8 Transseptal Access

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8.1 Introduction

Transseptal (TS) access was initially described in 1959 and since has been widely utilized for congenital and structural heart interventions. A thorough understanding of the anatomy is crucial for TS access (Fig. 8.1). Perfoming contemporary TS access stresses on not only understanding the anatomy but also on the knowledge of modern imaging modalities, alternative techniques for difficult or high-risk patients, site-specific puncture based on the type of procedure, and a systematic approach to management of complications (1). Advanced imaging such as fusion imaging may improve the site specificity of the TS access. There is a steep learning curve, and trainees may benefit from collaborating with other disciplines and doing simulator training. There is a renewed interest in percutaneous interventions for congenital and structural heart disease, and TS access remains an integral part of the skillset that is needed for safe and effective procedures.

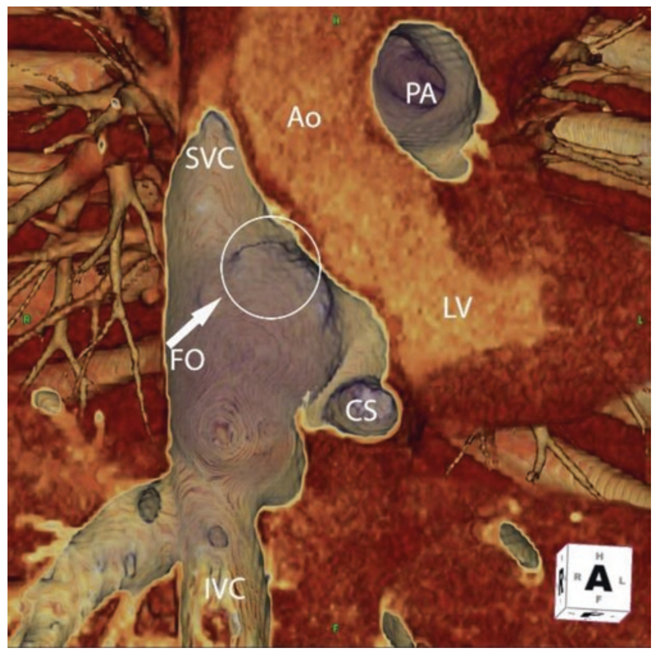

Fig. 8.1 Understanding transseptal anatomy. A majority of the atrial septation is formed by infolding of the right and left atrial walls (interatrial groove), with puncture outside the fossa ovalis valve (FO) and adjacent margins of its muscular rims (limbus), leading to perforation. The interatrial septum (IAS) is bounded posteriorly by a fold of the pericardium between the left and right atria, superiorly by the superior vena cava (SVC), anterosuperiorly by the noncoronary sinus of the aortic valve, anteroinferiorly by the coronary sinus, and inferiorly by the IVC. The superoposterior rim is often referred to as the septum secundum. The aortic mound is located anterior and superior to the FO, overlying the aorta; posterior to the aortic mound is the transverse sinus or retroaortic space. More caudally, the pyramidal space constitutes the posterior septum where the right-sided pulmonary veins and their pericardial reflections forming the oblique sinus are located

Electronic Supplementary Material The online version of this chapter (https://doi.org/10.1007/978-3-319-72443-0_8) contains supplementary material, which is available to authorized users.

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G. Butera et al. (eds.), *Atlas of Cardiac Catheterization for Congenital Heart Disease*,
https://doi.org/10.1007/978-3-319-72443-0_8

