Pregledni rad / Review article

Transseptalna kateterizacija

Transseptal catheterization

Nikola Pavlović[1,2]*, Šime Manola[1], Vjekoslav Radeljić[1], Ivica Benko[1], Michael Kühne[2], Christian Sticherling[2]

[1]Klinički bolnički centar Sestre milosrdnice, Zagreb, Hrvatska
[2]Klinička bolnica Basel, Basel, Švicarska

[1]University Hospital Centre Sestre milosrdnice, Zagreb, Croatia
[2]University Hospital Basel, Basel, Switzerland

SAŽETAK: Transseptalna punkcija (TSP) je postupak koji omogućuje perkutani transvenski pristup strukturama lijevog srca. TSP je razvijena primarno radi hemodinamske procjene valvularnih grešaka i mitralne valvuloplastike, dok je danas, u eri izolacije plućnih vena (PVI), postala rutinska procedura većine elektrofiziologa. Obzirom na porast broja PVI u Hrvatskoj, tehnika TSP postaje svakodnevica elektrofiziologa. Stoga liječnici i osoblje moraju biti upoznati s TSP i potencijalnim komplikacijama. Svrha ovog preglednog članka je prikazati kratku povijest i razvoj TSP, samu tehniku, indikacije te potencijalne komplikacije.

KLJUČNE RIJEČI: transseptalna punkcija, fibrilacija atrija, izolacija plućnih vena.

SUMMARY: Transseptal puncture (TSP) is a procedure that allows transvenous access to the structures of the left heart. TSP has been primarily developed for the evaluation of valvular disease and mitral valvuloplasty, while today, in the era of pulmonary vein isolation (PVI), it has become a routine procedure performed by a great number of electrophysiologists. Since there is a constant increase in a number of PVIs in Croatia, TSP is becoming a standard procedure for electrophysiologists. Physicians and staff must therefore be trained in TSP and its potential complication. This review focuses on the historical development of TSP, its technical aspect, indications and complications.

KEYWORDS: transseptal puncture, atrial fibrillation, pulmonary vein isolation.

CITATION: Cardiol Croat. 2014;9(3-4):127-133.

Povijest

Transseptalna punkcija TSP je razvijena tijekom 50-ih godina XX. stoljeća primarno radi kateterizacije lijevog atrija i procjene valvularnih bolesti srca[1]. Razvili su je Ross, Morrow i Braunwald[1]. Daljnji napredak transseptalne punkcije i učinio je Brockenbrough razvojem igle i katetera[2] te Mullins[3] daljnjim razvojem dilatatora i uvodnice. Sam sustav za TSP se nije previše mijenjao do danas te, iako postoje različiti proizvođači kao i veličine sustava, sam sustav i tehnika TSP ostaju gotovo isti kao u originalnim opisima. Danas se velika većina TSP izvodi u elektrofiziologiji radi ablacije lijevostranih aritmija[4]. Indikacije i kontraindikacije za TSP danas su prikazane u **Tablici 1**.

Anatomija

Transseptalnom punkcijom cilj je pristupiti lijevom atriju kroz najtanji dio interatrijskog septuma, a to je fossa ovalis. Fossa ovalis omeđena je anteriorno trikuspidnom valvulom, anterosuperiorno korijenom aorte, posteriorno stražnjim stjenkama desnog i lijevog atrija te dublikaturom perikarda dok se inferiorno nalazi bazalni dio desnog atrija i donja šuplja vena, a superiorno limbus fossae ovalis. Fossa ovalis zauzima oko 25% površine interatrijskog septuma i veličine je

History

TSP was developed in the 1950s for left atrial catheterization, and evaluation of valvular heart disease[1]. It was developed by Ross, Morrow and Braunwald[1]. Further improvements were made by Brockenbrough with the development of a special needle and catheter[2] and Mullins[3] contributing with a designated dilatator and sheath. Although there are many products by different manufacturers available today, the system and the technique remain essentially the same. Nowadays, TSP is mainly being used by electrophysiologists for left atrial ablation procedures and access to the left ventricle[4]. Indications and contraindications for TSP today are shown in **Table 1**.

Anatomy

The goal of transseptal puncture is to access the left atrium through the thinnest part of the interatrial septum, the fossa ovalis. Fossa ovalis is limited by the tricuspid valve anteriorly, the aortic root antero-superiorly, right and left atrial free wall with pericardial duplicature posteriorly, while inferior border is thr lower right atrium and inferior vena cava and superior border is limbus fossae ovalis and above it superior vena cava. The fossa takes up 25% of the septal area and has

Table 1. *Indications and contraindications for transseptal puncture.*

Indications for transseptal approach

Eletrophysiology
- Pulmonary vein isolation
- Left atrial tachycardia/flutter ablation
- Left accessory pathway ablation
- Ventricular tachycardia (antegrade app)
- Slow pathway/AV node ablation (rare)

