Original Article

Radiofrequency Catheter Ablation of Left Accessory Pathways by Transeptal Approach

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Objective

To study a series of patients submitted to radiofrequency catheter ablation (RFA) of left accessory pathways (AP) using the transeptal approach (TSA) as compared to the conventional retrograde arterial approach (RAA).

Methods

One hundred consecutive patients (56 male; mean age of 34.3 ± 11 years) with 100 left APs (62 overt and 38 concealed) underwent catheter ablation using the TS method (50 patients) and the RA method (50 patients) in an alternate fashion. The analysis was performed according to the intention-to-treat principle.

Results

The transeptal puncture was successfully performed in 48 patients (96%). This access allowed primary success in the ablation in all the patients without any complication. When we compared this approach with the RAA there was no difference as regards the primary success ($p = 0.2$), recurrence rate ($p = 1.0$), fluoroscopy time ($p = 0.63$) and total time ($p = 0.47$). One patient in the RAA group presented a vascular complication. The TSA allowed shorter ablation times ($p=0.01$) and smaller number of radiofrequency applications ($p = 0.003$) as compared to the conventional RAA. The patients who had recurrence and unsuccessful ablation in the first session in each approach underwent another session with the opposite technique (cross-over), with a final ablation success rate of 100%.

Conclusion

The TS and RA approaches showed similar efficacy and safety for the ablation of left accessory pathways. The TSA allowed shorter ablation times and smaller number of radiofrequency applications. When the techniques were used in a complementary fashion, they increased the final efficacy of the ablation

Key words

Catheter ablation, heart septum/surgery, tachycardia supraventricular, radio waves.

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Radiofrequency ablation (RFA) is currently the treatment of choice for most patients with accessory pathway-mediated tachycardia. Left accessory pathways are the most commonly found in clinical practice and account for 40%-70% of all AP cases referred for catheter ablation[1-4]. Because of the inherent risks of the approach of the heart's left chambers special technical skills are required for their [of the APs] mapping and ablation.

Two major methods have been described for the approach of APs in the mitral ring: the retrograde arterial approach (RAA) which involves a peripheral arterial access, with the manipulation of the catheter in the left ventricle to map the atrioventricular ring (in this approach the atrial connection may also be mapped using retrograde catheterization of the LA) and the transeptal approach (TSA) which consists in trespassing the interatrial septum with a special catheter introducer and place the ablation catheter directly in the LA to map preferably the atrial insertion of these APs.

The RA approach is the most widely used in most laboratories. However, with the advancements in ablation procedures for atrial arrhythmias, markedly for atrial fibrillation, the transeptal puncture has been incorporated to the routine of electrophysiologists. Retrospective studies have compared these two techniques and reported controversial results, usually related to the experience of each group[5-13].

The objective of this study was to prospectively compare the efficacy and safety of these techniques in a consecutive group of patients referred for catheter ablation of left APs.

Methods

We studied one hundred consecutive patients, in that 56 were male, with a mean age of 34.3 ± 11 years (ranging from 12 to 65 years) with one hundred left APs (62 overt and 38 concealed) referred for RF ablation. Only three patients presented structural cardiopathy: inferior wall myocardial infarction, with mild regional hypokinesia (P48), rheumatic valvulopathy with mild aortic and mitral insufficiency (P41) and moderate concentric left ventricle (LV) hypertrophy (P49).

The exclusion criteria were: children under twelve years of age; presence of multiple accessory pathways, complex congenital cardiomyopathies, patent oval foramen, repaired interatrial communication, peripheral arterial disease or aortic disease, mechanical prosthesis in the aortic or mitral valve position, catheter ablation prior to the beginning of the study.

After diagnostic confirmation by electrophysiological study (EPS) the patients were systematically assigned the RAA or TSA in an alternate manner according to a data base with no prior knowledge on the part of the operator, thus ensuring the randomization of the sample studied. The unsuccessful cases or those which presented recurrence were submitted to a second session with the other technique (*cross-over*).

Procedure - The procedure was performed after an 8-hour fast, upon written consent from the patient or other qualified person, and after the interruption of antiarrhythmic drugs for five half-lives and of amiodarone hypochloride for a month, under sedation and analgesia with intravenous midazolam and phentanyl. Two 7Fr quadripolar catheters were introduced through a puncture in the right femoral vein and guided by fluoroscopy until they were placed in the high right atrium (RA) and the bundle of His region; through a puncture in the right internal jugular vein, right subclavian or right femoral vein a 7Fr multipolar (decapolar, octapolar or hexapolar) catheter was placed in the coronary sinus; in order to record the ventricular electrogram and the ventricular stimulation one of these catheters was introduced in the right ventricle (RV).

The PC-EMS system (Personal Computer Electrophysiology Measurement System, version 4.2; University of Limburg, The Netherlands) was used, with a frequency cut-off between 50 and 500 Hz and a recording speed of up to 300 mm/s, in order to record intracavity signals and the peripheral ECG, as well as for programmed stimulation. For the ablation we used 7Fr catheters with deflectable 4 mm-tips (EP Technologies) and an RF generator with temperature control (EP Technologies). In the applications we set the power threshold at 50 W with a maximum temperature of 70°C during sixty seconds. For the TS approach we used long introducers (Swartz™ Guiding Introducers, SL1, SL2, SL3 e SL4, DAIG, St. Jude Medical Company) and Brockenbrough needles.

Retrograde arterial technique - Guided by fluoroscopy, we introduced the ablation catheter through a puncture in the right femoral artery up to the left ventricular cavity, where we started the mapping. As part of the routine, we used intravenous heparine (5000 UI *bolus* IV followed by 1000 UI per hour) for anticoagulation.