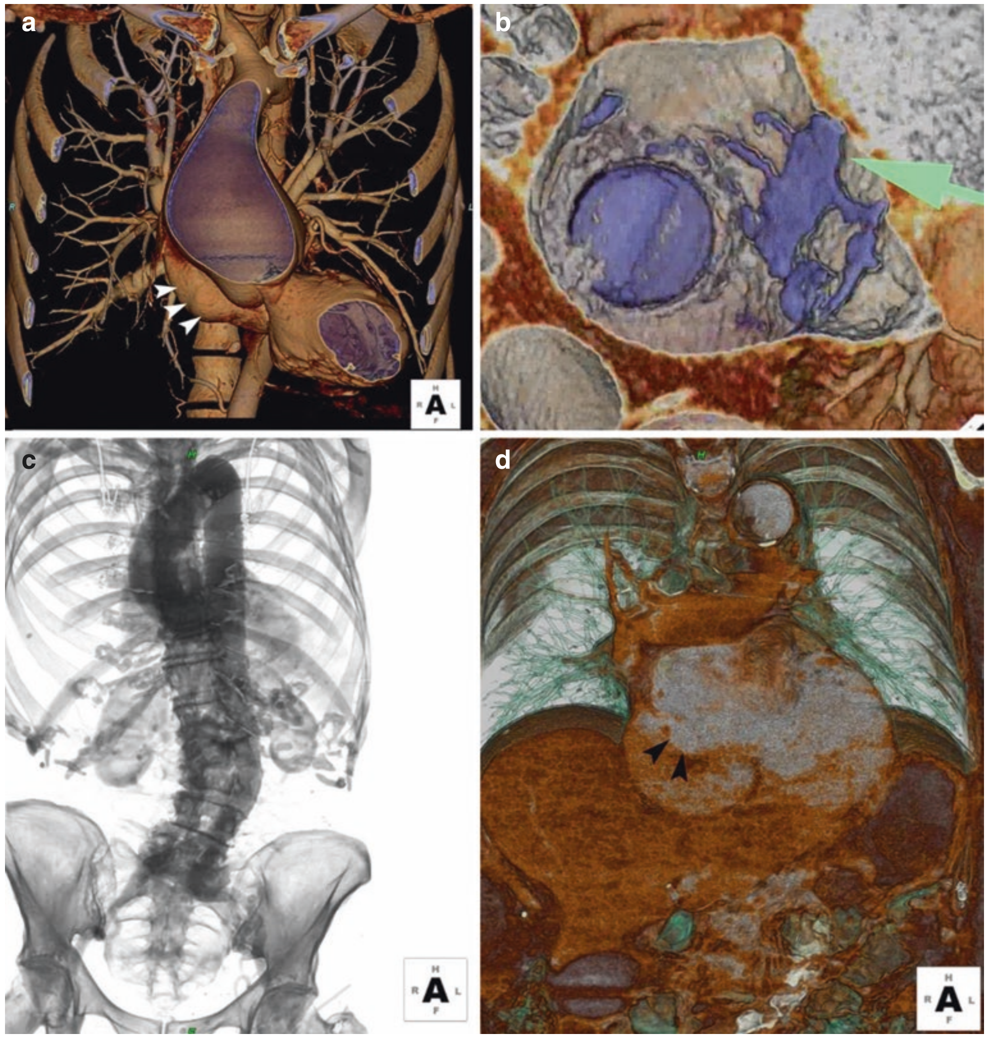


Fig. 8.2 High-risk transseptal anatomy. (**a**) Extracardiac distortion by an ascending aortic aneurysm can cause bulging of the anterosuperior aspect of the interatrial septum (*white arrowheads*). (**b**) Extensive calcification (*green arrow*) of the IAS can be visualized in a postsurgical patient with limited location for transseptal puncture. (**c**, **d**) Patient with significant scoliosis leading to a more horizontal orientation of the IAS (*black arrowheads*)

Table 8.1 Indications and contraindications of transseptal access for congenital and structural heart procedures

Indications	Absolute and relative contraindications
Hemodynamic assessment	Lipomatous or thickened atrial septum
Patent foramen ovale closure	Hypoplastic left atrial cavity
Atrial septal defect closure	Presence of atrial thrombus or mass
Left-sided electrophysiology procedures	Organized thrombus (relative contraindication)
Pulmonary hypertension with low cardiac output	INR >2.5 without reversal
Single ventricle physiology with low cardiac output or hypoxemia	Platelet count <50,000 cell/dL
Protein-losing enteropathy (failing Fontan physiology)	Abnormal IVC precluding normal access to the septum
Percutaneous balloon mitral valvuloplasty	
Antegrade aortic balloon valvuloplasty	
Transcatheter mitral valve repair	
Transcatheter mitral valve/valve-in-valve implantation	
Percutaneous mitral paravalvular leak repair	
Percutaneous left ventricular assist devices	
Left atrial appendage closure	

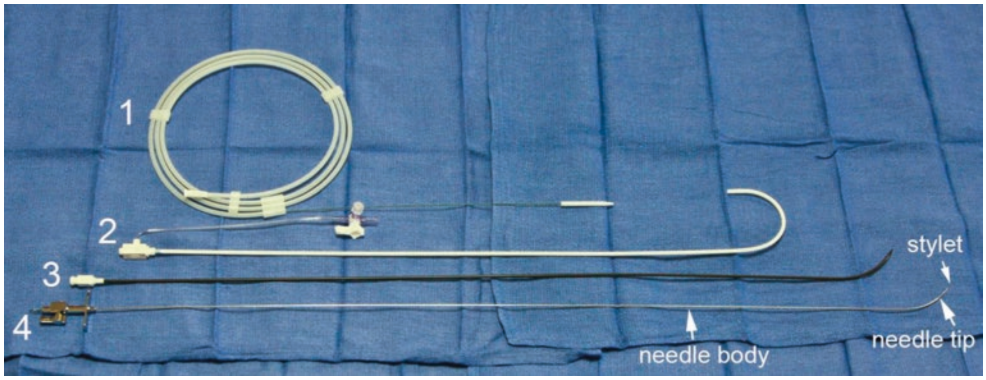


Fig. 8.3 Standard equipment for transseptal access is shown in the above figure: (1) 0.025-in. guidewire, (2) Mullins sheath, (3) dilator, (4) and Brockenbrough needle (Medtronic, Santa Rosa, Calif). The needle body is 18G, the needle tip is 21G, and the stylet is 0.014-in. in diameter. The Brockenbrough needle is available in multiple lengths and curves. Various other equipment are used (not shown). The NRG RF transseptal needle (Baylis, Montreal, Quebec, Canada) uses RF energy and can be used to avoid forced entry with the needle or when thick septum is present. Steerable sheaths (Agillis NxT; St Jude Medical, St. Paul, Minn) allow maneuverability in complex anatomy