Left atrial appendage occluder

Valvular interventions
- Mitral balloon valvuloplasty
- Mitraclip

Hemodynamic assessment
- Invasive evaluation of LA pressure (Pts with mitral or aortic v prosthesis)

Hemodynamic support
- TandemHeart (percutaneous VAD)

Contraindications for transseptal approach

Left atrial thrombus
Left atrial tumor
Uncooperative patient
Severe bleeding diathesis

10-25 mm (prosječno 16 mm)[5]. Kod TSP najvažnije je izbjeći punkciju korijena aorte anteriorno te slobodne stjenke desnog ili lijevog atrija posteriorno. Transezofagusnim (TEE) i intrakardijalnim ultrazvukom (ICE) je moguće direktno prikazati navedene strukture. Obzirom da korištenje ultrazvuka povećava kompleksnost i cijenu procedure, kao i da nije uvijek dostupan razvijeno je nekoliko metoda za indirektno označavanje fossae ovalis korištenjem fluoroskopije.

Jedna od metoda je direktno označavanje korijena aorte — postavljanjem duge žice ili pigtail katetera transfemoralnim pristupom direktno u korijen aorte. Ova metoda, međutim, zahtijeva punkciju arterije i povećava rizik krvarenja. Druga metoda je pozicioniranje dijagnostičkog elektrofiziološkog katetera u područje Hisovog snopa koji se nalazi u neposrednoj blizini desnog koronarnog kuspisa aorte. Ipak, najčešće korištena metoda je jednostavno postavljanje katetera u koronarni sinus (CS). CS prolazi stražnjom stranom atriventrikularne brazde i označava razinu mitralnog anulusa koji je anteriorna granica interatrijskog septuma. Iako ova metoda ne označava direktno položaj korijena aorte, ona omogućava anatomsku orijentaciju i smjer TSP pogotovo u kombinaciji s kateterom na His poziciji (**Slika 1**).

Opis postupka

TSP se izvodi korištenjem posebno dizajniranih i preformiranih igala, uvodnica i dilatatora. Iako postoje različiti oblici i veličine i dalje su najčešće u upotrebi tzv. Brockenbroughova igla i Mullins uvodnice (**Slika 2**). Procedura počinje kanulacijom femoralne vene Seldingerovom tehnikom. Postavlja se najcesce jedna kratka uvodnica putem koje se postavi kateter u koronarni sinus, a služi i za i.v. primjenu lijekova ili nadoknadu volumena. Dvije duge uvodnice zajedno s dva dilatatora postavljaju se u gornju šuplju venu (SVC) preko duge žice (J žica 0,032). Nakon toga, žica se izvuče, sustav

a diameter of 10-25mm (average 16mm)[5]. It is of utmost importance to avoid aortic root puncture anterosuperiorly and right and left atrial free wall puncture posteriorly. All critical structures can be visualized during the procedure by using transesophageal (TOE) or intracardiac echocardiography (ICE). Since the use of these modalities adds cost and complexity to the procedure and they may not always be available, several methods have been developed to delineate the boundaries of the fossa ovalis using fluoroscopy.

One of the methods includes directly marking the aortic root by positioning a long J-tip guidewire or pigtail catheter in the aortic root. However, this technique requires arterial access and increases bleeding complications. Another method is to position a diagnostic EP- catheter in the His-bundle position, which is in close proximity to the right coronary cusp. The most frequently used method is to simply position an EPcatheter in the coronary sinus (CS). The CS runs along the posterior aspect of the atrioventricular groove and delineates the level of the annulus of the atrioventricular valves, the anterior boundary of the interatrial septum. While this does not directly visualize the aortic root, it allows for proper anatomical orientation and direction of TSP, particularly in conjunction with catheter in his-position (**Figure 1**).

Technique description

TSP is performed by using specially designed and preformed needles, sheaths and dilatators. Although there are many forms, designs and sizes in use, still the most frequently used are Brockenbrough needle and Mullins sheaths (**Figure 2**). The procedure typically starts with access to the femoral vein using a Seldinger technique. One short sheath is placed for a coronary sinus catheter and as a vascular access for drug and fluid administration. Two long sheaths together with dilators are placed in the SVC

