INNOVATIVE TECHNIQUES

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Side-selective Atrial Transseptal Laser Puncture

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ABSTRACT. Safe and reproducibly effective transseptal puncture and access to the left atrium and ventricle has become a prerequisite for practicing invasive electrophysiologists. Frequently, side-selective transseptal puncture is needed for targeting areas of special interest or particular anatomical structures in the left heart. To achieve that goal a variety of techniques by being tested. We report our experience with side-selective interatrial transseptal puncture using the laser technique. A total of 57 side-selective transseptal puncture procedures were attempted in 45 candidates (ages 22–84 years, 23 female) for ablation of various arrhythmias originating from the left side of the heart. Laser impacts of a cw1064 nm laser (Dornier MedTech) at 10 W/ 2 s delivered via the TransLas (LasCor GmbH), a custom-made transseptal puncture catheter set guided by a steerable sheath (Agilis, St. Jude Medical) allowed for successful side-selective left heart access in all of the patients without complications. Side-selective transseptal laser puncture can be achieved safely and is reproducibly effective by using the laser technique as described.

KEYWORDS. Laser, left heart catheterization, side-selective transseptal puncture, transseptal laser puncture.

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Introduction

Since its development in the 1950s, transseptal puncture (TP) procedure has been continuously refined.¹ The development of invasive cardiology in recent years has increased the use of TP.² Over the last 15 years, cardiac electrophysiologists have become the most common cardiac subspecialists called upon to effectively and safely puncture the interatrial septum.³ Beside the widespread catheter ablation of atrial fibrillation, transseptal catheterization is used for a wide spectrum of interventional procedures, including left atrial appendage occlusion, percutaneous mitral valvuloplasty, and left ventricular arrhythmia ablation. Although the

current TP technique has changed very little since the initial reports in 1959,^{4,5} and success rates in some series approach 95%,^{6,7} TP is still a technically demanding procedure which necessitates familiarity and an adequate level of expertise in order to avoid complications that may be also life-threatening.

Side-selective TP is needed especially when anatomic abnormalities of the septum are present.⁸ In an effort to meet these demands, we have tested in animal experiments the feasibility of TP by using the laser.^{9,10} Based on our results with these experiments and after approval by the Ethics Committee of the Medical Chamber of the Land of Bavaria, we used side-selective transseptal laser puncture (TLP) in patients.

Patients and methods

A total of 57 TLPs were attempted in 45 candidates for laser ablation of arrhythmias originating from the left heart. Ages ranged from 22 to 84 years (mean 62.3 years); 23 were female (**Table 1**). All were in good clinical condition and had signed informed consent prior to

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Table 1: Indications for the TLP procedure in this study

No.	Patient initials	Age years	Gender m/f	Indication for interatrial TLP procedure
1	LG	64	f	LA lateral AP, paroxysmal SVT and AF with syncope
2				Redo after 21 days
3	GF	55	f	VT after MI and LV aneurysm surgery, with syncope
4				Redo after 43 days
5	RH	37	m	Familial Idiopathic left ventricular tachycardia with Syncope
6	CK	84	f	Longstanding persistent AF
7	JG	63	m	Paroxysmal AF
8	AM	74	f	Paroxysmal AF, occasionally followed by VF (torsade)
9		75		Redo after 10 months
10	BG	75	f	Paroxysmal AF
11	LB	63	f	Paroxysmal AF
12	HG	78	m	Paroxysmal AF
13	WK	53	f	
14	WU	54	m	Paroxysmal atrial flutter/AF
15				Redo after 21 days
16		55		Redo after 11 months
17	EM	84	f	Longstanding persistent AF
18	TS	83	f	Paroxysmal atrial flutter/AF
19	JH	51	m	Persistent AF
20	HH	80	f	Persistent AF
21	JH	61	m	Paroxysmal AF
22	BM	74	f	Persistent AF
23	ER	74	f	Paroxysmal AF
24				Redo after 8 days
25	EF	77	f	
26	RB	39	f	Paroxysmal AF
27				Redo after 5 months
28	RV	50	f	Paroxysmal AF
29	JR	49	m	Permanent AF
30		50		Redo after 11 months for persistent AF
31				Redo after 4 months for persistent AF
32				Redo after 20 days for paroxysmal AF
33	EB	78	f	Paroxysmal AF
34	NG	62	f	Paroxysmal atrial flutter/AF
35	HN	74	f	Paroxysmal AF
36	RB	56	m	Paroxysmal AF
37	HJ	75	m	Paroxysmal AF (on 15.03.98 first TLP reported in KMH)
38	ES	80	f	Longstanding persistent AF
39	JR	62	m	Paroxysmal AF
40				Redo after 6 days
41	WE	65	m	Paroxysmal AF
42		67		Redo after 2 years
43	HM	49	m	Paroxysmal AF
44	GM	65	f	Paroxysmal AF
45	RS	22	m	Paroxysmal SVT due to AVNRT and paroxysmal AF
46	HO	73	m	Paroxysmal AF
47	VK	58	m	Paroxysmal atrial flutter/AF
48	PH	87	f	Persistent AF
49	MS	66	f	Paroxysmal AF
50	GW	47	m	Paroxysmal atrial flutter/AF
51	MH	62	m	Non-sustained and sustained VT attacks with syncope
52	HK	42	m	Paroxysmal AF
53	ER	79	f	Longstanding persistent AF
54	AS	72	m	Paroxysmal AF
55	WE	67	m	Paroxysmal AF
56	HK	52	m	Paroxysmal AF
57	JD	72	m	Permanent AF