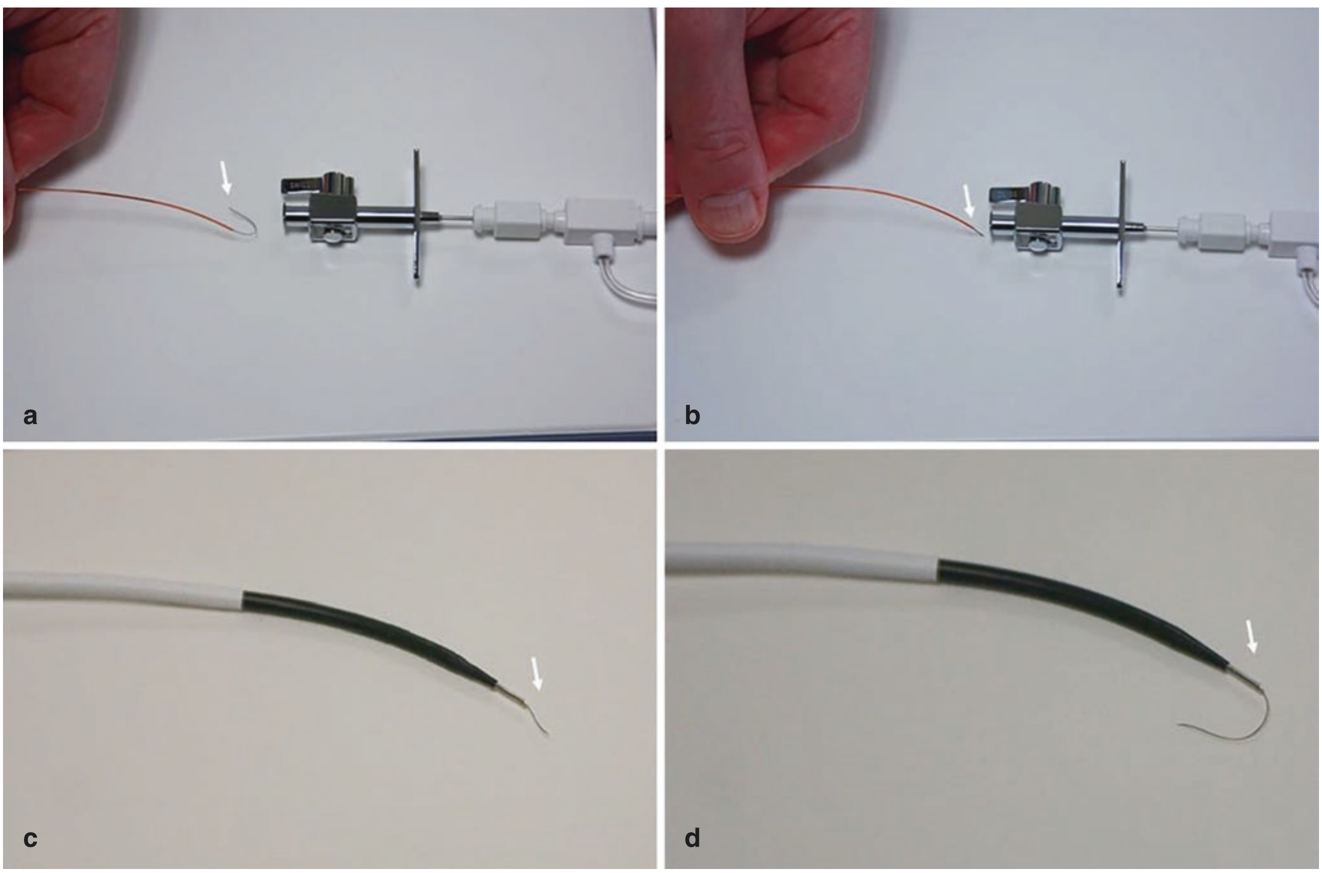


Fig. 8.4 The SafeSept wire (Pressure Products, San Pedro, California) is a nitinol guidewire (0.014-in. diameter) that has a sharp floppy "J tip" (white arrows). The tip assumes a straight orientation (**b** and **c**, white arrow) while inside the needle and allows crossing the septum, but upon entry into the left atrium, it assumes a J shape (**a** and **d**, white arrows). This allows for a safer entry into left atrium