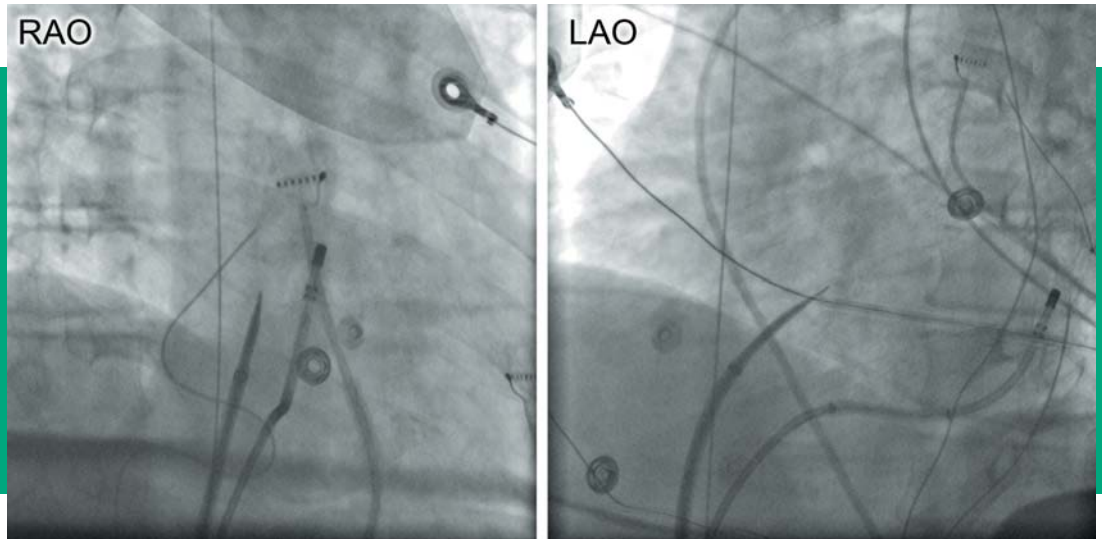

Figure 1. *Right anterior oblique and left anterior oblique projections. In the right anterior oblique projection, coronary sinus catheter is pointing away from the operator and is marking the position of atrioventricular groove. The assembly for transseptal puncture is at the fossa ovalis, in the right anterior oblique, it is parallel to coronary sinus catheter and approximately half way between the coronary sinus catheter and posterior wall. In the left anterior oblique, it is above the level of the coronary sinus ostium.*

aspirira te se postavlja igla za punkciju do samog vrha dilatatora.

Daljnja orijentacija i procedura ovise o tehnici kojom se operater koristi. Ovdje ćemo opisati TSP uz korištenje fluoroskopije te kontrastnog sredstva i mjerenja tlaka putem igle za punkciju. Koristeći LAO 45 projekciju cijeli sustav (igla, dilatator, uvodnica) se polako povlače iz gornje šuplje vene prema desnom atriju. Važna je orijentacija cijelog sustava i u većini slučajeva se orijentacija igle i dilatatora drži tako da je bočni izlaz dilatatora usmjeren prema 4-5 sati (vrh igle i uvodnice moraju biti usmjereni u istom pravcu). Kod povlačenja sustava radiološki se mogu uočiti dva ''preskoka'' vrha dilatatora. Prvi je kod prelaska iz gornje šuplje vene u desni atrij, a drugi kod prelaska s muskularnog dijela septuma preko limbusa fossae ovalis u fossu ovalis. Vrh dilatatora sada u LAO projekciji mora biti iznad katetera u koronarnom sinusu, a u RAO projekciji mora biti posteriornije i paralelno s kateterom u distalnom koronarnom sinusu (**Slika 1**). Smjer transseptalne uvodnice i dilatatora ne bi smio prelaziti anteriornije od katetera u koronarnom sinusu jer se povećava mogućnost preanteriorne punkcije (punkcija korijena aorte).

over a long 0.032 inch J tip wire. The wire is then removed, blood aspirated and the transseptal needle is positioned just at the tip of the system. It is important to forward the needle in the sheath with a stylet in place in order to avoid inadvertent avulsion of the lining of the dilator by the sharp needle tip.

Further orientation and procedure depends on the technique used. We will describe TSP with the use of fluoroscopy with contrast injection and pressure measurement from the tip of the needle. In the LAO 45 projection, the whole system (needle, dilator and sheath) is slowly pulled back from the SVC to the RA. Orientation of the system is important, and it is held so the dilatator handle points to the 4-5 o'clock (needle and sheath should be pointing in the same direction). While pulling the system down, two ''jumps'' can be seen on the fluoroscopy image. The first jump occurs, when the system enters the RA from the SVC, and the other when system jumps from muscular part of the septum, over the limbus fossae ovalis into the fossa. At this point the tip of the dilator should be above the CS catheter in the LAO projection and behind and parallel to it in the RAO projection (**Figure 1**). The direction of the system (projected from the tip) should not cross

