Learning Process for Transseptal Puncture Guided by Intracardiac Echocardiography

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We prospectively analyzed the learning process for transseptal catheterization guided by intracardiac echocardiography, in 50 patients who underwent radiofrequency ablation for left atrial arrhythmias. In 20 patients the intracardiac echocardiography catheter was positioned in the right atrium to visualize the fossa ovalis and the tenting of the fossa caused by the Brockenbrough needle. In the other 30 patients, the intracardiac echocardiography catheter was positioned so that it impinged upon the fossa ovalis, and the needle was advanced alongside the intracardiac echocardiography catheter under fluoroscopic guidance in two orthogonal projections. In all but one patient, transseptal catheterization was performed successfully on the first attempt. The learning process for transseptal puncture guided by intracardiac echocardiography was uncomplicated, resulting in a procedure that is safe and effective. The intervention is simplified by positioning the echocardiography catheter at the fossa ovalis and using this as a reference point for fluoroscopic monitoring of the progress of the Brockenbrough needle.

Key words: *Ablation. Echocardiography. Hemodynamics.*

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Resultados de la curva de aprendizaje de la punción transeptal guiada mediante ecografía intracardíaca

Hemos analizado los resultados de la curva de aprendizaje del cateterismo transeptal guiado por ecocardiografía intracardíaca en 50 pacientes tratados por arritmias auriculares izquierdas. En 20 pacientes se situó el catéter de ecocardiografía intracardíaca en la aurícula derecha para visualizar la fosa oval y la deformación en tienda de campaña que producía en ella la aguja de Brockenbrough. En los restantes pacientes se situó el catéter de ecocardiografía haciendo impronta en la fosa oval y se avanzó la aguja siguiendo fluoroscópicamente al catéter de ecocardiografía intracardíaca en proyecciones ortogonales. El cateterismo transeptal se llevó a cabo sin complicaciones y con éxito en el primer intento en todos menos en un paciente. Concluimos que la ecocardiografía intracardíaca permite el aprendizaje seguro y eficaz de la punción transeptal. Asimismo, la colocación del catéter de ecocardiografía en la fosa oval permite una referencia fluoroscópica fácil de seguir, lo que simplifica el procedimiento.

Palabras clave: *Ablación. Ecocardiografía. Hemodinámica.*

INTRODUCTION

Transseptal catheterization requires the use of the Brockenbrough needle to puncture the interatrial septum in the region of the fossa ovalis. Anatomical reference points that are not visible fluoroscopically, such as the aortic valve, are used to position it.[1] Transesophageal echocardiograms are useful, but they are uncomfortable for the patient and expose the professionals who carry out the procedure to ionized radiation.[2] These problems are avoided with intracardiac echocardiogram, for which reason it is used in electrophysiology procedures.[3-9]

We describe the results of the learning process for transseptal puncture guided by intracardiac echocardiography and propose modifications to conventional techniques.

PATIENTS AND METHODS

Transseptal puncture was performed in 50 consecutive patients by 2 researchers without previous

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TABLE 1. **Clinical Characteristics of the Patients Included in the Study**

Patients, n	50
Age, years	52±15
Males	37 (74%)
Heart disease, n	
Pericarditis	1
Mitral valve prolapse	1
Mild mitral valve stenosis	1
Myocardial infarction	3
Hypertrophic cardiomyopathy	1
Hypertensive cardiomyopathy	1
Arrhythmia, atrial fibrillation	38 (76%)
Left atrium, mm	38±5
Thickness of interatrial septum, mm	7±2.5
Fossa ovalis	14.2±2.5

personal experience in transseptal catheterization, but with broad experience (more than 200 arrhythmia ablation procedures) in therapeutic electrophysiology. The clinical characteristics of the patients included in the study are summarized in Table 1. The right femoral vein was cannulated with an 11 F introducer sheath, a 135-cm by 0.89-mm (0.035") guide was inserted up to the vena cava superior, and a 60-cm sheath with a 55° angle was advanced through it. A 9 F intracardiac echocardiography catheter (EP Technologies, Boston Scientific Corp; San Jose, California) was introduced via the sheath, which was withdrawn by clockwise rotation until it was in contact with the fossa ovalis. For transseptal catheterization, the Brockenbrough needle was placed within a dilator introduced into an 8 F sheath (Mullins Transseptal Catheter Introducer Set, Medtronic, AVE Ireland).