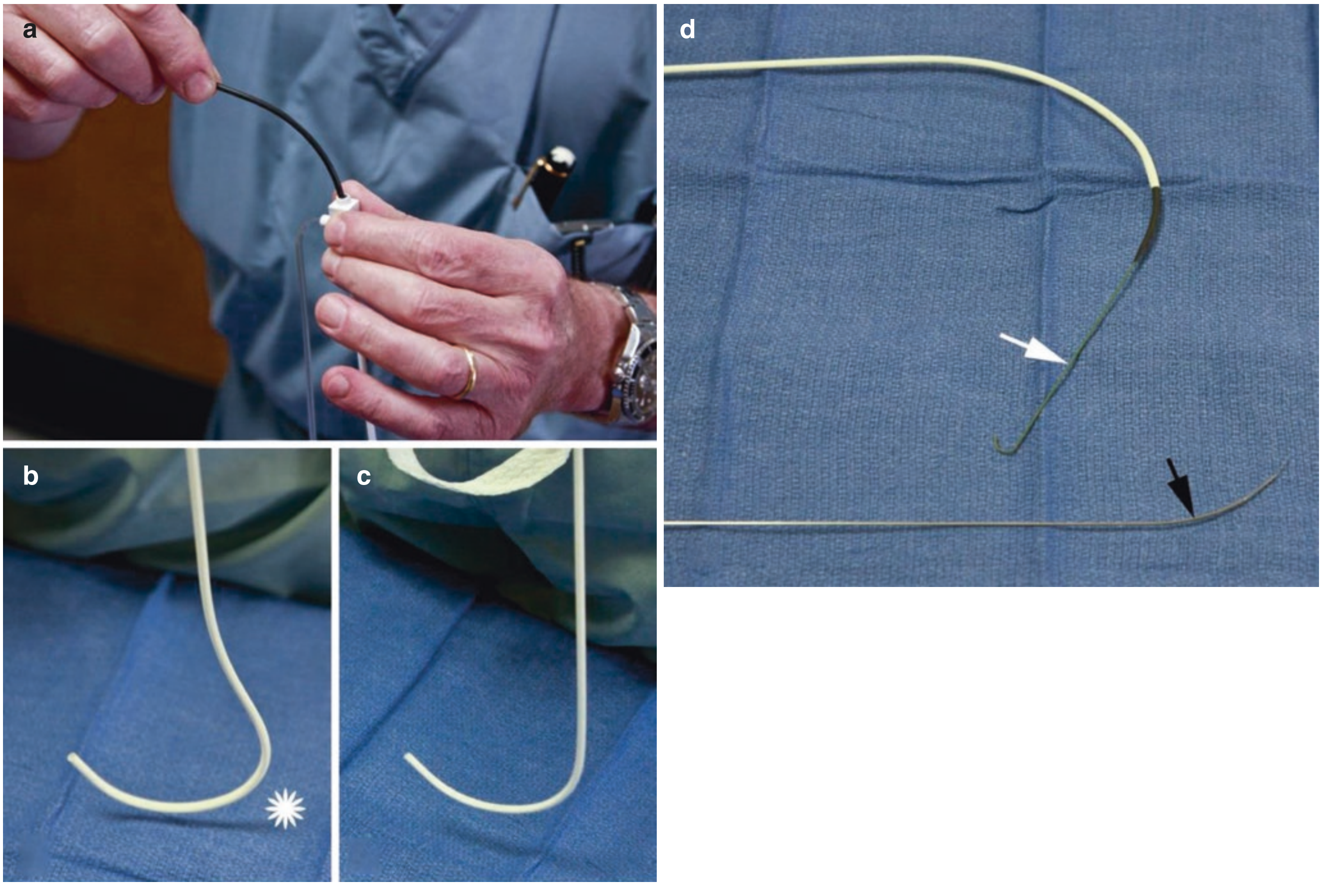


Fig. 8.5 Prepping the standard transseptal access equipment. (**a**) Dilator is inserted into the sheath in the air to align the curves of the dilator and the Mullins sheath. (**b**) Incorrectly aligned dilator and sheath. A secondary curve is seen in the sheath (*). (**c**) Correctly aligned dilator and Mullins sheath, a single curve is noted. (**d**) With a correctly aligned dilator and sheath, wire and needle follow the curve allowing a more predictable angle when externalizing the needle for puncture