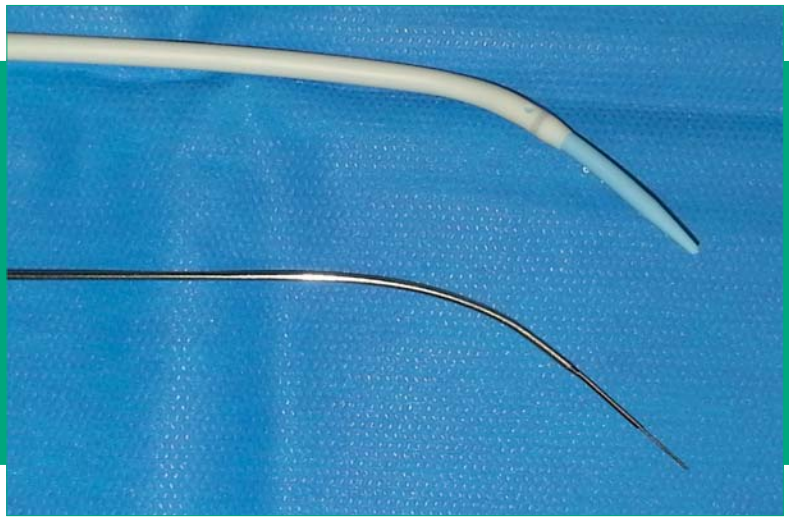

Figure 2. *Tip of transseptal dilator, sheath and the transseptal needle.*

Kada smo zadovoljni s pozicijom sustava, potrebno je polako pozicionirati iglu prema naprijed. U isto vrijeme primjenjuje se kontrast kroz transseptalnu iglu kojim se nakon prelaska u lijevi atrij ispunjava šupljina lijevog atrija. Nakon prelaska, dodatno se položaj igle potvrđuje mjerenjem tlaka u lijevom atriju.

U slučaju otežane punkcije ''staining'' odnosno opacificiranje septuma kontrastom je korisna metoda. Kako je vidljivo na **Slici 3**, kontrast se primijenjuje jos prije prelaska septuma te se jasno može vidjeti ''tenting'' interatrijskog septuma prema lijevom atriju tijekom prelaska igle.

the line of CS catheter as it increases the risk of an anterior puncture (aortic root puncture).

When the operator is satisfied with catheter position, the needle is advanced. At the same time, the contrast is applied through the needle which opacifies the left atrium. Additionally, the position is verified by removing the syringe and performing a pressure measurement from the needle tip.

In case of a difficult puncture or a rigid interatrial septum, staining of the septum may prove very helpful. As depicted in **Figure 3**, the operator can then observe a "tenting" of the stained septum into the left atrial cavity when advancing the needle.

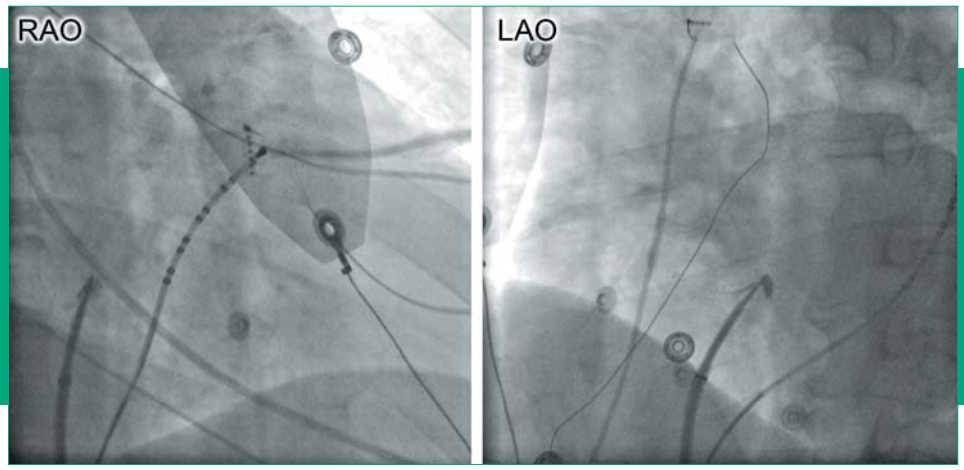

Figure 3. *Right anterior oblique and left anterior oblique projections. Catheter positions are same as described in Figure 1. While advancing the needle and applying pressure at the fossa ovalis with the system, the contrast is applied. ''Tenting'' can be best seen in left anterior oblique and ''staining'' of the fossa ovalis just at the tip of the needle indicating the correct spot for the transseptal puncture.*

U slučaju neadekvatne pozicije sustava za TSP ili nesigurnosti kao i u slučaju da nakon izvlačenja igle kontrast opacificira neku drugu strukturu potrebno je iglu povući te cijeli sustav ponovo repozicionirati. Dok god je učinjena punkcija neke strukture (**Slika 4**) osim fosse ovalis samo iglom rizik komplikacije je minimalan. Prolaskom dilatatora i uvodnice (8,5 Fr) u aortu ili slobodnu stijenku atrija komplikacije postaju potencijalno fatalne. U slučaju pojave kontrasta u korijenu aorte ili u/iza stražnje stjenke atrija savjetujemo rano intraporceduralno učiniti ehokardiografiju radi isključivanja ozbiljnih komplikacija.

In case of uncertainty or inadequate position of the system for TSP as well as in case of staining of other structures apart from the fossa ovalis after needle advancement, the needle and the system should be withdrawn and the whole system repositioned again. As long as other structures have only been punctured with the needle, (**Figure 4**) the latter can be withdrawn and the risk of complications is minimal. In case of dilator and sheath advancement (8.5 Fr) into the aorta or through the atrial free wall, the complications beome potentially fatal. In case of staining of the aortic root or atrial free wall/pericardium we advise early use of echocardiography to exclude serious complications.

