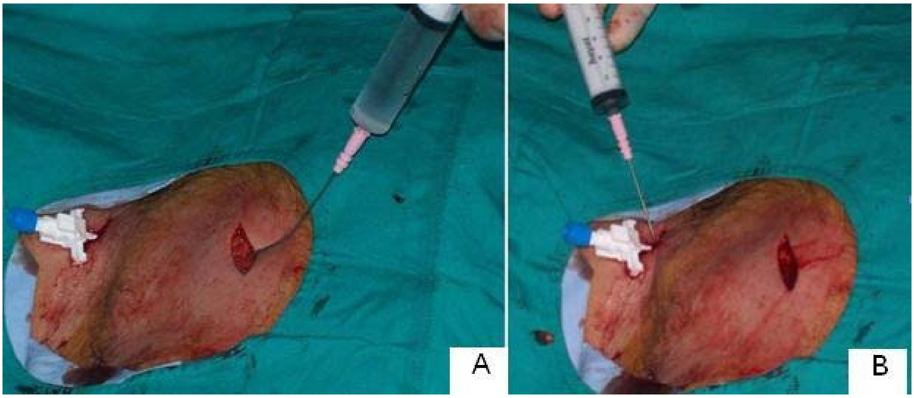


**Figure 6.12:** Applying local anesthesia for the tunnel; through the port pocket incision (A), venous entry site (B).

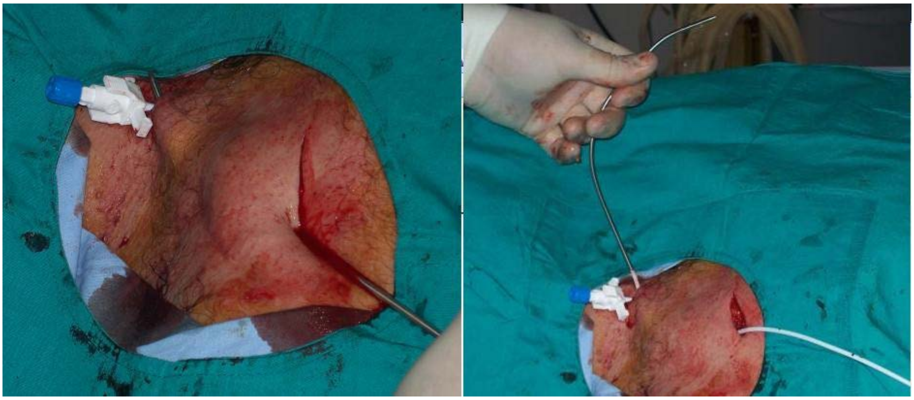

**Figure 6.13:** Establishing a tunnel with trocar.

Following the separation of the tunneler from the catheter, a reservoir is attached to the end of the catheter in the port pocket using the appropriate locking technique (Figure 6.14). The locks may have different shapes depend-ing on the model. The reservoir is then placed in the port pocket (Figure 6.15).

The fluoroscopy-guided catheter is cut after calculating the catheter length. For this procedure, the catheter is first placed on the body on a similar

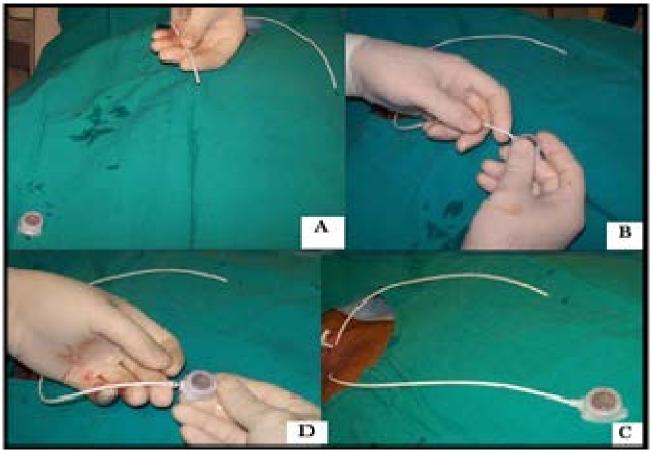


**Figure 6.14:** Locking the catheter tip by inserting reservoir (Sequential images)

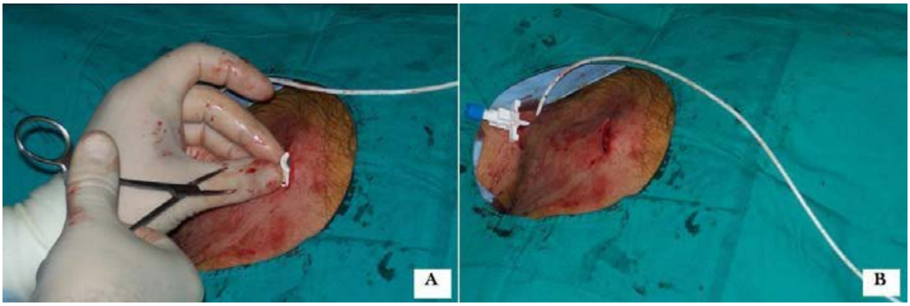


**Figure 6.15:** Placing the reservoir in the port pocket

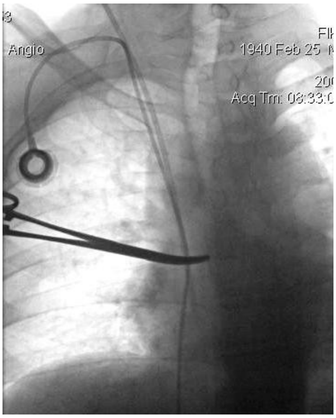


**Figure 6.16:** Calculation of the length of the remaining part of the catheter placed on the body under fluoroscope with the help of clamp.

**Figure 6.17:** Removal of the tissues between the catheter and the peel away sheath with the clamp.

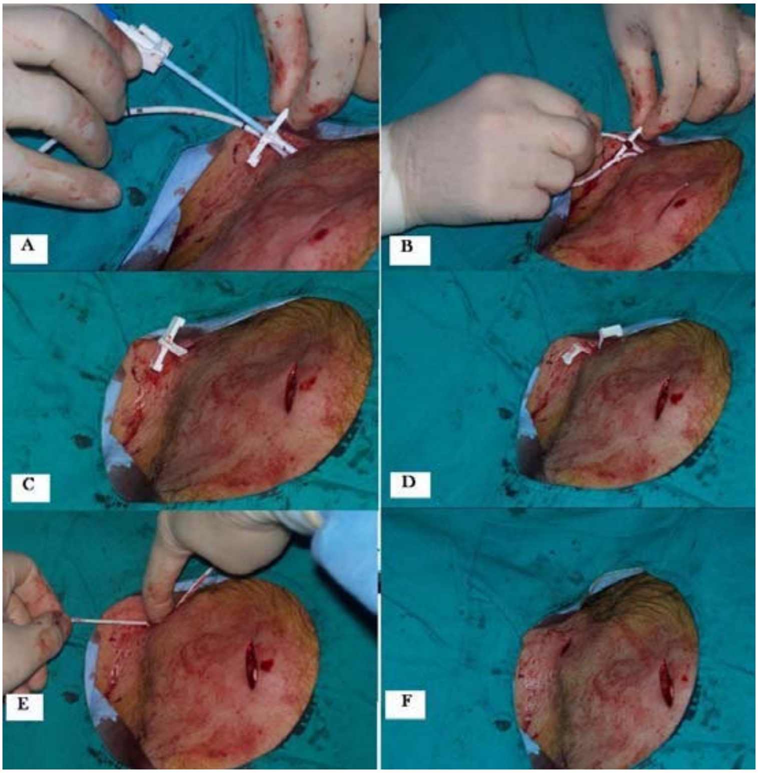


**Figure 6.18:** Placement of the catheter through the sheath into the target venous structure. The expander is removed from the peel-away sheath (A). The catheter is placed in the sheath (B, C). The sheath is broken (D). Care is taken to prevent the catheter from coming back (E). Post-processing view (F).

line tracing the location it will follow in the vessel. It is then marked with a metallic object (e.g., collet, etc.) (Figure 6.16).

Another method to calculate the size of the catheter is to fold the remaining part of the wire by inserting the peel-away sheath to the desired point of the distal section of the guide wire before the guide wire is removed. Thus, since the length required to remain in the vessel will be determined, the cath-eter can be placed side by side with the guide wire and the catheter can be cut to the required length. However, we generally prefer the first method.

Once the catheter is confirmed not to be folded, the system is checked by attaching a port needle to the reservoir. There should be no leakage from the connection point and infusion-aspiration should be performed easily.

After checking the catheter function, the soft tissues between the sheath and the catheter are separated by clamp in the venous entry region (Figure 6.17).

The expander of the peel-away sheath is removed and pushed into the catheter sheath. The sheath is broken and the catheter is gently removed (Figures 6.18 and 6.19). The dilator in the peel-away sheath has a locking mechanism to prevent premature return. The feature of this lock is different for each brand port. Some of them have locking mechanisms that are opened by pressing on their sides, some of them have mechanisms that can be turned and some of them can be opened by pulling the lock.

After checking the catheter and reservoir with fluoroscopy and confirma-tion of proper placement, the incision areas are sewn and the procedure is finalized (Figures 6.20 and 6.21). In the suturing process, the first step should be bringing subcutaneous tissues closer to each other. T


**Figure 6.19:** Sheath and expander (dilator) parts of the peel away sheath and the appearance of the sheath broken during the process.

**Figure 6.20:** View of the operation site following suturing.

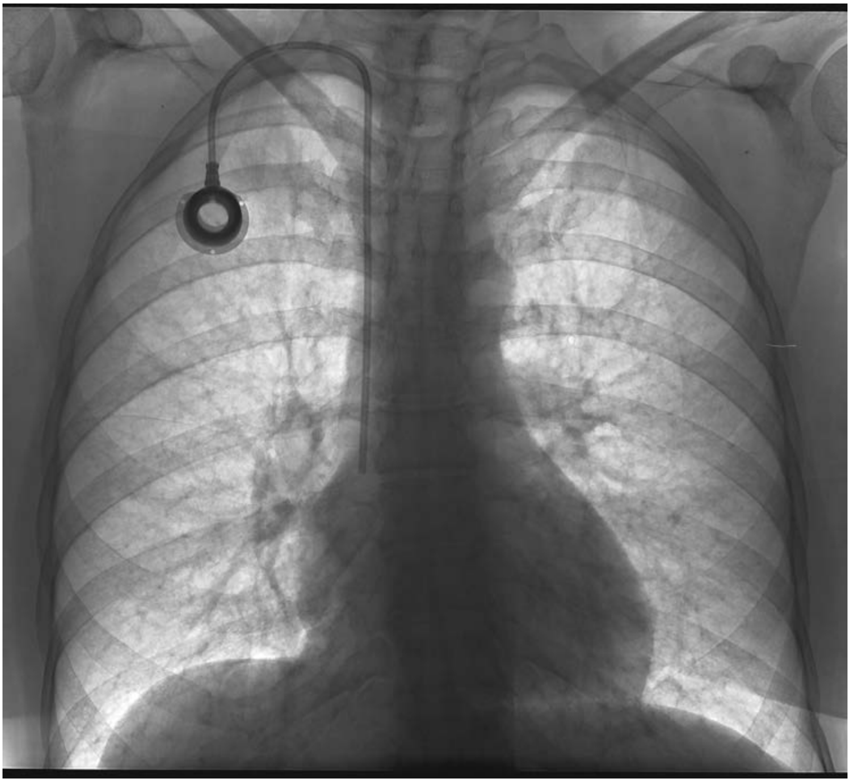

**Figure 6.21:** Digital radiogram obtained at the completion of the procedure of a case where a subcutaneous venous port catheter was inserted from the right internal jugular vein.

stabilizes the port but also ensures that there is no free space for bleeding or infection and also makes it easier to bring the skin closer to each other during skin suture.