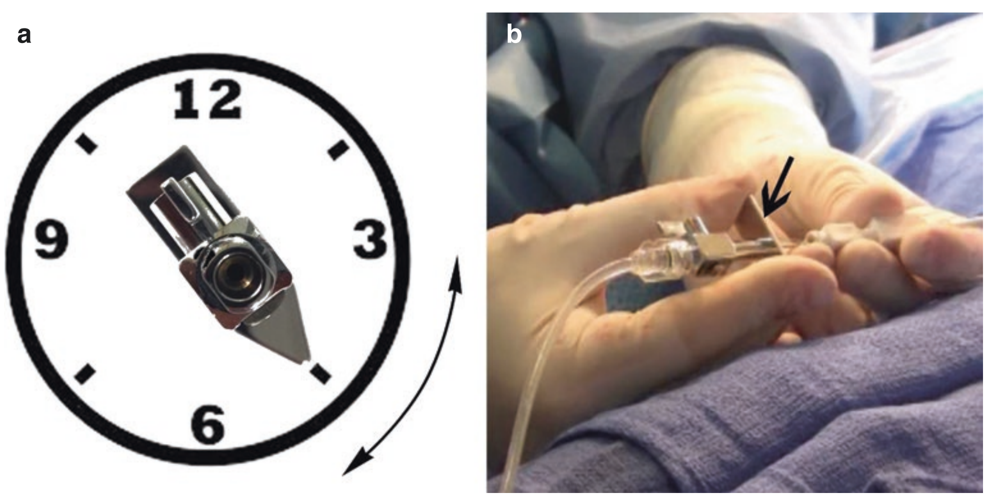


Fig. 8.6 Transseptal needle position. (**a**) The transseptal (TS) needle indicator arrow dictates the location of the needle tip. With the patient on a horizontal plane, the sheath with side port and the indicator arrow are pointed in the same direction to the 4–5 o'clock location. This allows for reaching the fossa ovalis and interatrial septum which is located posteriorly. (**b**) Holding of the needle and the TS sheath/dilator requires maintaining the same distance from the distal dilator tip (1–2 cm) and concordant movements of the system

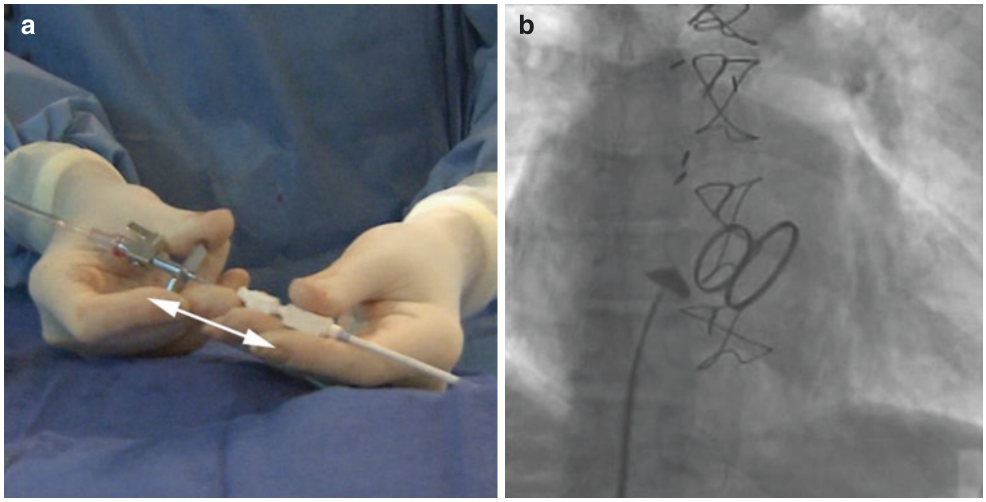


Fig. 8.7 Technique of transseptal puncture. (**a**) The 8Fr 62 cm-long sheath is advanced over a J-tipped guidewire to the superior vena cava. The guidewire is removed a 71 cm transseptal (TS) needle is introduced under continuous flush. The needle is kept approximately 1–2 cm away from the sheath hub; the entire system is pointed at the 4–5 o'clock location and withdrawn caudally until it encounters two leftward jumps: SVC/right atrial junction and muscular interatrial septum. (**b**) TS tip subsequently engages the fossa ovalis (FO), confirmed by the contrast injection

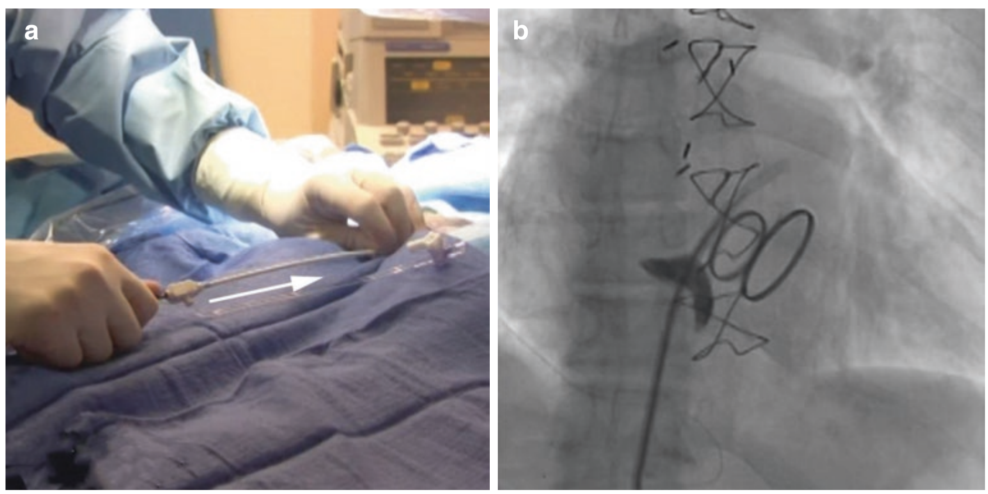


Fig. 8.8 Technique of transseptal puncture—contd. Once the needle position is confirmed in the left atrium (LA), the entire system is advanced 1 cm (**a**). The dilator is disconnected from the sheath, and the needle/dilator is turned toward the 12–1 o'clock location (**b**). Then the dilator is held still with the right hand and the sheath is advanced over the dilator into the LA. Then the dilator/needle are removed and passive back bleeding is done to de-air the system