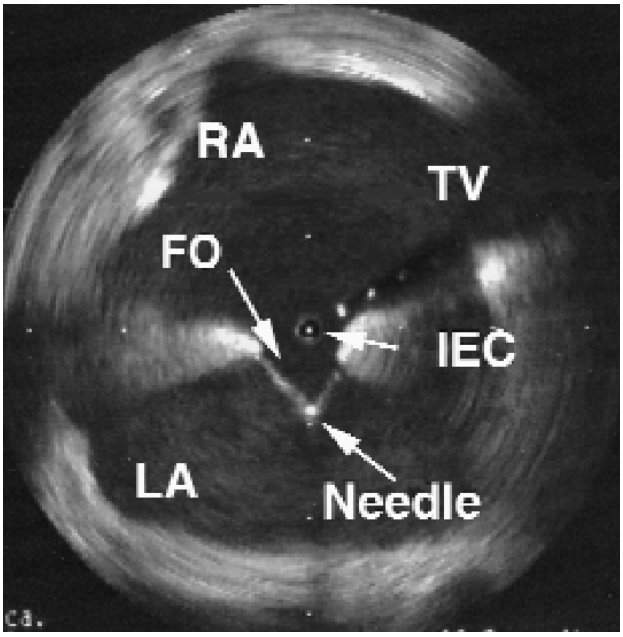

Fig. 1. "Classical" procedure for transseptal puncture guided by intracardiac echocardiography. The intracardiac echocardiography catheter (IEC) is located in the right atrium (RA) near the fossa ovalis (FO). The Brockenbrough needle (Needle) is positioned in the fossa ovalis, which produces an echogenic shadow on the left atrium (LA). When pressure is applied on the fossa ovalis with the needle, a tent-shaped deformation of the interatrial septum can be seen.
TV indicates tricuspid valve.

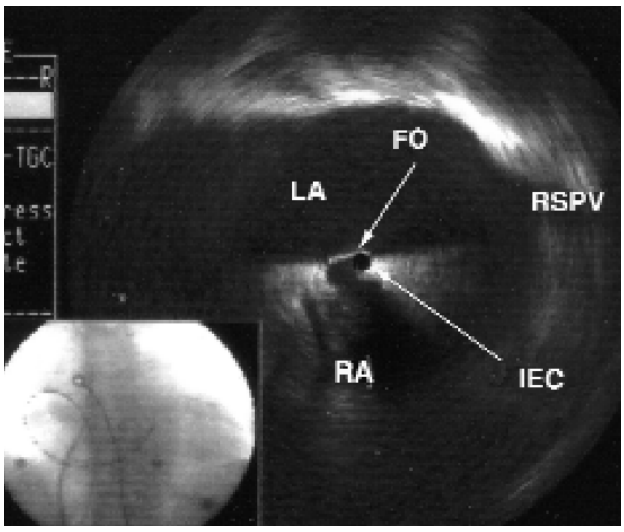

Fig. 2. "Modified" procedure for transseptal puncture guided by intracardiac echocardiography. The intracardiac echocardiography catheter (IEC) protrudes toward the left atrium (LA) in the fossa ovalis (FO). This yields the characteristic image of the catheter tip surrounded by septal tissue.
RSPV indicates right superior pulmonary vein; RA, right atrium

In the first 20 patients, the intracardiac echocardiography catheter was placed in the medial right atrium to visualize the foramen ovale. The Mullins sheath, with the dilator and the needle inside, was positioned in the superior vena cava and was withdrawn with a clockwise rotation until verifying that the characteristic tenting deformation of the membrane was visualized (Figure 1). In the other 30 patients the intracardiac echocardiography catheter was positioned so that it was in contact with the fossa ovalis yielding the characteristic echocardiographic image (Figure 2). Subsequently, the intracardiac echocardiography catheter was utilized as the reference and the Mullins sheath, dilator and needle were advanced passing as near as possible to the intracardiac echocardiography catheter, in right (30°) and left (45°) anterior oblique projections (Figure 3). When it was verified that they followed the same trajectory, the needle was advanced in order to cross the interatrial septum. This was checked by contrast and/or pressure.