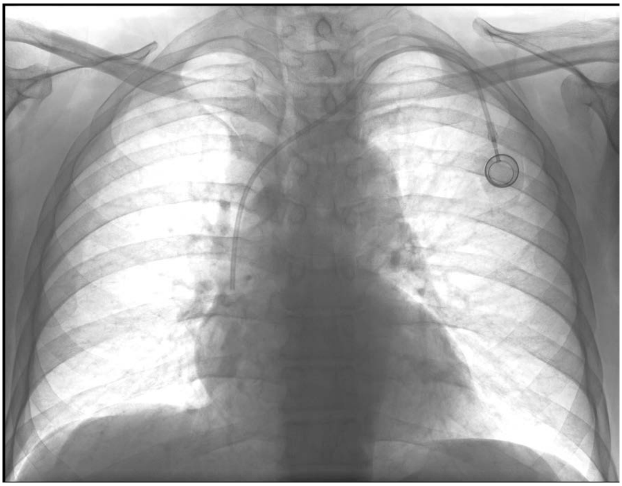

**Figure 6.22:** Digital radiogram of a case of inserted port catheter through the left internal jugular vein.

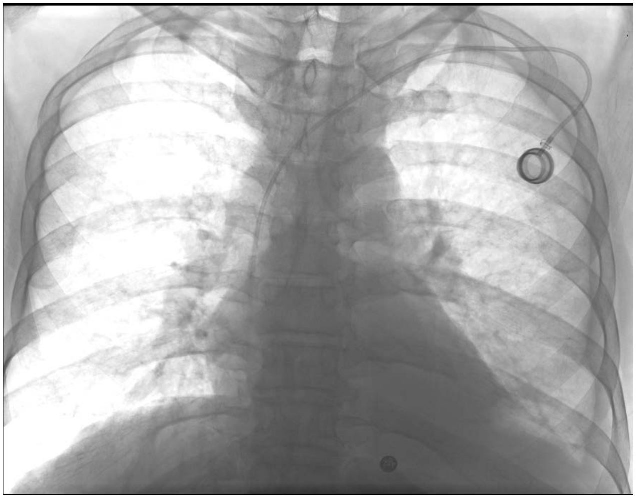

**Figure 6.23:** A case with a port catheter inserted through the left subclavian vein.

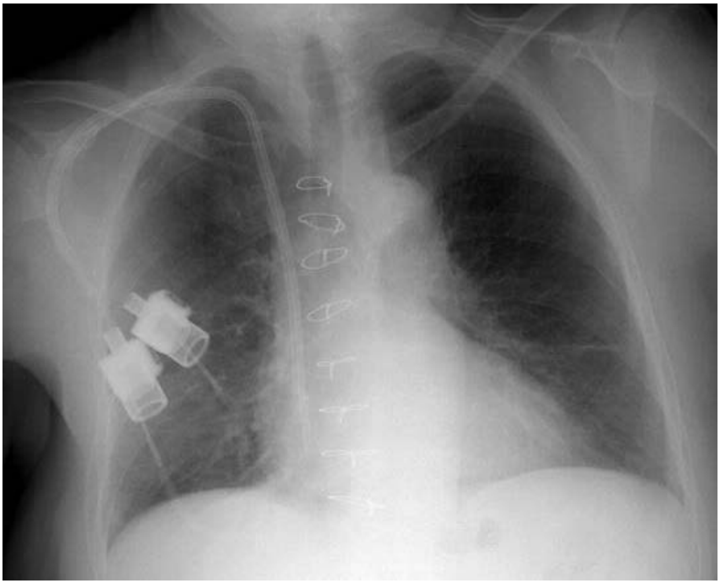

**Figure 6.24:** A case of inserted port catheter for dialysis through the right internal jugular vein (dialysis needle in both reservoirs is immersed).

We use polyglactin 3/0 for suturing. However, other suitable absorbable sutures can be used. It should be noted that monocryl sutures cause less scar tissue during the recovery (scarogen).

We prefer continuous subcuticular sutures which we think is the best aesthetic result for skin closure.

After the procedure, the patient should be observed for 1-2 hours in case of bleeding or slow developing pneumothorax.

Patients should be called back for evaluation after 72 hours for removal of sutures and wound control (Figures 6.22, 6.23, and 6.24).

It is recommended to use the port 3-5 days after the procedure. However, in case of emergency, the set port pin can be used immediately after the patient leaves the intervention room. In such a case, using port pin needle by the attending physician reduces the potential complications.

## SUBCUTANEOUS VENOUS PORT REMOVAL

### Preparation

Subcutaneous venous ports may be removed if no relapse is detected at the 6 month follow-up after chemotherapy, and if there is no need for chemotherapy again. It is not recommended to remove it earlier, except if there are any complications.

Some patients do not want to undergo a surgical procedure and may not want to have their ports removed despite ceasing their treatment. Our experience is that there is no additional complication in patients who have long-term ports remaining in situ 5-7 years after treatment. Nevertheless, we recommend the removal of any foreign material from the body.

In cases for whom a port catheter is going to be removed, the patient should be informed about the procedure and their consent should be obtained. Bleeding tests and complete blood counts should then be performed.

For the procedure, the INR value should be below 1.5 and platelet count above 75,000/$mm^3$.

According to our experience, prophylactic antibiotic use is unnecessary if the necessary asepsis-antisepsis rules are followed during the procedure. It is sufficient to perform the procedure in adults only under local anesthesia. However, IV sedation or general anesthesia may be used in children and in adults who are intensely worried about the procedure or who have a low pain threshold.

Once the patient is admitted to the intervention room, the vascular access should be opened and the patient should be monitored. The team should wear a mask and cap and wear sterile gowns and gloves. There is no need to wear a lead apron as fluoroscopy will not be used during the procedure.

**Figure 6.25:** A case with a subcutaneous port placed in the right pectoral region with an internal jugular vein entrance.

## Venous Port Removal Procedure

The patient's head should be rotated in the oposite direction to where the procedure will be performed (Figure 6.25). Simple elliptical excision is recommended if scar removal after revision (port placement) is also planned. In an ideal elliptical excision, the long axis should be parallel to the incision scar and the length-to-width ratio should be 4-fold. If it is planned shorter or if the lengths of the opposite sides are not equal, port formation occurs at the ends when the wound is closed.

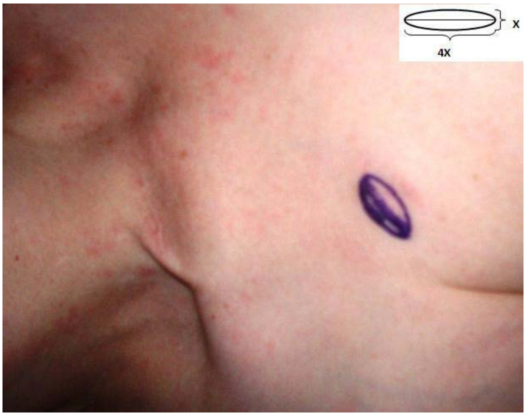


**Figure 6.26:** Marking the incision line with a pencil before the procedure in the case where an elliptical incision is planned.

**Figure 6.27:** Local anesthetic application to the incision site.

It is useful to make an incision plan before cleaning the skin and mark it with a pencil prior to making a proper incision (Figure 6.26. If incision revision is not planned, the primary incision can be made over the old incision.

Surgical skin cleaning is performed by wiping from the mandible to breast subfold at least 3 times with povidone-iodine (Batticon™). In order to prepare an aseptic treatment area, sternum to midaxillary line should be wiped in the same manner (alternatively, 2% chlorhexidine or 70% alcohol may be used.).

Following skin preparation, the surgical cover is laid down and a local anesthetic is applied to the incision site (Figure 6.27). The anesthetic should also be applied to the lower, upper and lateral edges of the port reservoir outside the incision site.

After local anesthesia application, a skin incision is made over predetermined lines. Skin tissue in the middle of the incision site is excised. If an

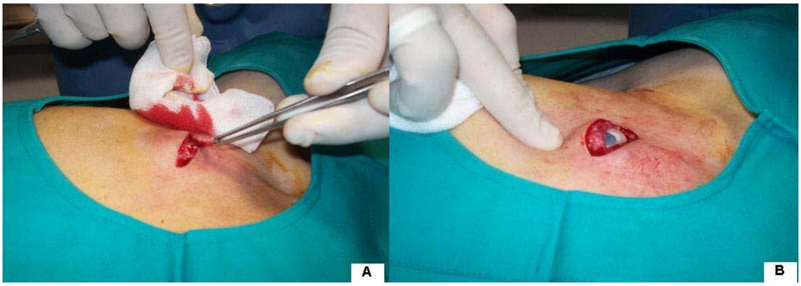


**Figure 6.28:** The appearance of the port connection point (B) in the case with simple elliptical incision and skin excision (A).

**Figure 6.29:** Gently pulling the catheter from the connection point with the aid of a clamp.

appropriate excision is made, the incision should be above the catheter reservoir connection point (Figure 6.28).

With the help of a clamp, the 3-5 cm portion of the catheter is slowly pulled out by entering the underside of the port (Figure 6.29).

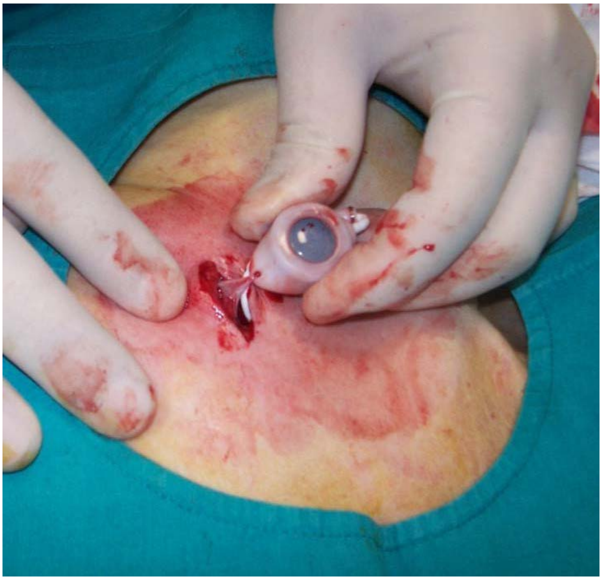

**Figure 6.30:** Fibrin bundles formed between fixing holes and surrounding tissue.

**Figure 6.31:** The appearance of the port pocket after the port catheter is removed, as the catheter has just been withdrawn pressure needs to be applied to the localization of the internal jugular vein (lower hand).

The port reservoir is then removed. In the meantime, solid fibrin bundles extending from the perforations around the catheter to the surrounding tissue are seen (Figure 6.30). The tissue needs to be cut before the port can be released.