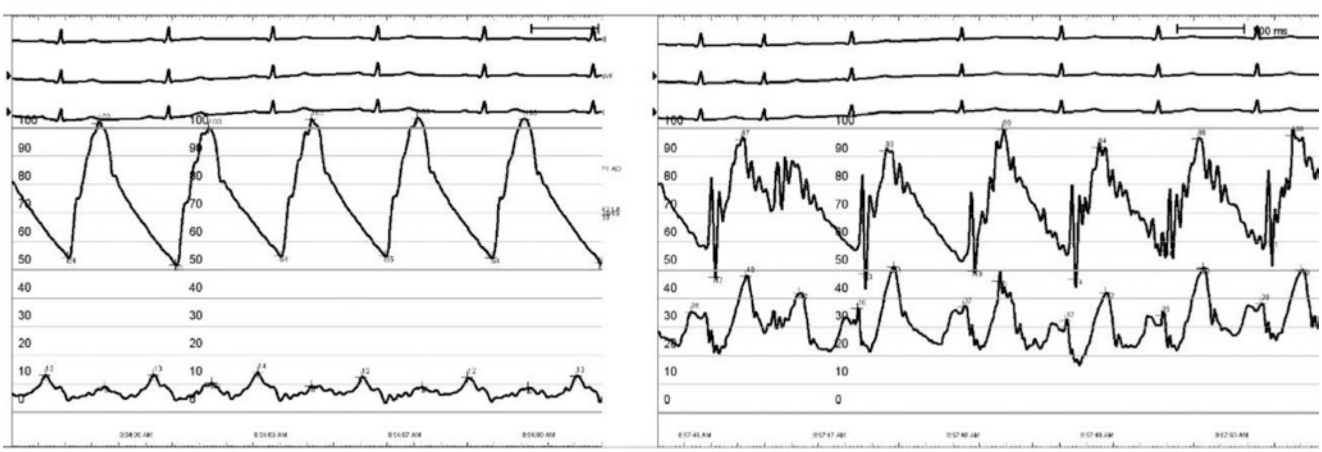


Fig. 8.9 Pressure monitoring can be performed during the transseptal puncture to observe the pressure change from right atrial wave form (left figure, lower tracing) to left atrial wave form (right figure, lower tracing). In this case, pulmonary artery pressure is being monitored (upper tracing) with a Swan-Ganz catheter

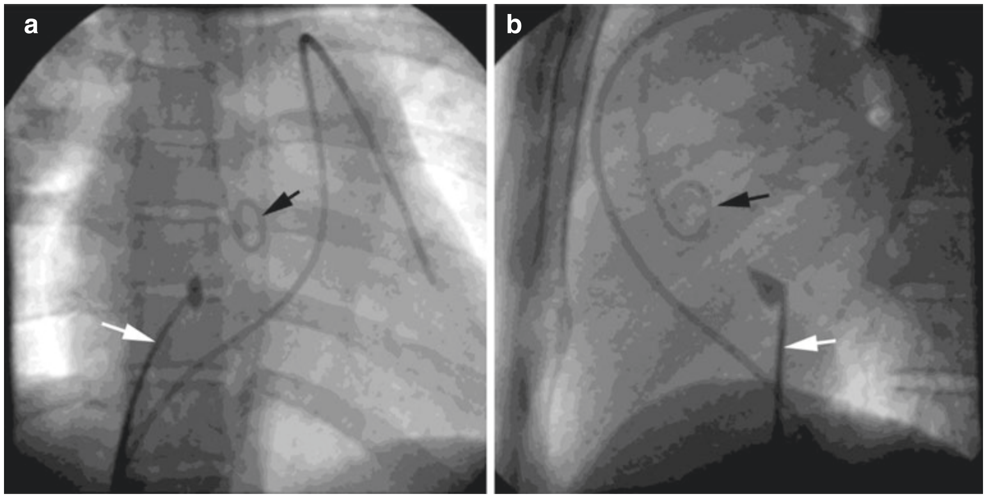


Fig. 8.10 Fluoroscopic guidance for transseptal access. The anteroposterior view (**a**) shows a pigtail placed in the noncoronary aortic valve cusp (**a**, black arrow) identifying the posterior border of the aortic wall and aortic root. A balloon-tipped catheter is also visualized within the right ventricular outflow tract into the left branch pulmonary artery. The TS system (white arrows) and puncture site (contrast injection) is seen lower and medial to the pigtail catheter. In the left anterior oblique view (**b**) at 30–35°, the needle is directed posterior to the pigtail catheter

