Transseptal Laser Puncture (TLP)

Transseptal Left Heart Catheterization

The development of invasive cardiology, especially that of catheter ablation of arrhythmias in the recent years, has increased the use of transseptal catheterization of the left heart (1,2). The left heart can be catheterized retrogradely, after arterial puncture via the aortic arch and valve or pervenously via an open foramen ovale (FO). However, a patent FO can be identified only in 10%-25% of people (3). Therefore, needle puncture of the interatrial septum is the standard technique for transvenous introduction of catheters to the left side of the heart.

Routinely, the interatrial septum is punctured with a long needle, the Brockenbrough needle. A transseptal dilator is loaded with such a needle that is advanced to within 2-4 cm of the dilator tip. From the high right atrial position, the dilator and needle are rotated towards the interatrial septum and slowly withdrawn under fluoroscopic guidance while assessing for a characteristic “jump” as the tip of the dilator is passed over the aortic knob and onto the FO. The dilator is manipulated until the tip is in intimate contact with the FO. The needle is then advanced, and with sudden movement of its tip towards the left atrium, the interatrial septum is punctured, and the advancement of the needle immediately halted. Under fluoroscopic control a floppy guidewire is advanced through the needle into a pulmonary vein in order to confirm successful puncture of the interatrial septum and access to the left atrium.

As compared to the retrograde aortic approach, the transseptal technique can avoid inadvertent damages to the femoral artery, the coronary arteries or the aortic valve, and thromboembolic events with cerebrovascular accidents. In addition, it allows for a safer and easier manipulation of catheters in the left atrium, providing a more stable catheter position and close endocardial contact of catheters. So it contributes to the reduction of procedure duration, X-ray exposure times, increases success rate for catheter ablation of left sided arrhythmogenic substrates (4).

However, complication rate of the routine transseptal procedure is 2%-6%. Complication can be serious and life-threatening and include atrial and aortic perforation, pericardial tamponade, and death mainly due to unintentional puncture of wrong structures (5,6). For a better control of the procedure, transesophageal or intracardiac echocardiography is used as an adjunct to fluoroscopy to guide transseptal left heart catheterization (7-9). In some cases, however, transseptal needle puncture is not practicable because of a resistant fibrous interatrial septum or for other anatomical reasons. Especially, when a site-selective transseptal left atrial access as recently propagated is needed, needle puncture may be unsuitable and risky (10-12). Based on our experiences (13), the transseptal laser puncture (TLP) procedure may help to overcome these limitations, because of the following advantages:

1. in contrast to the stiff Brockenbrough needle, the flexible optical fiber allows for easy pervenous advancement over the bifurcation of the the vena cava without painful stretching;
2. easy, selfguiding orientation and stable position of the TLP puncture set due to its preshaped configuration, adapted for targeting selective areas of the interatrial septum;
3. high density energy laser application aimed at the interatrial septum allows for an easy and quick puncture of the septum regardless o its structure, soft or dense, the FO area or other;
4. a minimal trauma is produced in the interatrial septum, and safety control of puncture prior to advancement of the catheter over the guidewire into the left atria is mandatory;
5. Easy, controllable handling of the TLP set reduces risk, fluoroscopy and procedure times.
The Transseptal Laser Puncture (TLP) Technique

Interatrial transseptal laser puncture can be performed by using an optical fiber loaded in the lumen of a transseptal dilator, component of a special TLP set, the TranLas, LasCor GmbH.

*Left:* the figure illustrates the distal segment of an assembled TLP set. It consists of a preshaped 8F inner tube (1), a preshaped 10F outer tube (2), and preshaped transseptal dilator (3). The optical fiber tip (4), is advanced with 3 mm beyond the endhole of the dilator.

After venous puncture (Seldinger technique, from the groin) a guidewire is advanced into the high right atrium, the puncture needle is removed, and the saline (with heparin 5000 IU/l) flushed TLP catheter set is introduced over the guidewire and advanced under X-ray guidance up to the high right atrium. The catheter is slowly withdrawn and is manipulated towards the interatrial septum with the tip of the dilator in intimate contact with the septal wall, the area of the FO or other if needed.

While keeping the transseptal dilator in place, the guidewire is replaced by an optical fiber and the tip of the fiber is advanced 3-5 mm beyond the endhole of the dilator towards the interatrial septal wall producing a slight tenting of the septum towards the left atrial cavity. After laser application for 2-3 s the fiber tip is suddenly penetrating the septum and the tapered tip of the dilator wedged in the channel created in the septal wall.

The fiber is replaced by the guidewire which is advanced deep in the left atria and pulmonary vein to make sure that puncture procedure was successful. Subsequently the catheter is pushed over the guidewire into the left atrial cavity, guidewire, dilator, and the inner tube are removed and the outer tube (sheath) with its distal end positioned deep in the left atria or ventricle.

In case of incertitude the fiber is removed, and while the dilator kept in position blood sample and pressure measurement can be performed via the transseptal dilator. In case of failure the dilator is repositioned and the procedure repeated. Only if a correct orientation of the dilator and an easy access of the guidewire to the left heart is confirmed, the dilator can be advanced over the guidewire together with the overriding catheters in the left atrium.

A rather simplified TLP procedure can be performed by using solely a preshaped transseptal dilator of desired diameter for manipulation and orientation of the optical fiber towards the interatrial septum. After that, the needed catheters systems can be introduced over the guidewire positioned in the left atrium as described above.
Own Experiences

In a consecutive series of 24 patients a TLP procedure was performed successfully and without complications using the transseptal laser puncture and introducer set TranLas, LasCor GmbH.

The above three frontal chest X-ray images of a patient show the TLP procedure by using a TransLas catheter set. **Left**: the catheter with the tip of the dilator pointing towards the area of the foramen ovale, in intimate contact with the targeted spot during laser application. **Mid**: Advancement of the dilator over the guidewire that is advanced deeply into the left atrial cavity with its floppy end close to the mitral annulus. **Right**: After removal of the wire, dilator, and inner tube, the outer tube (sheath) is advanced deep into the left ventricle. An electrode catheter in the His-bundle area (left and mid), and in high right atrial position (right), and three chest-lead electrodes on the bottom of the images.

The TLP is a safe technique, easy to handle and allows for site-selective puncture of the interatrial septum in a well controllable manner, with a high success rate at a low risk. The TLP is a substantial progress in the left heart catheterization and again demonstrates the variety of cardiovascular laser applications.

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