It is not available in our practice, but these holes may be stitched for fixing purposes. These stitches are cut during the same process.

Following the removal of the port reservoir, the remaining portion of the catheter is also withdrawn. Applying pressure for 3-5 minutes to the vessel entry site will eliminate the low risk of bleeding (Figure 6.31). After insertion

**Figure 6.32:** The view of the reservoir and catheter portions of the removed port as a whole.

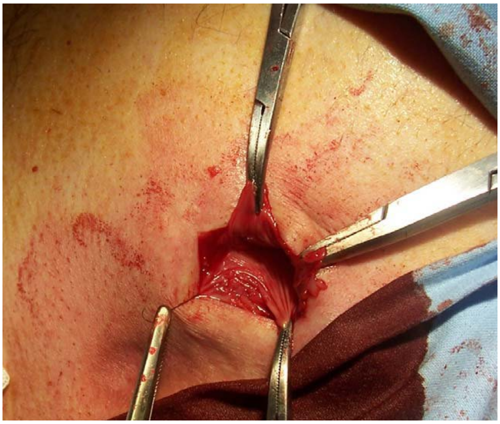

**Figure 6.33:** The appearance of the fibrin sheath laying the port pocket following the removal of the reservoir.

of the port, a solid fibrin sheath will form rapidly around the reservoir in the first couple of weeks by foreign body reaction. The sheath acts as a barrier between the reservoir and the body tissues. After removal of the reservoir (Figure 6.32), this sheath is laid on the inner wall of the port pocket area (Figure 6.33); if not removed, the vascular site of the port pocket prevents structures and connective tissue from progressively filling the cavity. A cavity will form (with a potential of infection), which is isolated from the surround-

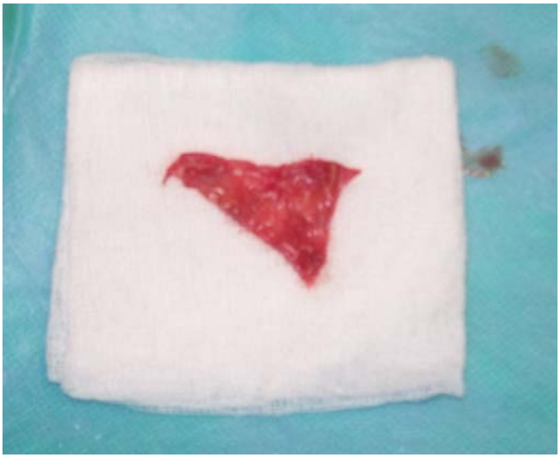

**Figure 6.34:** The appearance of the fibrin sheath removed from the port pocket.

**Figure 6.35:** Stitching, following the port removal.

ing tissues. As a result, it is recommended to remove as much of the fibrin sheath as possible (Figure 6.34). If not completely removed the fibrin can progress and the fill the cavity. This occurs due to disintegration of the connective tissue.

Following the removal of the fibrin sheath, subcutaneous tissues are sutured as close as possible without creating shrinkage of the skin (Figure 6.35).

**Figure 6.36:** Intervention site after skin closure.

Finish the process by closing the skin (Figure 6.36). We close the skin with a continuous subcuticular suture which we think gives the best aesthetic result. We use polyglactin 3/0 as a suture thread.

Following skin closure, the incision site is dressed. After an observation period of approximately 1 hour, the patient may be referred to the home or clinic. The catheter is cut into 5 cm pieces. Reservoir and catheter pieces are taken for microbiological assessment.

Cases are called back for evaluation after 72 hours for suture removal and wound control.

# CHAPTER 7

## Peripherally Inserted Central Catheters (PICC)

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In contrast to the first 3 catheter groups, interventional radiology has little role in inserting this group of catheters. However, PICC can be used with guidance of US in the bed side, for patients who have difficulty in finding the vascular access in the intensive care unit. There are many types of catheters in this group. Clinicians, even nurses in some countries, can easily insert these catheters at the bedside.

### US GUIDED PICC CATHETER INSTALLATION

The patient opens the arm to 45 degrees relative to the long axis of the body (abduction) and rotates outward (to external rotation). A tourniquet is applied close to the axillary region to make the venous structures visible.

After wearing sterile masks, gowns and gloves, surgical skin cleansing is performed by wiping at least 3 times with povidone-iodine (Batticon™) from the center to the periphery to the area where venous access will be applied (Alternatively 2% chlorhexidine or 70% alcohol can be used).

The patient's arm is covered with a sterile drape and the US probe is prepared for use in a sterile manner.

The catheter is washed with saline before the procedure. After the entry vein is determined by US, local anesthetic (e.g. prilocaine or bupivacaine for infants) is injected into the skin and subcutaneous tissues using a dental syringe. With the guidance of the US, the puncture needle is inserted into the vein. After entering the vein lumen, the catheter is advanced through the puncture needle (Figure 7.1) and the tourniquet opens.

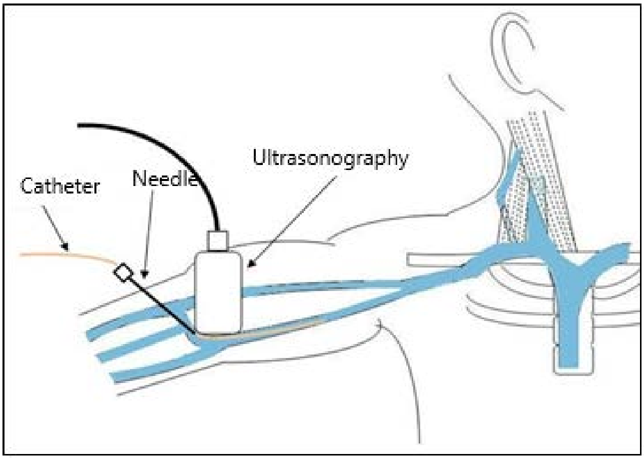


**Figure 7.1:** US guided puncture and sending the catheter through the puncture needle.

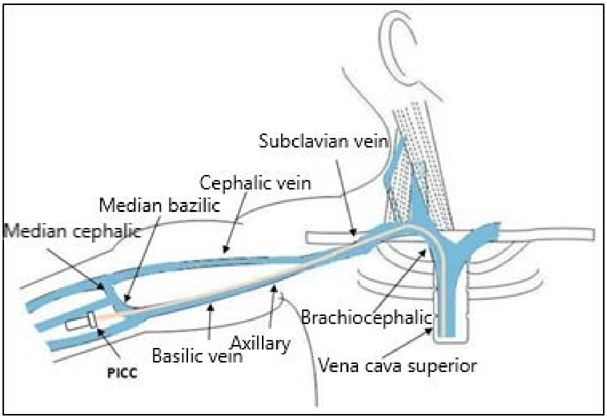


**Figure 7.2:** Schematic view of the PICC catheter


**Figure 7.3:** PICC catheter and vein entry needle (in pediatric sizes)

In sets with the catheter head, it is necessary to shorten the catheter by calculating the estimated length on the patient before the procedure. Shortening should be performed from the end of the catheter.

When the catheter tip reaches the desired point, the outer part of the puncture needle is broken and peeled (Figure 7.2, Figure 7.3). Catheter placement should be checked with chest X-ray and at the end of the procedure, the catheter head and wings should be sutured to the skin.

# CHAPTER 8

## Catheter Care

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### USE OF SUBCUTANEOUS VENOUS PORT AND CARE

Firstly, the skin over the port catheter (Figure 8.1) is cleaned with povidone-iodine (Batticon™) at least 2 times from the center to the periphery by wearing sterile gloves (Figure 8.2). Alternatively 2% chlorhexidine or 70% alcohol can be used. The sterile cover with a hole is then covered (Figure 8.3).

Saline is drawn into the syringe (the syringe should be at least 10 mL). The port needle is removed from the sterile package and attached to the syringe, taking care not to touch the tip. The syringe is held upwards to release air from the set (Figure 8.4). The set is then locked by pressing the latch on the set (Figure 8.5).

Without touching the point where the injection will be made, the port under the skin is felt with the fingers of the empty hand. The port is held firmly between the index and thumbs (Figure 8.6). The needle is inserted perpendicular to the port. After passing the skin and port membrane, the needle tip is advanced until it is felt to touch the bottom of the reservoir (Figure 8.7).

The latch of the set first opens and then, the piston of the syringe is pulled back slightly to check for blood (Figure 8.8). If blood is coming, the tip of the needle is in the right place. After the blood is easily seen in the set, the system is washed and cleaned with saline in the syringe. After this stage, the drug can be administered by infusion (Figure 8.9). There should be no pain during infusion. In case of pain, the infusion should be stopped immediately.

After each infusion treatment, the system should be flushed using at least 10 mL of saline. For the washing process, the injector used for drug admin-

**Figure 8.1:** A case with a subcutaneous venous port catheter inserted from the internal jugular vein to the right pectoral region (A skinny patient was chosen to be demonstrable).

**Figure 8.2:** Skin cleaning area in the port reservoir area.

**Figure 8.3:** View of the procedure area covered with sterile perforated drape.

**Figure 8.4:** Discaharge of air in the syringe and set

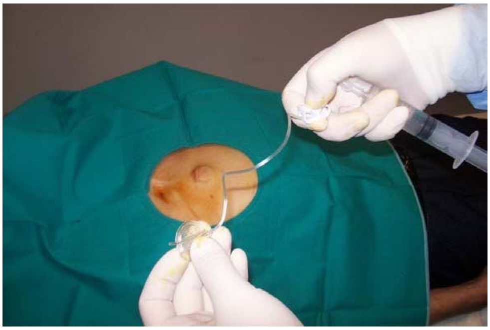

**Figure 8.5:** Locking the set by pressing the latch on the set with the right hand.

istration should not be used. There are also publications recommending flushing process to be done with heparinized saline (100 U heparin per mL). Once the port is flushed and filled with saline, the needle is pulled out while the plunger of the injector is slowly pushed.

If repeated injections are to be made at short intervals, the needle can be left in place with a sterile dressing. The residence time of the needle above the port should not exceed five days. Prolonged duration increases the risk of infection.

If the catheter is not used, flushing with heparinized saline (100 U heparin per mL) every 2-4 weeks should be performed.

The use of specially designed port pins (Huber) is required. The removed needle is discarded, never used a second time.

**Figure 8.6:** While the port reservoir is firmly gripped with the index finger and thumb of the left hand, the right hand is immersed the port needle at a perpendicular (90 degrees) angle to the middle of the port reservoir.