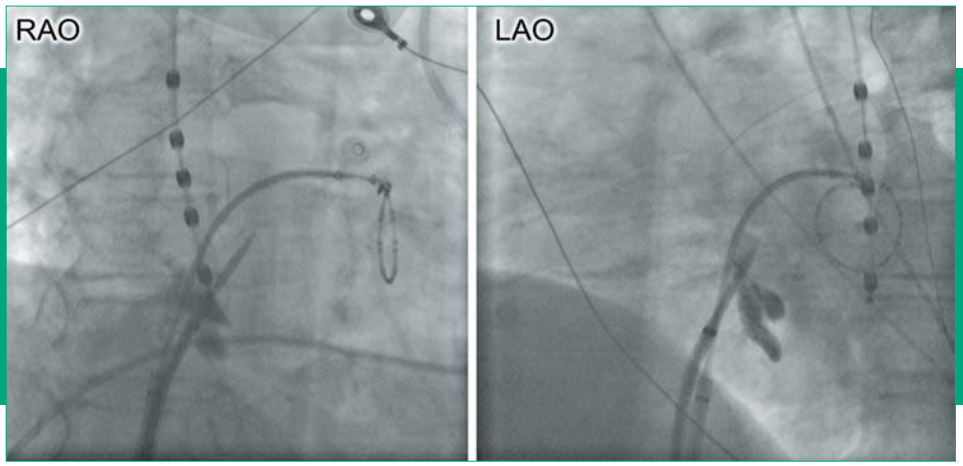

Figure 4. *Staining of the infero-posterior part of the interatrial septum before the current transseptal puncture. The contrast is seen in the septum and the current transseptal puncture is above and anterior to the staining. Staining was done only with the needle and the patient had no complications after the procedure (echo control).*

Nakon uspješnog prolaska igle kroz septum, igla i dilatator se dodatno pomiču prema naprijed dok operater nije siguran da je vrh dilatatora prošao septum. Zatim se igla izvlači, aspirira oksigenirana, arterijska krv (mjerenje saturacije također potvrđuje poziciju u LA) te se duga J žica postavlja u gornju ili donju plućnu venu (**Slika 5**). Cijeli sustav se zatim postavlja u lijevi atrij preko žice čime se smanjuje rizik punkcije slobodne stjenke LA ili aurikule tijekom prelaska u LA.

Nakon uspješne TSP, igla i dilatator se povlače, uvodnica se aspirira te se spaja na kontinuirano propiranje heparinizira-nom fiziološkom otopinom. Ovime je TSP završena te daljnji postupak ovisi o proceduri koja se izvodi. Za lijevostrane

After the needle has crossed the septum, the whole system is slightly advanced, ensuring positioning of the dilator tip in the left atrial cavity and then removed. After aspiration of oxygenated blood (at this point O_2 saturation can be measured to prove the correct position), the J tip wire should be positioned in the left superior or left inferior pulmonary vein (**Figure 5**). The whole system is then advanced across the septum over the wire. The wire positioned in a pulmonary vein minimizes the risk of an inadvertent injury to the left atrial wall or appendage when forcing the sheath into the left atrium.

After successful TSP, the needle and the dilator are removed. The sheath is aspirated and continuously flushed with heparinized saline. At this point the further management is dependent on the procedure being performed. A second

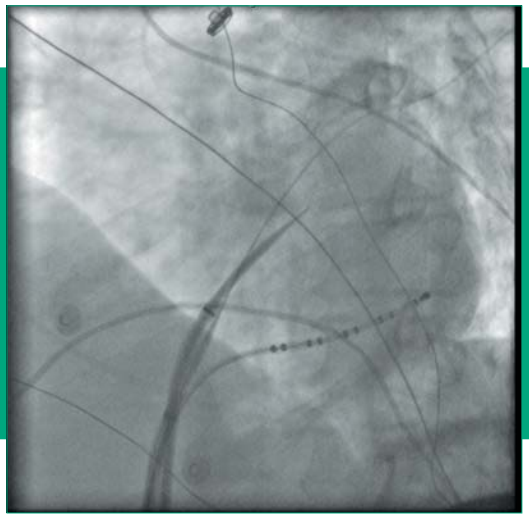

Figure 5. *Left anterior oblique view. After successful first transseptal puncture, guide wire can be seen in left superior pulmonary vein (beyond the left heart border). Second sheath, dilator and needle are at the fossa level before second transseptal puncture.*

ablacije najčešće je potrebno učiniti još jednu TSP koristeći prvu kao marker. Kod otežanih TSP, postavljanje druge uvodnice se može pokušati prolaskom žice ili elektrofiziološkog katetera uz prethodnu TSP.