RESULTS

The interatrial septum and the fossa ovalis could be visualized in all patients with intracardiac

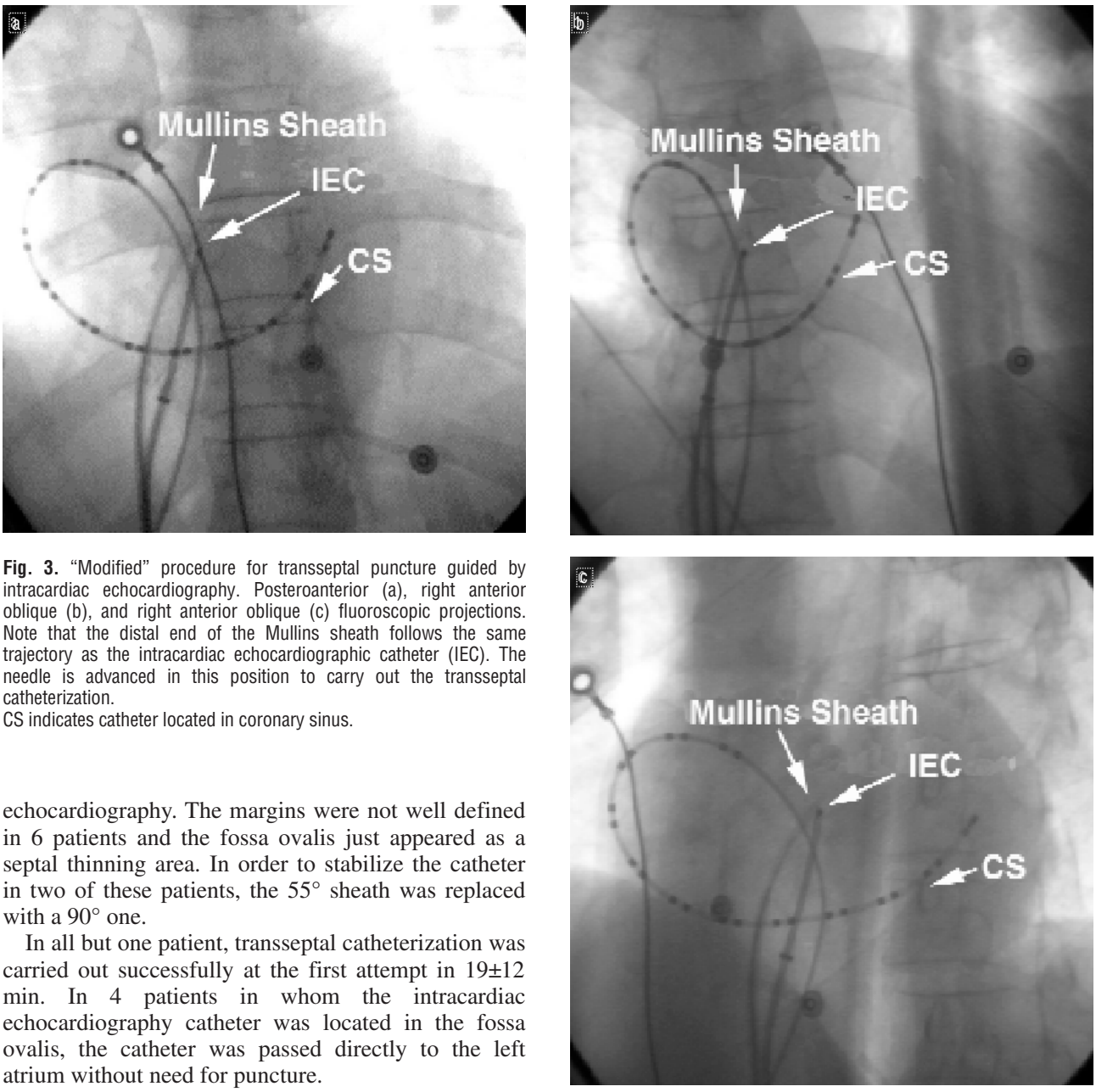

Fig. 3. "Modified" procedure for transseptal puncture guided by intracardiac echocardiography. Posteroanterior (a), right anterior oblique (b), and right anterior oblique (c) fluoroscopic projections. Note that the distal end of the Mullins sheath follows the same trajectory as the intracardiac echocardiographic catheter (IEC). The needle is advanced in this position to carry out the transseptal catheterization.
CS indicates catheter located in coronary sinus.

echocardiography. The margins were not well defined in 6 patients and the fossa ovalis just appeared as a septal thinning area. In order to stabilize the catheter in two of these patients, the 55° sheath was replaced with a 90° one.

In all but one patient, transseptal catheterization was carried out successfully at the first attempt in 19±12 min. In 4 patients in whom the intracardiac echocardiography catheter was located in the fossa ovalis, the catheter was passed directly to the left atrium without need for puncture.

The patient in whom the first attempt at transseptal catheterization failed belonged to the group of 6 subjects in whom the fossa ovalis was not well defined. Even though it was punctured while observing septal *tenting*, pressure curves from the left atrium were not obtained. Thus, contrast was used, and impact was observed on the posterosuperior wall of the left atrium. The procedure was interrupted without the need for anticoagulants. The procedure was repeated one week later without complication.