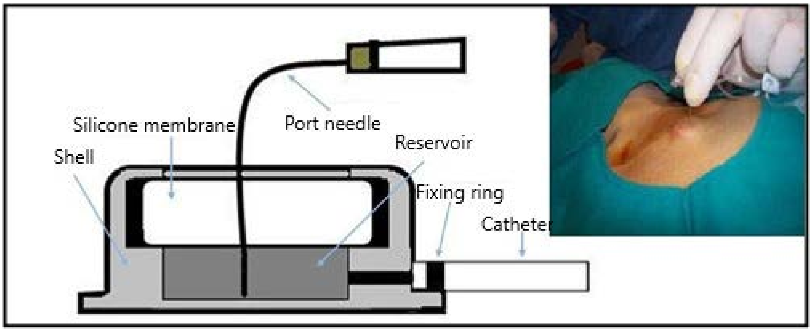


**Figure 8.7:** Inserting the port needle perpendicular to the reservoir.

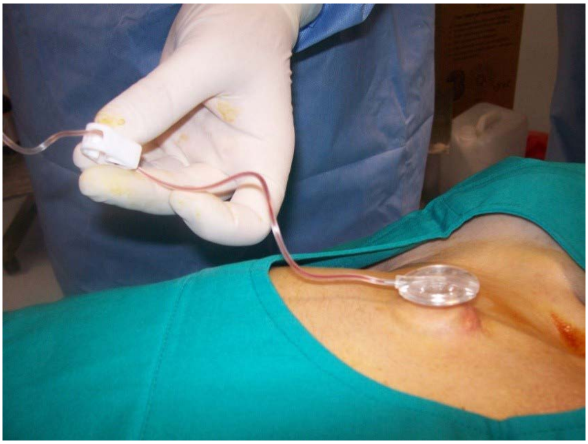

**Figure 8.8:** Checking if the system works by performing aspiration-infusion.

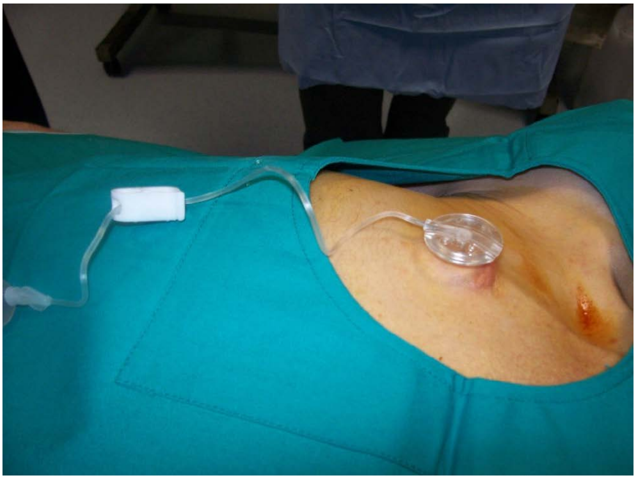

**Figure 8.9:** System ready to be used for infusion.

It is recommended that all these procedures be performed with sterile disposable gloves.

## Venous Port Needles

Special needles (Huber) that do not damage the port membrane. These needles pass through the membrane by making a very small hole which then closes easily due to the elasticity of the silicone. Normal injector needles pass through the port membrane by cutting it and they may break off the silicone membrane. Therefore, if no special port pins are used, the port membrane becomes unusable after approximately 100 entries. However, if a port needle is used, the port membrane allows needle passage approximately 3,000 times.

For short-term injections, set-free needles are used, and for long-term infusions, self-set needles that are well fixed to the skin are used (Figure 8.10).

## Power (High Pressure) Injection and Port

Until recently, ports could not be used in situations requiring high-pressure injection, such as contrast-enhanced tomography. Because, in this case, the port could become unusable after damage to the catheter and the port connection. Nowadays, high pressure-resistant ports have been produced to solve

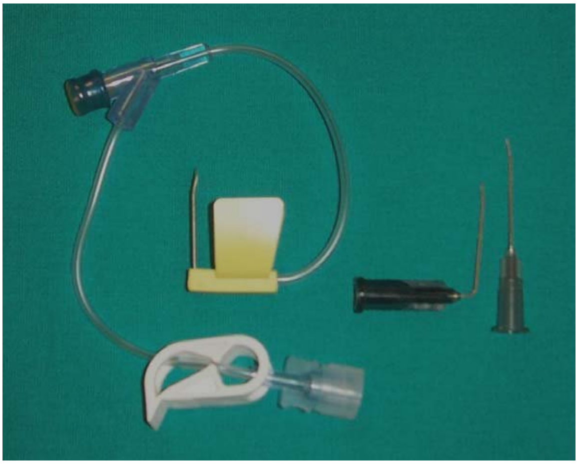

**Figure 8.10:** Port needle samples with and without set

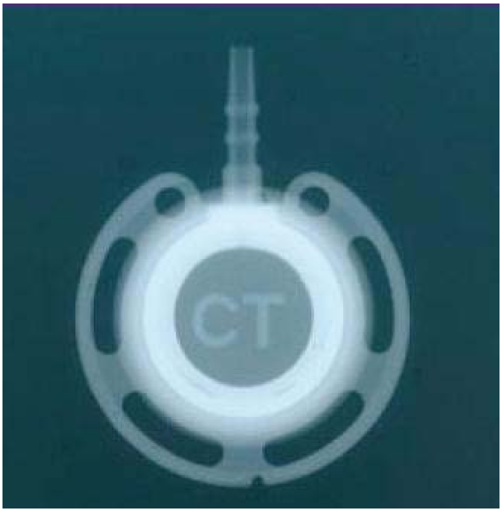


**Figure 8.11:** Direct radiography of the subcutaneous port produced for high pressure use.

this problem (Figure 8.11). The ports produced for this purpose can be easily used for contrast-enhanced computerized tomography examinations.

The base of the ports produced for this purpose has a "CT" inscription on the opaque character in order to distinguish them from other subcutaneous ports. This text can be easily seen on the radiography or tomography topogram.

## Tunnel Catheter Use and Care

Unlike subcutaneous venous ports, tunneled catheters have catheter tips outside the skin and have an entry site to the skin. When not in use, these tips and the entrance area should be covered sterile (Figure 8.12). This is recommended both in terms of infection and to reduce the risk of accidental catheter removal.

For patients with catheter who needs dialysis, infusion or blood samples, the first step should be removing the dressings around the catheter (Figure

**Figure 8.12:** A 55 y/o female patient with a tunneled dialysis catheter who was diagnosed with chronic kidney failure.

**Figure 8.13:** The appearance of the catheter after opening the dressing in the same patient.

8.13). This can be performed with a non-sterile glove and then a sterile glove is needed for sterilizing the skin and catheter with Povidone-iodine (Batticon™) (alternatively 2% chlorhexidine or 70% alcohol can be used) and then a sterile cover should be used to cover the area (Figure 8.14).

The caps of the catheters are then opened; if dialysis or infusion would be performed, then the caps can be discarded and not used again. At the end of the procedure, new caps are used to close the catheters. This is necessary so that the lids that remain open for a long time do not become infected after contact with the environment.

**Figure 8.14:** Double lümen dialysis catheter covered with perforated sterile drape.

**Figure 8.15:** Aspiration from lumens whose covers are removed before the procedure.

The cap should be placed on a sterile drape or gauze if it is planned to reattach after a short-term procedure, such as blood collection for examination. It is necessary to make sure that the environment and the inner surface of the caps are not in contact. Ideally, new caps should be used after each procedure.

Following the removal of the caps, the lumen content (heparin, blood, drug residue, etc.) should be aspirated with a syringe (Figure 8.15). Usually 3-5 cc aspiration from each lumen is sufficient. After checking the aspiration, the system is ready to process by flushing with saline (Figure 8.16).

It is recommended to flush the lumens with 20 cc saline at the end of the procedure (dialysis, infusion, etc.). Generally, the lumen of catheters for dialysis after flushing is filled with heparin (5,000 units/cc).

Lumen internal volumes are indicated on the catheter (Figure 8.17). The specified volume of heparin should be given into the lumen. It should be remembered that bleeding time will be prolonged if excessive heparin is given. Catheter locking solutions prepared with sodium citrate solution can be also used instead of heparin (see Section 5, Figure 5.15).

In dialysis catheters, the red end shows arterial and the blue end shows venous lumen.

If the catheter is not to be used for a long time, flushing the catheter lumens every 2-3 weeks should be carried out in accordance with the rules described above.

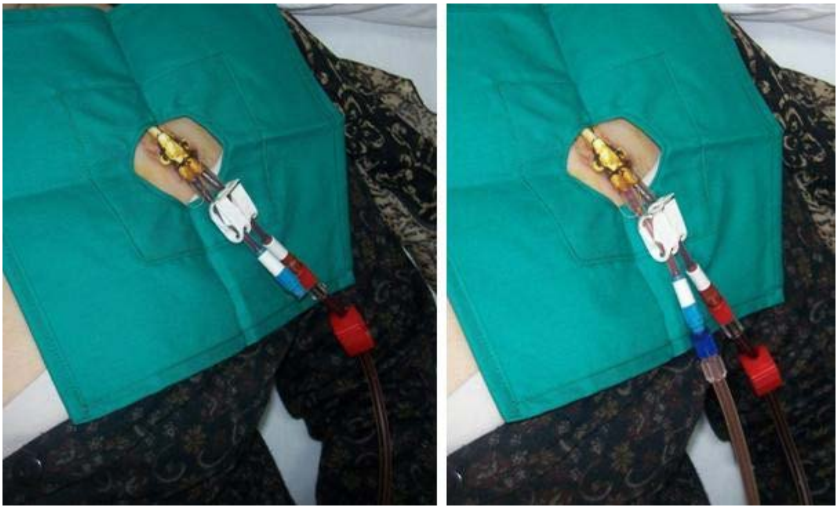

**Figure 8.16:** The appearance of a catheter with double lumen tunnel, ready to start dialysis procedure.


**Figure 8.17:** The internal volume of the catheter lumens is indicated.

## TEMPORARY CATHETER USE AND CARE

Temporary catheter use and care are similar to tunneled catheters and are not described in detail. Similar rules apply here.

Alternatively, dressings with sterile gauze instead of temporary catheter access should be changed every 48 hours, and dressings with semi-transparent dressing changed once a week.

## SURVEYANCE (CLOSE OBSERVATION) IN CVC

Infections related to CVCs are the fourth most common infection among nosocomial infections. 85% of hospital acquired primary bloodstream infections are due to SVCs. Considering the weakness of the immune system of the majority of patients who need these catheters, it will be clear how important these catheters are to be cared for.

The care and use of catheters described earlier in this chapter and the observance of some simple rules are effective in reducing the causes of catheter infection and loss of function.

Things that need to be done:

1. The person that installs the catheter should record the days and times the catheter is inserted and removed, and the dates of dressing.
2. Catheter use and care training should be given to the patients before and after the procedure and the training should be repeated intermittently. Any

changes or discomfort they notice at the entrance site should be reported to the doctor or nurse.

3. All catheters should be divided into 5 cm pieces and sent to culture in a sterile manner, even if they were removed for non-infectious reasons.
4. The CVC skin entry zone should be checked daily:
   a. In cases with transparent dressings, the catheter entry site should be checked with the eye.
   b. Cases with gauze are also examined daily by hand and the integrity of the region should be checked.
   c. In patients with signs of local infection or bacteremia, the catheter entry site should be examined by removing the cover in place.
5. Hand hygiene should be provided before and after any manual examination, dressing replacement or catheter manipulation of the CVC entry site. Sterile gloves should be used in all procedures. The use of gloves does not eliminate the need for hand hygiene before and after the procedure.
6. Sterile gauze or sterile transparent semi-permeable dressings should be used to cover the CVC insertion site. Tunneled catheters and subcutaneous venous ports do not need to be covered after wound healing]. Gauze should be preferred over semi-transparent covers if the patient has excessive sweating or bleeding.
7. Dressings with sterile gauze should be changed every 48 hours, and dressings with semi-transparent dressing should be changed once a week. If the catheter dressing becomes dirty, deteriorated or wetted, this time should be replaced immediately.
8. Patients whose indication of insertion has ended should have their CVC removed immediately.