Neki laboratoriji za TSP koriste i druge mogućnosti kao korištenje TEE[6], ICE[7] ili angiografije desnog atrija[8]. Korištenjem ultrazvuka moguće je potencijalno smanjiti komplikacije ali ICE značajno povećava cijenu procedure, a TEE povećava nelagodu kod bolesnika. Angiografija desnog atrija može biti od koristi kod bolesnika s anatomskim varijacijama ili rotacijom srca. Kod otežanih TSP danas se koriste i posebno dizajnirane ''oštre'' žice kroz lumen igle[9] ili se primjenjuje radiofrekventa energija putem vrha igle[10]. Nedavno su opisane i metode transseptalne punkcije bez korištenja fluoroskopije uz pomoć ultrazvuka i navigacijskih sustava[11].

Priprema bolesnika i postupak nakon intervencije

Kao i za svaki drugi invazivni postupak, priprema bolesnika je iznimno važna da bi se smanjio rizik komplikacija. Prije TSP kod bolesnika s AF kod svakog bolesnika potrebno je učiniti TEE, primarno radi isključenja postojanja tromba u LA i aurikuli. Također, anatomija interatrijskog septuma, postojanje otvorenog foramena ovale (PFO), atrijskog septalnog defekta ili hipertrofije septuma te ostalih anatomskih odnosa mogu uvelike pomoći operatoru. TEE je potrebno učiniti i kod ostalih bolesnika koji veći rizik za razvoj tromba u LA. Tijekom postupka, mi koristimo TEE samo rijetko, kod bolesni-

transseptal puncture is to be performed for left atrial ablation procedures, typically, using the first as a “roadmap”. In cases of a very difficult TSP, left atrial access of two long sheaths can be achieved by trying to pass the first puncture site along the guidewire with a second guidewire or a steerable EP catheter.

Some labs use additional methods for TSP like the use of transesophageal[6] and intracardiac[7] echocardiography or right atrial angiography[8]. While the use of echocardiography potentially reduces the risk of complications, ICE significantly increases the costs of the procedure, while TOE increases the patient’s discomfort. Angiography of the right atrium can be used in patients with unusual anatomy. Specially designed ''sharp'' J tip wires can be used[9] or radiofrequency energy over the tip of the needle can be applied[10] in difficult TSP. Recently, fluoroscopy free transseptal punctures have been described by using echocardiography and 3D navigation systems[11].

Patient preparation and postprocedure treatment

As in any other invasive procedure, a thorough preparation is important to minimize the risk for complications. Before performing TSP in patients with AF, transesophageal echocardiography should be performed to exclude a left atrial thrombus. During the TOE, anatomy of the interatrial septum, presence of PFO, ASD or septal hypertrophy can be defined and assist the operator in the procedure. TOE should also be performed in other patients who are at risk for the left atrial thrombus. During the procedure, we only use TOE in

ka koji imaju postavljen PFO okluder i kod kojih nije uspjela TSP uz koristenje samo fluoroskopije (**Slika 6**).

some patients who have a PFO occluder in place and TSP could not be performed using fluoroscopy only (**Figure 6**).

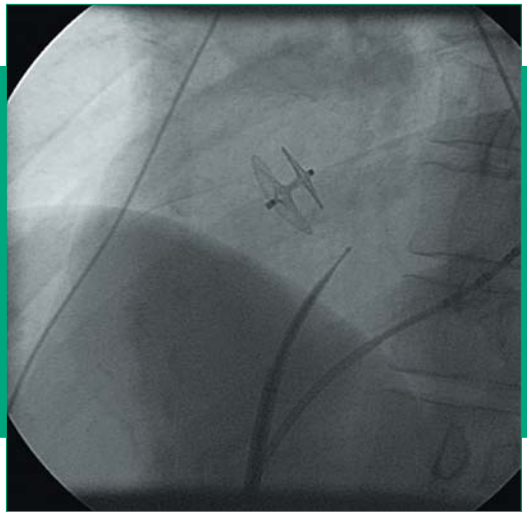

Figure 6. *Left anterior oblique view before transseptal puncture in patient with patent foramen ovale occluder.*

Obzirom da se radi o invazivnom postupku koja također zahtijeva sistemsku heparinizaciju, važni su i nalazi kompletne krvne slike kao i koagulogram (broj trombocita, INR). Radi prevencije tromboembolijskih komplikacija, nakon uspješne TSP bolesnici dobivaju 100 IJ/kg heparina. U daljnjem tijeku procedure svakih 20-30 minuta mjeri se ACT te se održava većim od 300 s[12]. Iako je povišen INR (>2.5) do nedavno bila kontraindikacija za proceduru[4,13], prema rezultatima COMPARE studije (NCT01006876) bolesnici s učinjenom ablacijom uz nastavak varfarina imaju manje tromboembolijskih incidenata. Stoga, danas sve više centara izvodi TSP I PVI bez prekidanja antikoagulantne terapije, uz terapijske vrijednosti INR.

Nakon TSP i završetka postupka vade se uvodnice te se krvarenje zaustavlja manualnom kompresijom. Bolesnik mora mirovati 6-8 sati, a ukoliko postupak prođe bez komplikacija idući dan se može otpustiti kući. Nakon TSP kod svih bolesnika je potrebno učiniti ehokardiografski pregled radi isključenja perikardnog izljeva. Kod bolesnika nakon PVI nastavlja se antikoagulantna terapija minimalno tri mjeseca, a dalje ovisno o riziku tromboembolije (CHADS2VASc score). Kod bolesnika nakon ablacije ljevostranih akcesornih putova dovoljna je terapija acetilsalicilatnom kiselinom tijekom 4 tjena.