Six patients formed another group with particular difficulties. Their fossa ovalis was clearly visible, but the membrane was so elastic that, upon applying pressure with the needle, the septum was displaced without perforating it (Figure 4). Advancing and withdrawing the needle with small, brief, fast movements led to successful puncture in all these patients without complication.

During the procedure, 2 patients experienced hypotension with symptoms suggestive of vagal reaction. In both cases, intracardiac echocardiogram confirmed the absence of pericardial effusion and hypotension was resolved by administration of liquids and atropine.

DISCUSSION

Transseptal catheterization is becoming increasingly frequent in electrophysiology clinics where there is a lack of previous experience in this technique which is

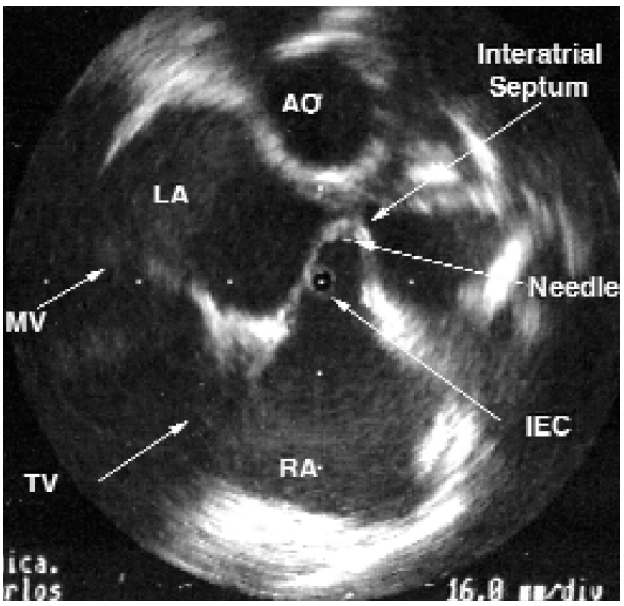

Fig. 4. Deformation of the septum during transseptal puncture in a patient with a very elastic interatrial septum. As can be seen, the septum, displaced by the needle, seems to "collide" against the left posterior atrial wall.
MV indicates mitral valve; TV, tricuspid valve; LA, left atrium; RA, right atrium; IEC, intracardiac echocardiography catheter.

used for treating patients with radiofrequency ablation for atrial fibrillation.[10,11] Although transseptal catheterization can be carried out successfully in most cases under fluoroscopic guidance, this technique can incur a fairly high number of complications, even in the hands of experienced interventionists. It is also difficult to do it with sufficient frequency to both learn it and maintain a suitable level of expertise.[1]