# CHAPTER 9

# Complications in Central Venous Catheterization

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Complications that develop in the first 24 hours are classed as perioperative; those that develop within 30 days are early and those that develop after 30 days are referred to as late complications. Table 9.1 comprehensively lists all the complications that may develop according to the periods. However, since most of these complications are very rare, only more common complications will be described in this section.

**Table 9.1:** CVC complications

| **Periopreatifve Complications (First 24 hour)** | **Early Complications (First 30 days)** | **Late Complications (After 30th day)** |
|---|---|---|
| *Unstoppable bleeding at the vascular access site | *Catheter migration | *Infection |
| *Unstoppable bleeding in the port pocket | *Catheter occlusion | *Venous thrombus |
| *Soft tissue edema | *Inadequate catheter/ port connection | *Soft tissue edema |
| *Hematoma | *Opening in suture area | *Catheter migration |
| *Cardiac Arrhythmia | *Venous thrombus | *Venous injury |
| *Arterial injury | *Soft tissue edema | *Cardiac perforation |
| *Venous injury | *Extravasation | *Cardiac Arrhythmia |
| *Cardiac perforation | *Catheter dysfunction | *Inadequate catheter/ port connection |
| *Arteriovenous fistula | *Infection | *Catheter breakage |
| *Venous thrombus | *Catheter breakage | *Catheter oclusion |
| *Vasovagal reaction | | *Skin necrosis |

| | |
|---|---|
| *Pneumothorax | *Catheter dysfunction |
| *Haemothorax | |
| *Air emboli | |
| *Allergic reactions | |
| *Contrast reactions | |
| *Constant pain in the port area | |
| *Complications due to anesthesia | |
| *Malposition | |
| *Damage or binding of the catheter during sewing | |

## MALPOSITION (MISPLACEMENT)

Malpositions occur when the tip of the catheter is in the extra-vascular area, in a wrong vessel, or in the subintimal portion of the appropriate vessel. Often, the catheter tip may extend into the contralateral internal jugular, contralateral subclavian, contralateral brachiocephalic, axillary or azygos vein. Less likely, it may end in the pericardiophrenic vein or the internal mammary vein. If the catheter is left too long, it may extend to the inferior vena cava.

Primary malpositions (Figures 9.1 and 9.2) develop spontaneously due to incorrect positioning of the catheter, and secondary malpositions due to changes in anatomic state and pressure within the thorax. The use of fluoroscopy during the procedure prevents primary malposition (Figure 9.3).

In adult cases, the tip of the infusion catheters should be placed to the atriocaval junction, but for dialysis catheters the tip should be placed to mid atrial level. Since the tip of the catheter can be observed in fluoroscopic guidance, the rate of malposition is significantly low. In cases where the Landmark technique (blind catheterization using anatomical landmarks) is used and the malposition rate is approximately 25-40%, catheter length can be estimated.

Due to the growth of children, the catheter may be short in size over time. Similarly, in overweight patients and in cases where the port catheter is placed from the left, the tip of the catheter can be moved backward by movement (secondary malposition) (Figure 9.4). In such cases, leaving the tip of the catheter at the mid-atrial level reduces the possibility of developing secondary malposition.

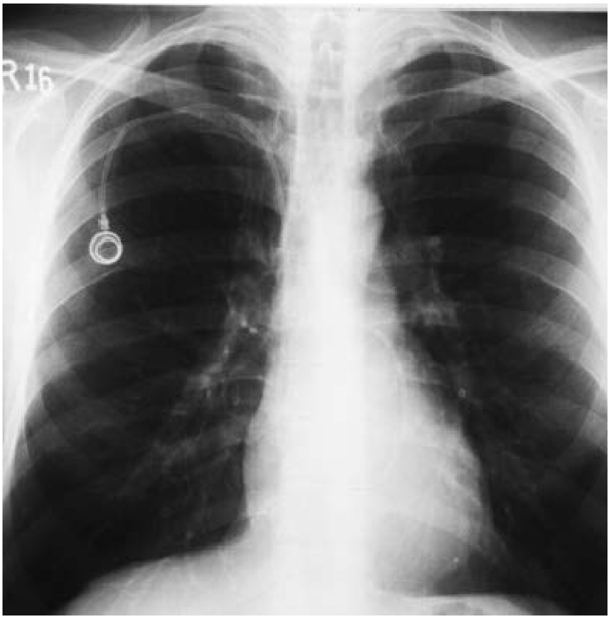


**Figure 9.1:** It is seen that the port catheter was left too long and terminated in the right main pulmonary artery, where the port catheter was inserted from the right subclavian vein in another hospital and referred to us due to catheter dysfunction (Primary malposition).

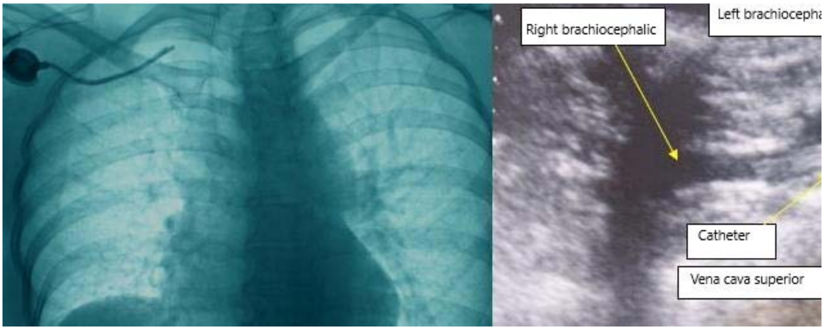


**Figure 9.2:** The catheter was inserted through the right subclavian vein in another hospital and referred to us due to catheter dysfunction, and the catheter was observed to be very short (primary malposition). US examination shows that the tip of the catheter rests against all of the superior vena cava.

In cases with catheter malposition, correction of the position of the catheter can be attempted. The repositioning process can be performed by strong

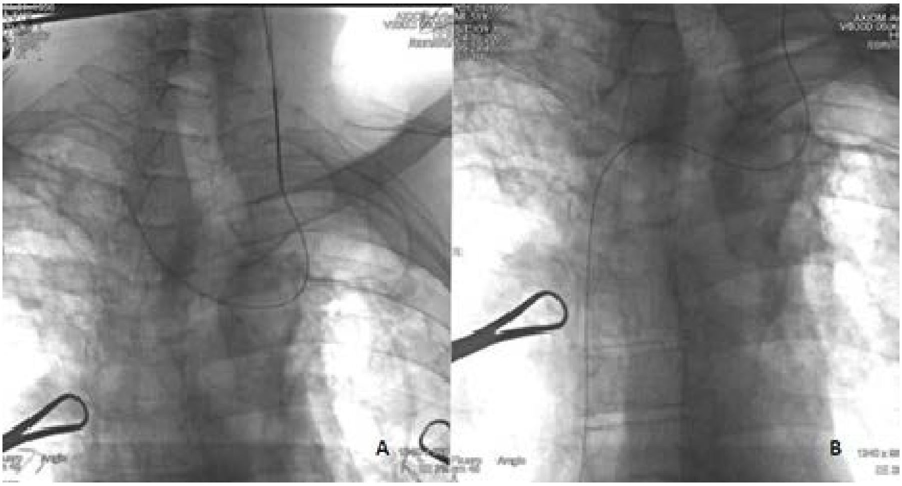


**Figure 9.3:** The guide wire guided through the left internal jugular vein under fluoroscopic guidance to be directed to the right internal jugular vein due to the curve in the left brachiocephalic vein (A), and with the help of appropriate maneuvers the guide wire redirected to the superior vena cava (B). The catheter was placed in the correct position with the help of fluoroscopic guidance.

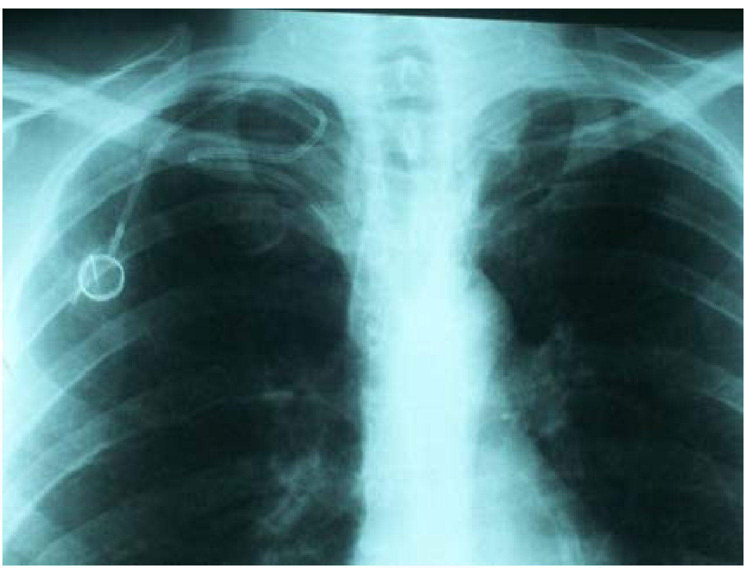

**Figure 9.4:** The port catheter was inserted through the right subclavian vein in another hospital and referred to us due to catheter dysfunction. It is observed that the port is inserted under the skin and is folded under the skin (Secondary malposition).

saline injection, by guide wire through the catheter, or by a transfemoral intervention.

In transfemoral intervention, curved tip catheters (Pigtail or Simmons) are used. The curved tip of the catheter is wrapped around the port catheter and the catheter tip is pulled in a controlled manner to the required location. If the tip of the catheter is stuck in the vein wall or thrombus and other methods fail, repositioning can be attempted with the long loop technique as the last option.

In this technique, a guide wire is sent through the catheter entangled around the free part of the malposed catheter. With the endovascular lasso sent from the other femoral vein, the tip of the guide wire is captured and the catheter is repositioned by pulling both systems together.

## PNEUMOTHORAX

Pneumothorax is a rare complication in venous access done by US. Although surgical series are generally given between 3% and 6%, some publications estimate rates as high as 12.5%. Pneumothorax is the most common perioperative central venous catheterization complication and constitutes approximately 25-30% of all reported complications.

The frequency of pneumothorax development is higher in the subclavian vein entry side than the internal jugular vein. Most of the pneumothorax is in the form of separation of the visceral pleura by 2-3 cm from the parietal pleura and it is asymptomatic. Sometimes it is noticeable after a few days. In general, small asymptomatic pneumothorax does not require treatment. Large and symptomatic ones can be successfully treated with a thorax tube or Heimlich valve. However, pneumothorax is a serious and life-threatening complication and requires careful monitoring.

## LARGE VASCULAR INJURY AND PERFORATION

Major vascular injury or cardiac injury most often occurs when placing the peel-away sheath. A peel-away sheath is an apparatus consisting of a dilator and sheath. The sheath contains a large hole that delivers soft catheters into the vein. The dilator part is a fairly hard plastic that serves to lead between soft tissues inside the sheath during entry to the vein (Figure 9.5). If the peel-


**Figure 9.5:** Peel away sheath has expander and sheath parts. The dilator placed inside the sheath (A) and each part is seen separately (B).

away sheath is advanced without a guide wire, the dilator part may damage the vessel wall.