Komplikacije

Komplikacije su opisane u oko 1% TSP[14,15]. Moguće komplikacije uključuju perikardni izljev i tamponadu, zatim punkciju korijena aorte, moždani udar ili tranzitornu ishemijsku ataku, tranzitornu elevaciju ST spojnice, bol u prsištu, perzistiranje atrijskog septalnog defekta te smrt. U početku TSP, prvi radovi koji su opisivali komplikacije transseptalne punkcije opisali su incidenciju tamponade u oko 1,2% bolesnika[16]. Prema najvećem istraživanju kojim je obuhvaćeno 5.520 TSP, incidencija tamponade bila je 0,74%[14] s jednim smrtnim ishodom (0.018%). Incidencija komplikacija razlikuje se također ovisno i o proceduri. Tako je tamponada opisana u 1.2% do čak 6 % bolesnika prilikom PVI što je znatno više nego kod ablacija lijevostranih akcesornih putova. Viši rizik povezan je s potrebom za dvije TSP, sistemskom antikoagulacijom, kao i opsežnijom ablacijom u lijevom atriju. Dio tog rizika sigurno je povezan sa samim postupkom ablacije, kao i manipulacije kateterima u LA, a ne samom TSP.

Since TSP is an invasive procedure which also requires systemic heparinization, complete blood count and coagulogram (thrombocytes, INR) should be obtained in all patients. For prevention of thromboembolic incidents, after successful TSP, patients receive 100 IU/kg of heparin. After that, ACT is measured every 20-30 minutes and should be kept >300 s[12]. Although increased INR (>2.5) was considered a contraindication for TSP[4,13], the COMPARE trial (NCT01006876) showed a decreased risk for thromboembolic incidents and major bleeding in patients who continued warfarin therapy. Today, an increasing number of centers perform TSP and PVIs without discontinuation of warfarin therapy and with INRs in the therapeutic range.

After TSP and the procedure, sheaths are removed and manual compression applied to stop the bleeding. A patient should rest 6-8 hours, and if there are no complications, he can be released home next day. A pericardial effusion should be excluded by transthoracic echocardiography. In patients after PVI, anticoagulation therapy is continued for at least three months and further management depends on thromboembolic risk (CHADS2VASc score). Patients who were ablated for left sided accessory pathways receive aspirin for 4 weeks.

Complications

Complications have been described to occur in around 1% of TSP[14,15]. Complications include pericardial effusion and tamponade, aortic root puncture, stroke, TIA, ST segment elevation, chest pain, persistence of ASD and death. In early days of TSP, first reports described an incidence of tamponade in 1.2%[16] patients. In the largest survey of TSPs which included 5,520 TSPs, the incidence of tamponade was 0.74%[14] with one death (0.018%). The incidence of tamponade also differs depending on the procedure. Tamponade is described in 1.2-6% of patients undergoing PVI which is much higher than in patients undergoing left sided accessory pathway ablation. The higher risk is probably attributable to double TSP, need for systemic anticoagulation, treatment of patients with structural heart disease (dilated chambers) and more extensive ablation in the left atrium. A part of the risk is related to ablation duration and catheter manipulation in the left atrium rather than TSP itself.

Incidencija tamponade može se potencijalno smanjiti korištenjem ultrazvuka prilikom punkcije[17] međutim incidencija tamponade kod TSP s korištenjem samo fluoroskopije i fluoroskopije i ultrazvuka nikada nije uspoređena u randomiziranoj studiji. Znatno važniji način smanjivanja broja komplikacija je vjerojatno trening, iskustvo i volumen operatora. Prema podacima iz nekoliko istraživanja krivulja učenja uključuje 25-50 procedura nakon čega se broj komplikacija znatno smanjuje[17,18].

Iako rizik tromboembolije postoji, on je više povezan s kasnijom procedurom nego sa samom TSP. Radi smanjenja incidencije moždanog udara/tranzitorne ishemijske atake potrebna je adekvatna antikoagulacija, kao i pažljivo propiranje dilatatora i uvodnica. Izvođenje procedure uz terapijske vrijednosti INR kao dodatak heparina znatno smanjuju incidenciju tromboembolijskih incidenata.

Zaključak

Transseptalna punkcija je jedna od osnovnih tehnika invazivnih elektrofiziologa. Porastom broja valvularnih intervencija (mitralna valvuloplastika, MitraClip), kao i pojavom okludera lijeve aurikule postaje potrebna i sve većem broju invazivnih kardiologa. U iskusnim rukama većina transseptalnih punkcija može se učiniti sigurno uz korištenje samo fluoroskopije.