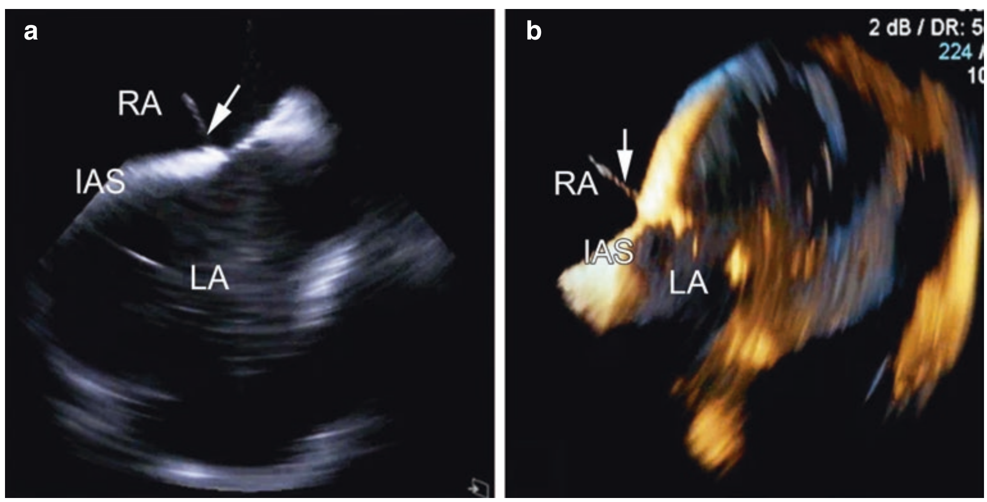


Fig. 8.11 Transseptal access with intracardiac echocardiography guidance. Intracardiac echocardiography (ICE) provides two-dimensional (**a**) and three-dimensional (**b**) imaging with clear definition of intracardiac chambers. The transseptal system (white arrow) is seen tenting prior to the puncture. Bubbles can be visualized in the LA confirming needle position

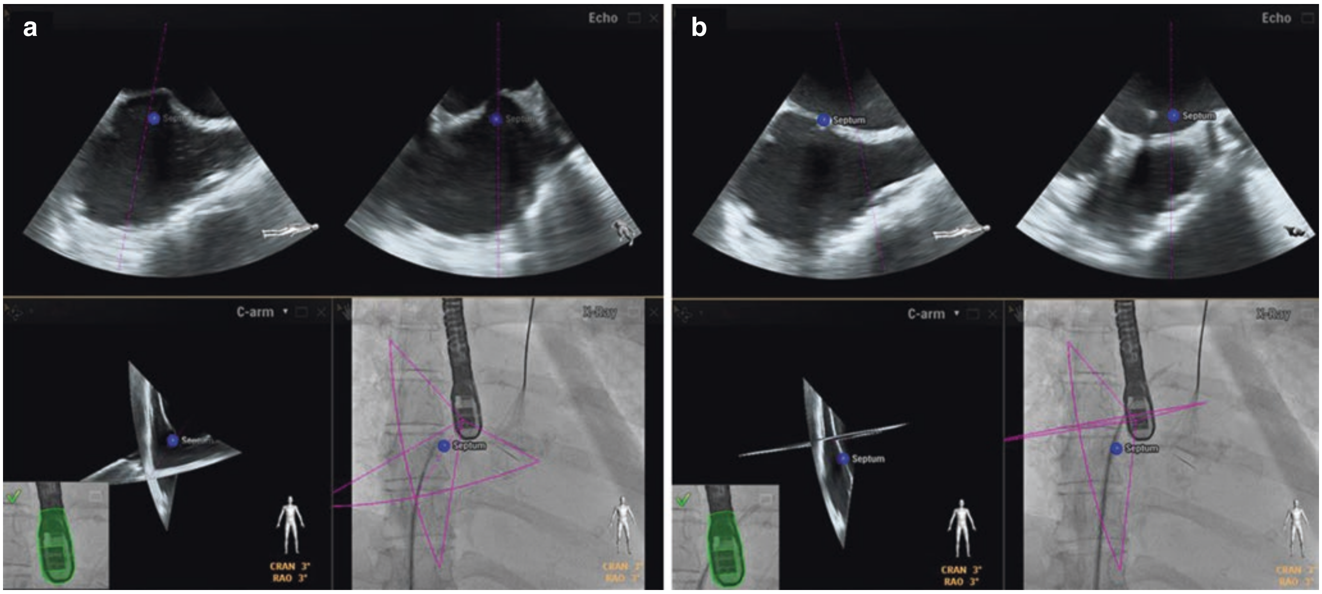
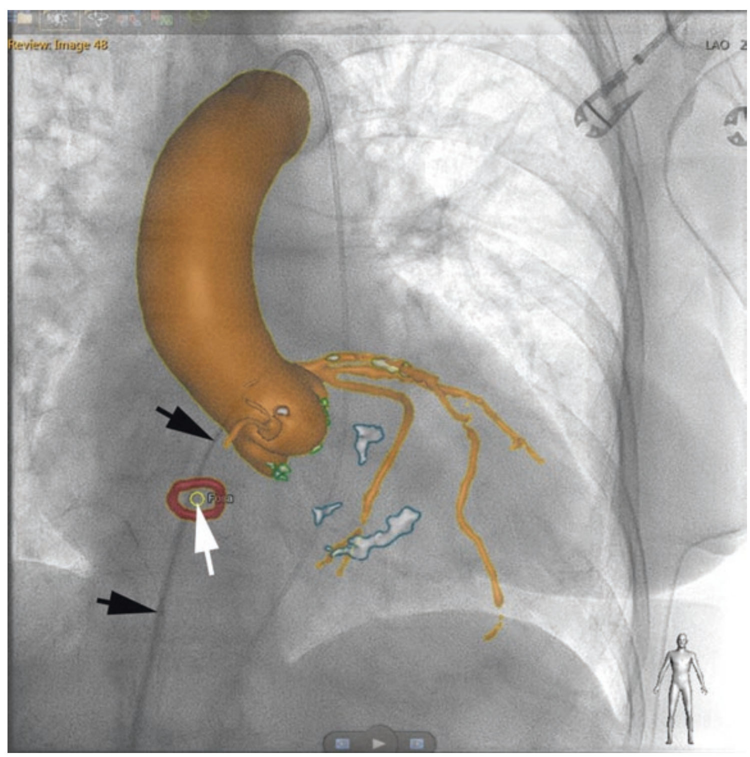