AF: atrial fibrillation; AP: accessory pathway; AVNRT: atrioventricular nodal re-entrant tachycardia; LA: left atria; SVT: supraventricular tachycardia; TLP: transseptal laser puncture; VF: ventricular fibrillation; VT: ventricular tachycardia.

Figure 1: (a) The TransLas with the optical fiber tip positioned at the end hole of the dilator tip and so protected within the dilator lumen, and (b) The fiber tip advanced beyond the end hole of the dilator when the catheter tube is advanced 5 mm through the hemostatic valve.

interventions. The study protocol was approved by the Ethics Committee of the Medical Chamber of the Land of Bavaria.

The TLP catheter set (TransLas, LasCor, LasCor GmbH – Laser Medical Devices, Taufkirchen, Germany) consists of a 600 μm core diameter bare optical fiber with a plane polished tip and with cladding and a polyimide jacket, length 300 cm, provided with an SMA (SubMiniature version) connector at its proximal end. The distal segment of the fiber was fed into a 96-cm-long 8F dilator with a tapered tip and proximal to a Luer connector with an 8.5F hemostatic valve with side arm and cock. The outer segment of the fiber was protected by an 8F Pebax tube with two circular markers (**Figure 1a**). The distal end of the Pebax tube was inserted in the hemostatic valve and tightened. The lengths of the dilator and of the optical fiber were adapted in such a way that the fiber was positioned with its tip at the end hole of the dilator tip. After manipulation and orientation of the dilator tip towards the desired area of the interatrial septum, the fiber could be advanced beyond the dilator tip for 5–8 mm after loosening the hemostatic valve. Advancement of the fiber was limited by the Pebax tube in the inner lumen of the dilator and was controlled by two markers on the catheter tube. The dilator itself was fed into a steerable AGILIS sheath (St. Jude Medical, St Paul, MN). The power source was a cw1064 nm Nd:YAG laser (Dornier MedTech, Wessling, Germany).

Access was achieved by puncture of a femoral vein in the right or left groin. After positioning of a steerable sheath with the tip in low right atrial position, the TransLas was advanced under X-ray control with its tip beyond the end hole of the sheath. In all patients puncture of selective sides of the atrial septum was aimed at regardless of location of the foramen ovale. The tip of the dilator was manipulated towards the area of interest of the interatrial septum. After intimate contact of the dilator tip with that area the hemostatic valve of the dilator was loosened and the catheter advanced up to the

second marker of the catheter (5 mm) so that the optical fiber itself was advanced beyond the end hole of the dilator tip (**Figure 1b**).