Rarely, hard tip temporary catheters can damage the atrium. For this reason, it is recommended that temporary catheters are left in the atriocaval junction.

Generally, it occurs if the guide wire breaks or is shorter than the dilator. As a result of these injuries, hemothorax, mediastinal hematoma, and cardiac tamponade or combinations thereof may develop. Since the progress of the guide wire and peel-away sheath is monitored in fluoroscpic guidance, major vascular injury is not an expected complication in this technique.

During port pocket opening or tunneling, the guide wire should not be pushed forward even if the peel-away sheath is moved backward since there is no guide wire inside the peel-away sheath.

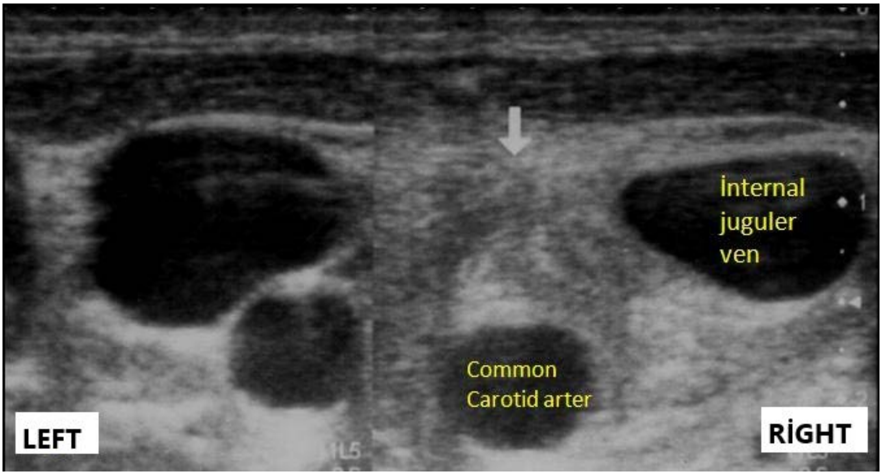


**Figure 9.6:** USG appearance of a hematoma in the carotid sheath (compared with the other neck half) in the patient who developed arterial injury due to the patient's movement during entry into the right internal jugular vein.

## ARTERIAL INJURY (PUNCTURE)

The arterial injury usually occurs during venous access (Figure 9.6). Arterial injury is a rare complication since vascular structures are observed in interventions performed with US. It is usually related to the experience of the person performing the procedure.

In the Landmark technique, the risk of arterial injury is higher in the internal jugular and femoral vein entry site than in the subclavian entry site. However, since these areas are superficial, bleeding can usually be controlled by pressure. Generally, 5-10 minutes of pressure to be applied to the artery after the needle is removed is sufficient to control the bleeding.

Particularly in the case of subclavian intervention, if a catheter or dilator is inserted into the artery it should not be withdrawn. As long as the catheter remains, there is usually no bleeding problem, but if it is withdrawn, bleeding begins. Fatal complications may develop. In this case, pulling the catheter using materials used for vessel closure or inserting a covered stent through another artery may resolve the problem. If these options are not possible, repair of the vessel is required by cardiovascular surgeons.

## AIR EMBOLISM

An air embolism is a rare complication. If the patient breathes deeply during the dilator retraction or insertion of the catheter into the peel-away sheath, it is caused by a negative pressure effect. Small air emboli are often seen and are insignificant, however, large emboli can be fatal. Typical symptoms are the development of cough and respiratory distress. The patient should be returned to the left lateral decubitus position and 100% oxygen should be inhaled.

Incommunicable patients, holding the breath during dilator retraction and pushing the catheter into the peel-away sheath is an effective method to prevent an air embolism.

## INFECTION

Infection is the most common postoperative complication of CVCs. Catheter-related infections are expressed as the number per 1000 catheter days. Catheter infection risk was reported on 1-2 / 1000 catheter days, and catheter sepsis rates were between 0.02-27%. The most common microorganisms in catheter infections are 31-54% coagulase-negative Staphylococci (S. epidermidis, S. haemolyticus, S. hominis, etc.). At 14-20% S. Aureus, Enterococcus, aerobic gram-negative bacilli and Candida albicans are the next common micro-organisms.

Microorganisms leading to intravascular catheter infection can originate from various sources. The skin is the most common source. However, as the catheterization time increases (after 30 days), the risk of infection due to hub (junction) contamination increases. The risk order according to the catheter type is (from low to high): port, tunneled catheter, temporary catheter. The risk of infection in large series is 0.21 / 1000 catheter days at ports, and 2.77 / 1000 catheter days in tunneled catheters. Risk factors for infection development in patients with CVC, are summarized in Table 9.2.

**Table 9.2:** CVC infection risk factors

| **Due To Host** |
|---|
| Age (<1 and >60) |
| Neutropenia |

| |
|---|
| Immunosupressive treatment |
| Loss of skin integrity (burn, psoriasis etc.) |
| Chronic conditions (Diabetes Mellitus etc.) |
| Infection from other sites |
| Due To Catheter |
| Type of catheter (port < tunneled < non-tunneled) |
| Catheter insertion site |
| Catheter features (polyvinyl chloride (PVC) > teflon > polyurethane) |
| Method of catheter insertion (cut down > percunateous) |
| Catheterization duration |
| Others |
| Emergency placement of the catheter |
| Placement of catheter by inexperience team |
| Inadequate asepsis-antisepsis during catheter placement and maintenance |

Table 9.2, Oncu S. Central Venous Catheter Infections and Treatment. Clinical Journal 2003; 16 (2): Modified from the article.

Infection that occurs within 3 days of CVC placement is defined as an early infection and usually develops due to peri-operative contamination. It is also possible to classify catheter-related infections according to the location and shape of the involvement: catheter colonization, catheter entry site infection, tunnel infection, bacteremia and septicemia and port pocket infection.

### Catheter Colonization

Bacteremia and isolation of ≥15 CFU (Colony Forming Unit) in the semi-quantitative culture taken from any segment of the catheter without any evidence of infection at the catheter entry site or ≥103 CFU microorganisms in the quantitative culture.

### Catheter Entry Site Infection

Tenderness, swelling and / or purulent discharge are present at a distance of 2 cm from the catheter access site, with fever and no accompanying bacteremia.

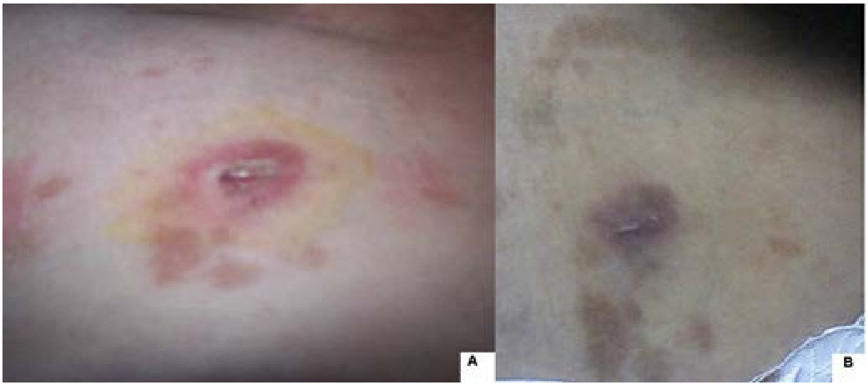


**Figure 9.7:** (A) A patient with complaints of pain, temperature increase, hyperemia and purulent discharge in the port pocket area at the 3rd month following port attachment (port pocket infection). The port of the case was removed and the wound was left to secondary healing with antibiotic treatment. (B) View of port pocket localization after 2 weeks.

### Tunnel Infection

It is characterised by a state of redness, pain and swelling at the distance of 2 cm from the entry point of a tunneled catheter, under the skin beneath the tunnel, and no accompanying bacteremia.

### Port Pocket Infection

Sensitivity, redness, swelling and/or purulent discharge in the reservoir implantation area in the subcutaneous venous ports and no accompanying bacteremia (Figure 9.7). Accompanying skin necrosis can be found.

### Phlebitis

Induration or erythema and temperature increase and sensitivity around the catheter entry site due to inflammation developing in the vein where the catheter is placed. Accompanying thrombus may develop inside the vein (thrombophlebitis).

## Bacteremia

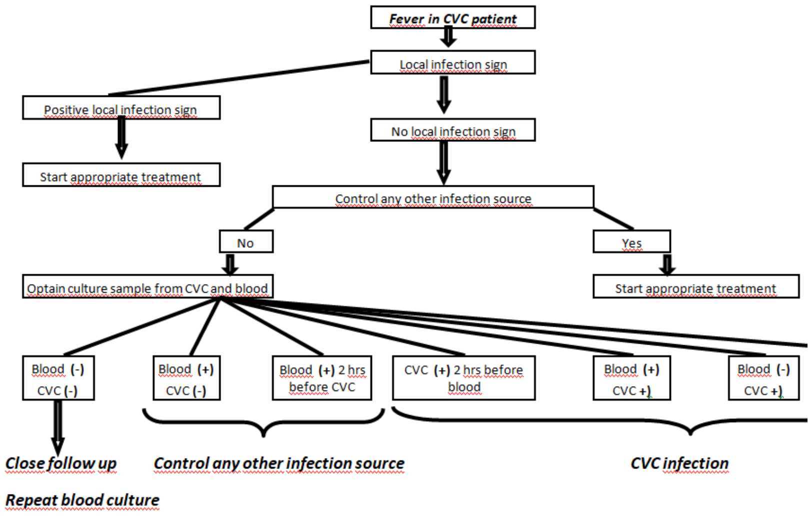


**Figure 9.8:** Flow chart in a patient with fever and CVC

Bacteremia is defined as having symptoms such as fever, chills, hypotension, tachycardia, leukocytosis, and no other focus of infection, plus bacterial growth with similar colony morphology and antibiotic sensitivity from blood taken from the catheter and peripheral vein should be detected in catheterized patient. One of the following must be present in the diagnosis.

1. In removed catheter reproduction of ≥ 15 CFU micro organism with semi-quantitative culture and ≥ 102 CFU with quantitative culture.
2. In quantitative cultures, the reproduction of micro organism in the blood taken from the catheter is 5 times higher in terms of the number of colonies relative to peripheral venous blood.
3. Reproduction of micro-organism in the blood taken from the CVC at least two hours before the simultaneous peripheral blood sample.
4. When there is negative peripheral blood culture, ≥102-3 CFU / ml reproduction of micro organism in catheter blood (25 CFU / ml for Candidal infections).
5. Clinical improvement after removal of the responsible catheter in a patient with bacteremia that was not validated by the laboratory (indirect finding).

In the case of infection, the main principles of treatment are catheter withdrawal and systemic antibiotic administration. Pulling the catheter alone is generally enough in most patients. The approach to febrile patients with CVC is summarized in Table 9.3.

However, most of the patients using CVC are critical patients. There are several risks associatied with changing the patients catheter including bleeding, pneumothorax, and no catheter re-insertion etc. Given that each catheter imposes serious financial burden on patients or institutions, the indication must be well established before the catheter replacement decision. Indications for withdrawal of the catheter and when the catheter may remain are indicated in Table 9.4.