Received; 28th Feb 2014; Accepted: 4th Mar 2014

*Address for correspondence: Zavod za kardiovaskularne bolesti, Klinički bolnički centar Sestre milosrdnice, Vinogradska cesta 29, HR-10000 Zagreb, Croatia.

Phone: +385-1-3787-111

E-mail: nikola.pavlovic@usb.ch

The incidence of tamponade and other complications can potentially be reduced with the use of ICE during the puncture[17]. However, TSP with the use of fluoroscopy and ICE versus fluoroscopy only has never been compared in a randomized manner. It must be training, volume and experience of the operator that is more important for the reduction of complications. According to several published papers, the steepest part of the learning curve includes 25-50 TSPs after which complication rates significantly decrease[17,18].

Thromboembolic risk during TSP exists, although it is more related to the procedure which is performed after the TSP. An adequate anticoagulation during the procedure and careful aspiration/flushing of the whole system is required for the reduction of the risk of stroke/TIA. Additional reduction in thromboembolic incidents is achieved by performing the procedures with therapeutic INR and additional heparinization during the procedure.

Conclusion

Transseptal puncture has become an indispensable technique for interventional electrophysiologists. The technique has become even more widely used with an increase in valvular interventions (mitral valvuloplasty and MitraClip) and the advent of left atrial appendage occlusion devices. When used by experienced hands, transseptal puncture can be performed safely and reliably when using fluoroscopy only.

Literature

1. Ross J Jr, Braunwald E, Morrow AG. Transseptal left heart catheterization: a new diagnostic method. Prog Cardiovasc Dis. 1960;2:3158.

2. Brockenbrough EC, Braunwald E, Ross J Jr. Transseptal left heart catheterization. A review of 450 studies and description of an improved technic. Circulation. 1962;25:15-21.

3. Mullins CE. Transseptal left heart catheterization: experience with a new technique in 520 pediatric and adult patients. Pediatr Cardiol. 1983;4(3):239-45.

4. Kuhne M, Oral H. Indications and contraindications of transseptal catheterization. In: Thakur RK, Natale A (Eds). Transseptal catheterization in cardiac electrophysiology. Cardiotext Publishing 2010, Minneapolis, Minnesota.

5. Sweeney LJ, Rosenquist GC. The normal anatomy of the atrial septum in the human heart. Am Heart J. 1979;98(2):194-9.

6. Hahn K, Gal R, Sarnoski J, Kubota J, Schmidt DH, Bajwa TK. Transesophageal echocardiographically guided atrial transseptal catheterization in patients with normal-sized atria: incidence of complications. Clin Cardiol. 1995;18(4):217-20.

7. Dravid SG, Hope B, McKinnie JJ. Intracardiac echocardiography in electrophysiology: a review of current applications in practice. Echocardiography. 2008;25(10):1172-5.

8. Rogers DPS, Lambiase PD, Dhinoja M, Lowe MD, Chow AWC. Right atrial angiography facilitates transseptal puncture for complex ablation in patients with unusual anatomy. J Interv Card Electrophysiol. 2006;17(1):29-34.

9. De Ponti R, Marazzi R, Picciolo G, Salerno-Uriarte JA. Use of a novel sharp-tip, J-shaped guidewire to facilitate transseptal catheterization. Europace. 2010;12(5):668-73.

10. McWilliams MJ, Tchou P. The use of a standard radiofrequency energy delivery system to facilitate transseptal puncture. J Cardiovasc Electrophysiol. 2009;20(2):238-40.

11. Reddy VY, Morales G, Ahmed H, et al. Catheter ablation of atrial fibrillation without the use of fluoroscopy. Heart Rhythm. 2010;7(11):1644-53.

12. Earley MJ. How to perform a transseptal puncture. Heart. 2009 Jan;95(1):85-92.

13. Tzeis S, Andrikopoulos G, Deisenhofer I, Ho SY, Theodorakis G. Transseptal catheterization: considerations and caveats. Pacing Clin Electrophysiol. 2010;33(2):231-42.

14. Roelke M, Smith AJ, Palacios IF. The technique and safety of transseptal left heart catheterization: the Massachusetts General Hospital experience with 1,279 procedures. Cathet Cardiovasc Diagn. 1994;32(4):332-9.

15. De Ponti R, Cappato R, Curnis A, et al. Trans-septal catheterization in the electrophysiology laboratory: data from a multicenter survey spanning 12 years. J Am Coll Cardiol. 2006;47(5):1037-42.

16. De Ponti R, Zardini M, Storti C, Longobardi M, Salerno-Uriarte JA. Trans-septal catheterization for radiofrequency catheter ablation of cardiac arrhythmias. Results and safety of a simplified method. Eur Heart J. 1998;19(6):943-50.

17. Bayrak F, Chierchia G-B, Namdar M, et al. Added value of transoesophageal echocardiography during transseptal puncture performed by inexperienced operators. Europace. 2012;14(5):661-5.

18. Yao Y, Ding L, Chen W, et al. The training and learning process of transseptal puncture using a modified technique. Europace. 2013;15(12):1784-90.