Fig. 8.12 Transseptal access with echo-fluoroscopy fusion. (**a**) Upper window demonstrates the position of the transseptal (TS) needle tenting the interatrial septum. Upper right window demonstrates the view from EchoNavigator; the blue marker placed on the TEE, identifying the best puncture location, is overlaid on live fluoroscopy and is used for guidance of the TS puncture. (**b**) The moment after puncture. Upper windows show the tip of the needle in the left atrium. Lower right window of EchoNavigator confirms the needle position. Blue marker—the optimal location to cross the atrial septum

Fig. 8.13 Transseptal access with CTA-fluoroscopy fusion. The optimal location for transseptal puncture is identified on the 3D CT and marked with yellow circle (white arrow). Fossa ovalis is marked with the large red circle. All markers are overlaid over the live fluoroscopy to guide TS access. The TS system is seen crossing the septum at the marked site into the left atrium



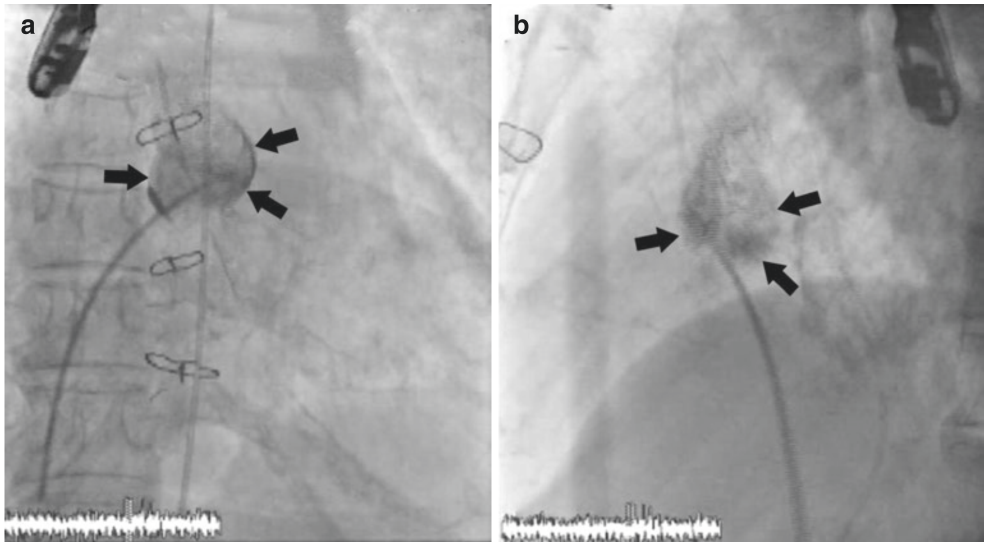


Fig. 8.14 One of the more serious complications during transseptal access is aortic root puncture. Due to the proximity of the aortic root, care must be taken to be lower the aortic root on anteroposterior view (**a**) and posterior to it the aortic root on left anterior oblique (LAO) view (**b**). In the above figure, TS system is seen in the aortic root evidenced by contrast injection (black arrows). The TS catheter is seen directed anteriorly in the LAO view (**b**)

Video 1 Transseptal puncture steps (MP4 234056 kb)

Video 2 The transseptal access can be closed by using a septal occluder (MP4 148507 kb)

Video 3 TrSept puncture assistance in performing a transseptal puncture in complex cases (MP4 44661 kb)