**Table 9.3:** Withdrawal indications of catheter and the conditions under which the catheter can stay

| **Withdrawal indication of the catheter** | **Conditions that the catheter should remain** |
|---|---|
| Serious sepsis or septic shock | Patients for whom catheter replacement may be difficult |
| Infective endocarditis | Hemodynamically stable patients |
| Septic thrombophlebitis | No source of metastatic infection |
| Continuing bacteraemia/sepsis in 72 hour of antibiotic treatment | Negative blood culture after 48-72 hr antibiotic treatment |
| Local infection | No local infection |
| Relapse after antibiotic treatment | <u>Treatable agents</u> |
| Blocked catheter | Coagulase negative staphyilococcus |
| Polymicrobial bacteraemia | Diphtheroids (Non-Corynebacterium JKs) |
| <u>Virulent or sticky feature agent</u> | α-haemolytic streptococcus |
| *S. aureus, C. Jeikeium, Bacillus spp,* | |
| *Vancomycin resistance enterococcus* | |
| *Lactobasillus casei, P. aerogenoza, Candida Sp.* | |
| *Acinetobacter spp., Stenotrophomonas maltophilia,* | |
| *Mycobacterium spp, Fusarium spp., Malassezia furfur* | |

Table 9.3, Özkocaman V. Identification and treatment of infections related to the tunneled central venous catheter (Hickman Type). Journal of Uludağ University Faculty of Medicine 2002; 28: 101-103 and Oncu S. Central venous catheter infections and their treatment. Clinical Journal 2003; 16 (2): Modified from this original article.

## FIBRIN SHEATHING

Fibrin sheath formation, which is the most common cause of CVC dysfunction, occurs in 5-10% of cases. It is seen in 56% of patients who have a short-term catheter inserted. The typical finding for fibrin sheath formation is that aspiration cannot be performed while an infusion is comfortably performed. A fibrin sheath is a proteinous structure consisting of eosinophilic and inflammatory cells surrounding the catheter.

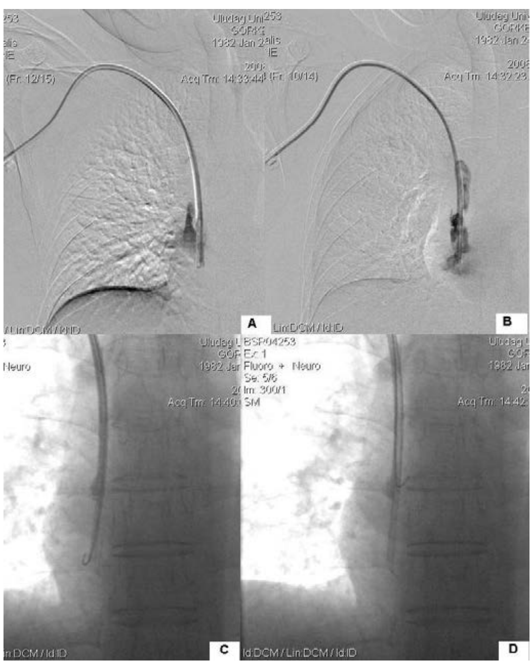


**Figure 9.8:** The images obtained by giving contrast agent from both lumens from a tunneled dialysis catheter and examined due to catheter dysfunction, reversed fibrin sheath. Fibrin sheath is disintegrated with J guide advanced from both lumens (A and C distal tip, B and D proximal tip).

Fibrin sheaths begin to form 24 hours after the insertion of the catheter. It wraps the entire catheter from the intervention site to the tip within 5-7 days. It can return to cell-rich collagen tissue and muscle cells within 1-2 weeks. After catheter removal, in some cases, the fibrin sheath remains adherent to the vein wall at the site of intervention, while in others it causes pulmonary embolism. However, in both cases it does not cause any symptoms.

In fluoroscopic images obtained by giving contrast through the catheter, the fibrin sheath makes a filling defect at the distal end of the catheter and the backward escape of the contrast agent under the fibrin sheath. If the fibrin sheath completely envelops the intravascular part of the catheter body, full occlusion of the catheter occurs. The fibrin sheath formed is primarily tried to dissolve with fibrinolytic agents (r-TPA, streptokinase, urokinase).

If unsuccessful, the fibrin sheath can be scattered using three techniques. The first technique: The guide wire with “j” tip sent from the catheter lumen is used to rotate the fibrin sheath by rotating 360 degrees around the tip of the catheter (Figure 9.8). In the second technique, the angioplasty balloon sent through the guide wire is advanced to the distal end of the catheter and inflated in the lumen of the vein, and the formed fibrin sheath is disrupted. In the third technique, the fibrin sheath is stripped by compressing the distal end of the CVC and pulling it back in a controlled way by means of an endovascular lasso that is advanced from the transfemoral way. The third technique is the most exhausting, the most expensive, and has the highest risk for catheter damage.

Another method that can be considered is to remove a catheter and insert a new catheter into the same or different vein.

Some tools have been recently launched that aim to break down the fibrin formed on the catheter. After these devices are advanced through the catheter lumen, they move from the tip back to the outer surface of the catheter and try to break the fibrin sheath by stripping. Since the use of such tools is new, it is necessary to wait for the results to be published in order to comment.

## CVC RELATED STENOSIS/THROMBOSIS

If infusion and aspiration can not be done through the CVC even with a change in position, valsalva maneuver, or even by effort, then CVC thrombosis should be suspected. Thrombus is a very common complication but its rate of becoming symptomatic is low. Symptomatic vein thrombosis should be suspected if stasis swelling at the distal part of the catheter is manifested by temperature increase and sensitivity, plus stasis increases the infection risk.

Central vein stenoses may produce similar results to fibrin sheath formation. Diagnosis can be easily made by venography, catheterrography or US. The risk of thrombosis and stenosis can be reduced by choosing the most suitable vein to be inserted before the catheter is inserted, choosing the appropriate diameter and length of the catheter, performing catheter placement with the appropriate imaging technique, maintaining the ideal position of the catheter tip and end point after catheter insertion, performing ideal catheter care and training.

If the thrombus is detected incidentally with CT or US, in small amounts around the catheter the next steps are controversial. Most of these patients may remain asymptomatic and aggressive treatments are not required. If the thrombus has a tendency to grow and has started to interrupt blood flow or to produce pulmonary embolism then it should be treated. The treatment is to administer anticoagulants with or without catheter removal. These patients should be treated conservatively most of the time because of their limited venous access.

The catheter should be left in place unless septic thrombophlebitis develops; arm elevation, hot compress, systemic anticoagulant and local thrombolytic therapy should be applied.

## CATHETER COMPRESSION/FRACTURE (PINCH-OFF SYNDROME)

Pinch-off syndrome occurs if the CVC placement is done through the subclavian vein and it develops due to compression of the catheter between the 1st costal, clavicle and subclavius muscle and the costoclavicular ligament. Internal jugular vein intervention should be preferred to avoid Pinch-off syndrome. However, if there is no choice other than the subclavian vein, the possibility of compression can be reduced by performing lateral puncture into the subclavian vein.

The typical finding for the syndrome is the difficulty in infusion, which is eliminated by changing the position of the arm. Repeated compression over time can cause catheter fatigue or fracture. In case of fracture, the embolized piece reaches the right heart.

Care should be taken as catheter fractures can often be missed on radiographs.

The part in the right heart or pulmonary artery can be removed with a loop snare. If endothelialization develops around it, it becomes impossible to remove.

## CLOT AND PRECIPITATES

Failure to wash the catheter lumen after treatment, administration of TPN (total parenteral nutrition) fluids, oily emulsions, calcium salts, sodium bicarbonate, and heparin prepared in teh preceding days causes precipitation and clot formation. Precipitates often occur suddenly, unlike a slow-formed thrombus. To prevent precipitation and clot formation, the catheter lumen should be washed with pressure using saline after each use.

## SKIN NECROSIS

Skin necrosis is a complication usually seen in patients with a subcutaneous venous port. In patients with insufficient subcutaneous adipose tissue, it develops due to chronic trauma caused by the port reservoir on the skin (Figure 9.9). For this reason, it is recommended to place the reservoir under the fascia in weak patients. However, the majority of patients who are placed


**Figure 9.9:** A. A 68-year-old male with a diagnosis of laryngeal carcinoma consulted us after skin necrosis developed 3 weeks after the end of treatment (192 days of catheter insertion). It was revealed that the patient had 14 kg weight loss during chemotherapy. The port pocket was left for the secondary healing process and appropriate antibiotic therapy was administered. The reservoir and catheter tip culture was negative. B. Port pocket area after 3 weeks.

in the port are chemotherapy patients and serious weight loss can be observed during treatment, and this reduces subcutaneous adipose tissue.

In our experience, it is possible to prevent the development of skin necrosis if the port reservoir is placed under the fascia. However, this may not always be possible in cases with excessive fatty tissue and especially in women due to breast tissue. Selecting a suitable size reservoir for the patient is also an effective method.

In cases with skin necrosis, the port catheter should be removed and the port pocket should be left to secondary healing with appropriate antibiotic treatment. If necessary for the continuation of the treatment, a port catheter can be placed again from another region.

**Figure 9.10:** The patient who underwent port catheterization from the right internal jugular vein was given oral antihistamine treatment in the 3rd month of the catheterization, where itching and hyperemia were observed in the reservoir localization. Her complaints had completely subsided at her second-day control. It was thought that leaks from the vein or the port needle allergy may be the causes.


**Figure 9.11:** The split (removable) catheter sample (A), developed to prevent the side wall effect, is another catheter (B) consisting of 3 lumens that surround the arterial lumen 360 degrees and are not connected to each other. It is an important feature that, even if two of the three lumens are blocked, the single remaining lumen can function.

## ALLERGIC REACTIONS

Allergic reactions may develop due to the contrast agent during the procedure, the material used after the procedure, or the extravasation of the chemotherapy among the vessel (Figure 9.10).

Contrast media is normally not used during catheterization. However, venography may be required for difficult catheterization. The resulting reaction shows a wide spectrum of features from anaphylaxis to mild rashes. Treatment is determined by the reaction that occurs.

## SIDE-WALL EFFECT

This complication is especially observed in tunneled dialysis catheters. Normally, when the lumens are functional, it develops as a result of obstruction by coming to the lumen end of the vessel wall when strong aspiration is performed. Generally, the position of the patient is changed and the catheter tip is removed from the vessel wall. Nowadays there are optional catheter models designed to avoid this effect (Figure 9.11).

# CHAPTER 10

# Advantages and Disadvantages of Imaging Guided Venous Catheterization Over Landmark Technique

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Central venous catheters provide safe and comfortable vascular access in cases requiring long-term infusion or total parenteral nutrition.

Since the last decade CVC placement were done by surgeons looking at anatomical landmarks (Landmark technique), but today CVC placement are done by interventional radiologists by using imaging and this became a common practice. Although the Landmark technique is a highly standardized method, it is well documented and has a percentage of complications that cannot be reduced even with experienced surgeons. In the literature imaging-guided venous interventions have been reported to have lower complication rates.

The difference between imaging guided CVC placement from the Landmark technique is that the procedure is guided by US and fluoroscopy. In this section, we will especially examine the differences that imaging methods bring to the catheterization process.