If the fiber tip did not penetrate the septum the laser was activated via a foot switch for a preset time of 2 s at 10 W. Subsequently, the dilator was kept in a stable position and the fiber was withdrawn to the first marker of the catheter. Now the fiber was replaced by a guidewire. If the wire assured left atrial access, the sheath was advanced over the dilator in the left atrium and the TransLas was removed. If the guidewire could not be advanced into the left atrium, the tip of the dilator was repositioned and the procedure was repeated.

Results

TLP procedures were successful at first attempt except in three instances, when the guidewire could not be advanced into the left atria. The dilator tip was then repositioned and the procedure was successfully repeated. There was no cardiac tamponade, puncture of great vessels, or damage to the TransLas, such as burning of the tip, broken fibers, or other complications during or after TLP. Owing to the position of the fiber tip at the end hole of the dilator without movement in the dilator lumen, scratches to the dilator inner lumen could not occur.

After successful TP the TransLas was replaced by an ablation catheter introduced via the steerable sheath (**Figure 2**).

Discussion

Owing to the flexibility of the optical fiber, pervenous insertion through the femoral vein and catheter passage of the cava bifurcation with the TransLas was not painful. Handling and manipulation in the right atrium

Figure 2: Transseptal laser puncture procedure performed by using the TransLas in a patient candidate for idiopathic left ventricular tachycardia ablation showing anterior–posterior chest X-ray images with (a) the tip of the TransLas catheter orientated towards the punctured area of the interatrial septum immediately after penetration of the optical fiber through the septal wall, (b) after replacement of the fiber by the guidewire assuring successful access to the left heart and advancement of the dilator into the left atrial cavity, and (c) replacement of the TransLas by the laser ablation catheter RytmoLas advanced into the left ventricular cavity through the sheath. 1: dilator; 2: dilator tip; 3: quadripolar electrode catheter; 4: guidewire; 5: endhole of the steerable sheath; and 6: tip of the ablation catheter inserted through the sheath.

were easy and rapidly performed, as was orientation towards and contact with the targeted area of the atrial septum. In addition to the 57 patients in whom TLP was performed, in another five patients the dilator tip passed the atrial septum after advancement of the relatively sharp tip of the optical fiber and TP was achieved without laser application.

Our animal experiments showed that in case of need more flexible fibers of 400 μm or 300 μm core diameters can be used. To assure successful puncture prior to the advancement of the dilator and sheath the optical fiber has to be replaced by a guidewire which is advanced into the left atrial cavity. Alternately, blood samples, pressure measurements, or injection of contrast medium through the dilator may help ensure successful puncture. In our experience the guidewire has priority.

Recently, side-selective puncture has become of more interest, especially for repeated ablation procedures for recurrent atrial fibrillation.¹¹ In general, the site of TP in the second procedure is located higher in the interatrial septum. Chronic scarring over the previously punctured atrial septal site is a reasonable hypothesis to explain these observations. The difficulty of the second procedure might be overcome by changing the needle curve from a small curve to a large curve design.¹¹ TLP may avoid this limitation because the laser fiber easily penetrates fibrous tissue.

Recently, a series of new technique refinements and adjunctive imaging tools have been tested with the aim to simplify and improve the TP. Thus, the dilator and needle methods,¹² novel sharp-tip, J-shaped guidewire,¹³ nitinol guidewire,¹⁴ radiofrequency energy delivery through the transseptal needle¹⁵ have been used to facilitate TP. In addition, real-time three-dimensional and minimally invasive transesophageal echocardiography-guided TP have been applied for atrial fibrillation ablation.^{16–18} Beside repeated TP, left ventricular lead placement may require a side-selective TP.^{19–21} In some selected procedures a transaortic approach may be an alternative to TP.²² Variations in the anatomy and thickness of the interatrial septum, including that of the foramen ovale, may affect the TP.²³ Although a relatively safe procedure with a complication rate of approximately 1%,²⁴ TP complications exist, including iatrogenic atrial septal defects²⁵ and RF needle fracture.²⁶

All these considerations demonstrate the need and importance of an effective TP procedure independent of the thickness and anatomy of the interatrial septum. In our experience, the TLP procedure may overcome the majority of the above-mentioned limitations and due to its safety and potential benefit for the patients with the spread of laser technology TLP may become an all-pervasive procedure.

Conclusion

Side-selective TLP is a safe and reproducibly effective transseptal access to the left heart.

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