We have verified that intracardiac echocardiography facilitates the learning process for transseptal puncture. This technique makes it possible to visualize the fossa ovalis. This is important in diseased and small hearts, typical of patients without structural heart disease where crossing the interatrial septum away from the target site may increase the risk of perforation and cardiac tamponade.[1]

Various studies have previously demonstrated the usefulness of transesophageal or intracardiac echocardiography for transseptal puncture, but none has investigated the learning process involved.[7-9] Intracardiac echocardiography has the added advantage of making it possible to observe the pericardium to rule out effusion.[12] This is of great assistance in patients with atrial fibrillation in which the pulmonary veins are normally the substrate targeted for radiofrequency ablation. This is because, in addition to requiring strong anticoagulation therapy, precordial pain is reported fairly frequently as a consequence of applying radiofrequency in the pulmonary veins or hypotension due to vagal reflexes. The only drawback of this technique is the cost. This should be assessed together with the probability of preventing serious complication, especially during the procedural learning process.

In conclusion, intracardiac echocardiography facilitates learning and carrying out transseptal puncture. This can be done effectively and safely in the patient by personnel experienced in interventionist cardiology procedures without specific previous experience in this technique. The modification proposed, i.e. placing the echocardiography catheter in the fossa ovalis and advancing it under fluoroscopic guidance with the Brockenbrough needle, facilitates the procedure even more.

REFERENCES

1. Baim DS. Percutaneous approach, including transseptal and apical puncture. In: Baim DS, Grossman W, editors. Cardiac catheterization, angiography, and intervention. 5th ed. Baltimore: Williams & Wilkins, 1996; p. 57-81.
2. Ballal RS, Mahan EF, Nanda NC, Dean LS. Utility of transesophageal echocardiography in interatrial septal puncture during percutaneous mitral balloon commissurotomy. Am J Cardiol 1990; 66:230-2.
3. Tardif JC, Vannan MA, Miller DS, Schwartz SL, Pandian NG. Potential applications of intracardiac echocardiography in interventional electrophysiology. Am Heart J 1994;127:1090-4.
4. Chu E, Fitzpatrick AP, Chin MC, Sudhir K, Yock PG, Lesh MD. Radiofrequency catheter ablation guided by intracardiac echocardiography. Circulation 1994;89:1301-8.
5. Chu E, Kalman JM, Kwasman MA, Jue JC, Fitzgerald PJ, Epstein LM, et al. Intracardiac echocardiography during radiofrequency catheter ablation of cardiac arrhythmias in humans. J Am CoIl Cardiol 1994;24:1351-7.
6. Ban J, Schwartzman D, Callans D, Mareblioski FE, Gottiieb CD, Chaudhry FA. Imaging technique and clinical utility for electrophysiologic procedures of lower frequency (9 MHz) intracardiac echocardiography. Am J Cardiol 1998;82:1557-60.
7. Epstein LM, Smith T, TenHoff H. Nonfluoroscopic transseptal catheterization: safety and efficacy of intracardiac echocardiographic guidance. J Cardiovasc Electrophysiol 1998;9: 625-30.
8. Daoud EG, Kalbfleisch SJ, Hummel JD. Intracardiac echocardiography to guide transseptal left heart catheterization for radiofrequency catheter ablation. J Cardiovasc Electrophysiol 1999;10: 358-63.
9. Szili-Torok T, Kimman G, Theuns D, Res J, Roelandt JR, Jordaens LJ. Transseptal left heart catheterization guided by intracardiac echocardiography. Heart 2001;86:E11.
10. Haissaguerre M, Jais P, Shah DC, Takahashi A, Hocini M, Lavergne T, et al. Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins. N Engl J Med 1998;339:659-66.
11. Cooper JM, Epstein LM. Use of intracardiac. echocardiography to guide ablation of atrial fibrillation. Circulation 2001;104: 3010-3.
12. Clark CB, Davies LR, Kerber RE. Intracardiac echocardiography identifies pericardial fluid and can monitor the success of pericardiocentesis: experimental studies. J Am Soc Echocardiogr 2001; 14:712-4.