## ADVANTAGES OF US GUIDANCE

The use of US allows venous anatomy and the ability to dynamically observe blood flow. Thus, anatomical differences (variation), the diameter of the vein, the relationship between the vein and other anatomical structures, especially the arteries, and lesions that may prevent access to the vein (mass, lymphadenomegaly, etc.) can be easily detected. This leads to accurate venous access at the planning stage of the procedure.

Real-time monitoring of needle movements with US during the procedure (Figure 10.1) protects the operator from complications such as pneumothorax, hemothorax, arterial injury (Figure 10.2) and hematoma which are common in landmark technique.

In the Landmark technique, the average success rate at the first entry into the vein is 68.9%, while it is 93.1% with imaging guidance. The higher success rate at the first entry into the vein also contributes to the shortening of the intervention time.

In addition, in imaging-guided venous access unlike the landmark technique, the first puncture is passing through the anterior wall only, and this may also contribute to the reduction in complication rates.

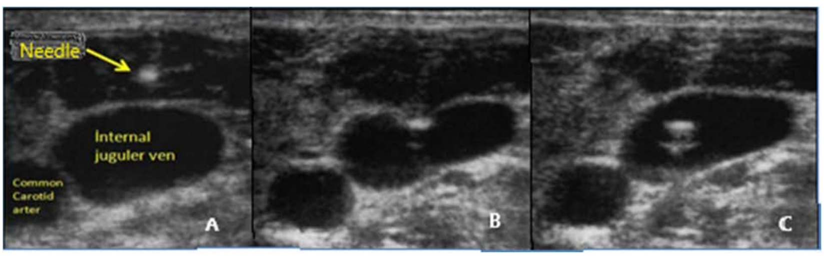


**Figure 10.1:** Consecutive images of US guidance venous puncture procedure.


**Figure 10.2:** The patient who developed arterial injury during the venous entry procedure. US view of the hematoma (white arrow) in the right carotid sheath (compared to the other side)

## ADVANTAGES OF FLUOROSCOPY GUIDANCE:

When the procedure is guided by fluoroscopy, the movement of the guide wire, peel-away sheath and catheter can be monitored in real time. This eliminates the possibility of incorrect catheter placement (primary malposition).

Once the needle is placed into the vein, the needle tip can be displaced before the guide wire is inserted. There may also be a problem in the vein lumen, which may prevent catheterization, such as thrombus, stenosis, or anatomical changes. These can be noticed from the movement of the guide wire when the process is guided by fluoroscopy.

If the guide wire is collected under the skin, it means the needle is outside the vein. It is necessary to repeat the venous entry. The guidewire and needle must be retracted together otherwise the guide wire may break if it retracts through the needle.

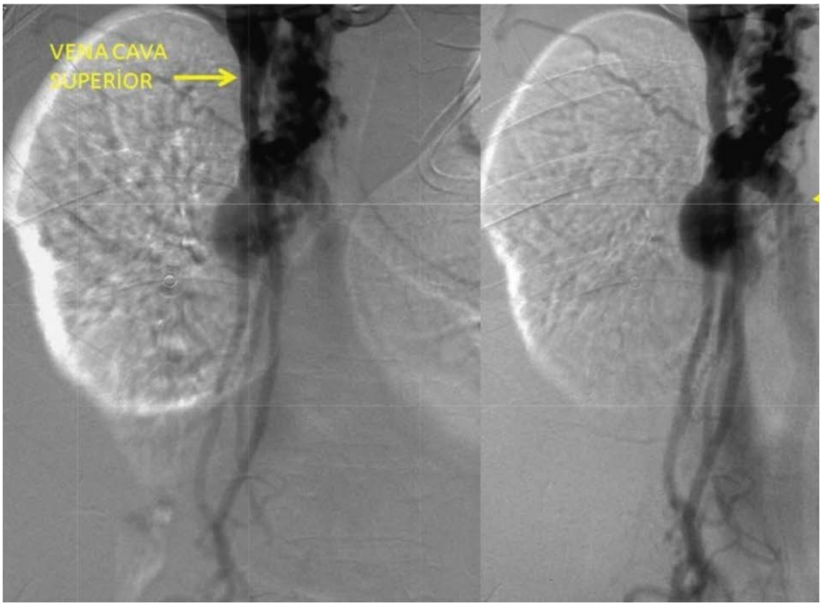


**Figure 10.3:** In the case where catheterization procedure was performed from the right internal jugular vein; the guide wire was collected in the superior vena cava, and venogram was obtained by giving contrast material from the venous needle. Occlusion in the inferior of the azygos arc in the superior vena cava is seen and venous circulation is provided through the azygos vein and collateral venous structures.

If the guide wire is not moving where it should normally be advanced, venograms are obtained by injecting contrast material through the venous needle after the procedure is stopped to clarify the problem (Figure 10.3). If the problem is stenosis or thrombus, either catheterization should be per-formed from another appropriate vein, or catheterization should be completed after the stenotic segment is recanalized.

If the guide wire moves outside the expected path due to anatomical varia-tion, the procedural technique is decided according to the type of variation (Figure 10.4). Catheterization is completed by performing the necessary maneuvers under the guidance of fluoroscopy with the help of hydrophilic guide wire or if the variation is not suitable for catheterization, then catheter-ization should be performed from another vein.

Another advantage of fluoroscopy is that the catheter tip can be placed in the appropriate position. In the Landmark technique, since catheter length is estimated, it cannot be placed in an ideal position in 25-40% of cases.

## VENOUS ENTRY SITE SELECTION:

Landmark technique users generally prefer the subclavian vein for catheter-ization. This is because the landmark technique allows a safer access to the subclavian vein than the internal jugular vein. According to literature data, subclavian access has an average risk of 5% technical failure, 3% pneumo-

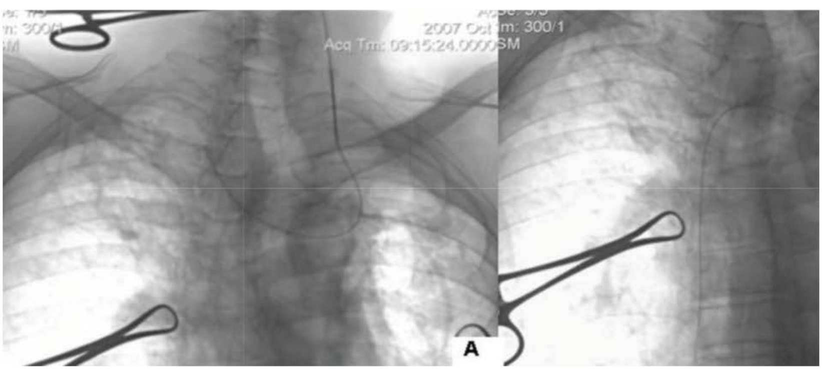


**Figure 10.4:** In the case where catheterization is performed from the left internal jugular vein, the guide wire is directed towards the right internal jugular vein due to the angle (anatomical variability) that the brachiocephalic vein be formed at the point where it joins the vena cava superior (A). Guide wire was redirected to the right atrium by appropriate maneuvers with fluoroscopic guidance (B).

thorax, 3% hemothorax and 5% arterial injury. Internal jugular access has an average risk of 12% technical failure, 0.5% pneumothorax and 8% arterial (carotid) injury. These rates explain why the subclavian vein is preferred in the landmark technique.

The disadvantages of subclavian access are its obstacle to become a primary venous access site. Thrombus, which may be caused by catheter in the subclavian vein, may cause pain and swelling in the arm, need of anticoagulant therapy, thrombolytic therapy and/or catheter removal. In addition, venous catheterization cannot be performed in patients with hemodialysis graft or fistula due to the possibility of stenosis in the subclavian vein.The incidence of pneumothorax and hemothorax at the subclavian vein entry is higher than the internal jugular venous entry. At the same time, the compression of the costoclavicular ligament and subclavian muscle to the subclavian vein may cause catheter fatigue and/or folding of the catheter (Pinch-off syndrome) and embolization.

With the imaging guided technique both routes can be used, but many interventional radiologists prefer internal jugular vein, specifically right internal jugular vein as an entry site. US guided access to the internal jugular vein is technically easier and the risk for pneumothorax is almost none.

The right internal jugular vein is preferred to the left internal jugular vein because it contains a straight pathway that facilitates catheterization and is also larger in size. In addition, the possibility of symptomatic stenosis and thrombus development is insignificant since the right internal jugular venous access allows direct access of the catheter to the heart without contact with the vessel wall.

There are also differences between surgeons and interventional radiologists in the use of internal jugular pathway. Surgeons prefer a high jugular approach as pressure can be applied more easily in case of arterial injury. This does not cause a significant problem in temporary catheters, but causes sharp angulation in permanent catheters and this increases the likelihood of catheter dysfunction. It also creates a non-aesthetic appearance on the patient's neck. However, interventional radiologists prefer a low jugular approach, especially in permanent catheters, in this way, the catheter has a better angle with the support of clavicle.

The disadvantage of internal jugular venous site for temporary (infusion or dialysis) catheters is restraining patient's neck movements. Furthermore, temporary catheters inserted through the subclavian site can also be covered under the clothes, while the jugular catheters can not. In addition, due to excess sweat glands and neck movements in the neck region, temporary catheters from the internal jugular vein have a higher risk of infection than those placed in the subclavian vein.

Considering the advantages and disadvantages described above, it is suggested that internal jugular site should be the first choice in tunneled and port catheters, and for the temporary catheters, depending on the experience of the person performing the procedure, the internal jugular or subclavian vein sites should be the first choice.

The use of both routes with high success rates is one of the advantages of imaging guided catheterization.

Catheterizations by non-classical routes (translomber inferior vena cava, external jugular vein, hepatic veins, internal mamarian vein, etc.) can only be performed under imaging guidance.

## DISADVANTAGES OF IMAGING GUIDED CATHETERIZATION;

Imaging guided catheterization requires US, fluroscopy, and experienced personnel to perform catheterization with these instruments. Unfortunately, not all of these components are always available at the same center and at all times.

The procurement of these devices requires a certain cost. On the other hand presence of an experienced practitioner in the Landmark technique is the only requirement.

It should also be taken into account that the patient and personnel are exposed to radiation during the procedure.

It is also impossible to perform all catheterization procedures with image guidance due to fewer number of interventional radiologists. In addition, interventional radiologists perform many different vascular or non-vascular procedures. Within these procedures, the time available for catheterization is limited.

## LAST WORDS

Venous catheterization with imaging guidance has significant advantages in terms of low peri-operative and early complication rates and shorter duration of the procedure compared to the Landmark technique (Figure 10.5). There are many publications in the literature comparing the two techniques.

**Figure 10.5:** Picture of a patient that was catheterized from both internal jugular and subclavian veins by the Landmark technique with no success and was referred to our interventional radiology unit.

In cases that need long-term infusion or total parenteral nutrition and have concomitant health problems, it is very important to complete their procedure with as few complications as possible. Because such patients need long-term catheterization (subcutaneous venous port, permanent catheter).

When the advantages and disadvantages mentioned above are evaluated together, in cases requiring long-term catheterization and in patients who have difficulty in transient catheterization, it is clear that imaging guided catheterization is the technique of choice in centres where this service is available.

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