Transeptal technique - We used the transeptal puncture technique performed by the electrophysiology team of Instituto do Coração (USP – São Paulo-SP, Brazil/ the Heart Institute of the University of São Paulo) were we received specific training. This technique is similar to the one described by Brockenbrough and Braunwald[14], and Mullins[15], with some changes proposed by De Ponti et al[16]. Through the right femoral vein we introduced a long guide wire up to the vena cava superior and through this wire [we introduced] an 8Fr Mullins sheath. The guide wire was removed to allow the introduction of the Brockenbrough needle. We punctured the interatrial septum at the level of the oval foramen guided only by radioscopy and contrast injection. We did not monitor the pressure of the needle or of the guide catheter in the aortic root. After anticoagulation we introduced the ablation catheter through the sheath to reach the left atrium.

Echocardiogram-guided puncture was not used in any of the patients. All the punctures, arterial and transeptal alike, were performed exclusively by members of the electrophysiology team (three operators) randomly chosen according to their availability for each procedure. Operator 1 assisted the others in TS punctures since he was more experienced in this technique. All of them performed a similar number of TSA and RAA procedures (Operator 1 = 26/23; Operator 2 = 16/18; Operator 3 = 10/11). No hemodynamicists or other professionals were directly or indirectly involved in the procedures.

Ablation - The RF application was performed in sinus rhythm in overt APs and with ventricular stimulation in concealed APs. We interrupted the RF application in the event of catheter displacement, unsuccessful blocking of AP conduction in ten seconds or after sixty seconds of the effective RF application. After twenty seconds of the effective application, we performed the programmed atrial and ventricular stimulation to confirm the absence of AP conduction. A test with adenosine (6 to 18 mg bolus IV) was carried out only in doubtful cases.

Variables studied - The following variables were analyzed and compared between the two groups: success rate, complications, recurrence rate, A/V ratio, ablation time (AT), puncture time (PT), fluoroscopy time (FT), total time of procedure (TT) and number of RF applications. We defined PT as the time spent in performing the arterial or TS puncture and AT as the time elapsed from the beginning of the mapping through the effective application. These variables were also analyzed according to the location of the AP (septal or free wall), the characteristics of the AP (overt or concealed) and the operators (O1, O2 and O3).

Statistical analysis - For the comparison of dicotomic nominal variables (recurrence, complications and result) we adopted Fisher's exact test. As regards continuous variables (PT, AT, TT, FT and the A/V ratio) we adopted Student's t test for independent samples, considering the homogeneity of variances. For the counting variable (number of applications) we performed the transformation by squaring the results and applying Student's t test on the values obtained from the transformation. In the analysis of subgroups we used the Mann-Whitney non-parametric test due to the small number of patients. For all tests we adopted the level of significance of 5% ($p < 0.05$).

The results were analyzed according to the intention-to-treat principle, considering the initial approach chosen for each patient. Therefore, fifty patients (64% male with a mean age of 37.6 ± 14.6 years) were included in the RAA group, and fifty patients were included in the TSA group (48% male with a mean age of 33.2 ± 12 years). There was cross-over of two patients of the TSA group to the RAA during the procedure due to technical problems regarding the performance of the transeptal puncture; these patients were analyzed as part of the TSA group.

Results

The patients of both groups had similar characteristics (table 1). There was no statistical difference as regards age, gender, characteristic (concealed or overt) or location of the AP. Overt APs (RAA = 62% and TSA = 63%) and left lateral APs (RAA = 71% and TSA = 62.5%) prevailed.

Table 1 – Characteristics of patients

	Grupo AR	Grupo TS	p
n	50	50	-
Gender (%)			
Male	64	48	0.158
Female	36	52	0.158
Age	37.57 ± 14.6	33.16 ± 11.9	0.103
Cardiopathy (%)	4	2	1.000
Type			
Overt	28	34	0.303
Concealed	22	16	0.303
Location			
LAL	5	6	1.000
LL	36	32	0.52
LP	4	9	0.234
LPS	5	3	0.712

LAL- left anterolateral; LL- left lateral; LP- left posterior; LPS- left posteroseptal

The transeptal puncture was successfully performed in 96% (48/50) of the patients and the arterial puncture was successful in 100% of the patients.

Primary success in the ablation (first session) was achieved in 100% of the patients (50/50 patients) in the TSA group and in 94% (47/50 patients) in the RAA group ($p = 0.24$). There was AP recurrence in one patient (2%) of the TSA group and in two patients (4%) of the RAA group ($p = 1.0$).One patient of the TSA group (recurrence) was successfully submitted to a second session using the RAA approach, while five patients of the RAA group (three unsuccessful procedures and two recurrences) were submitted to a second ablation session using the TS approach, with success, defining a total efficacy of 100% (figure 1).

The time spent for arterial punctures (PT) was shorter than for TS punctures ($p < 0.0001$). However, in the TSA group the AT was shorter ($p = 0.01$) and the number of RF applications was smaller ($p = 0.003$). The A/V ratio in the ablation site was greater in the TSA group ($p < 0.0001$), thus indicating that the atrial AP insertion was preferably approached in this group. There was no significant statistical difference between the TSA and RAA groups as regards TF and TT (table 2).

Analysis of subgroups - We observed the same results for APs located in the free wall (posterolateral, lateral and anterolateral), but not for septal APs (posteroseptal), for which there was no difference between the groups (except as regards the PT). As regards AP's

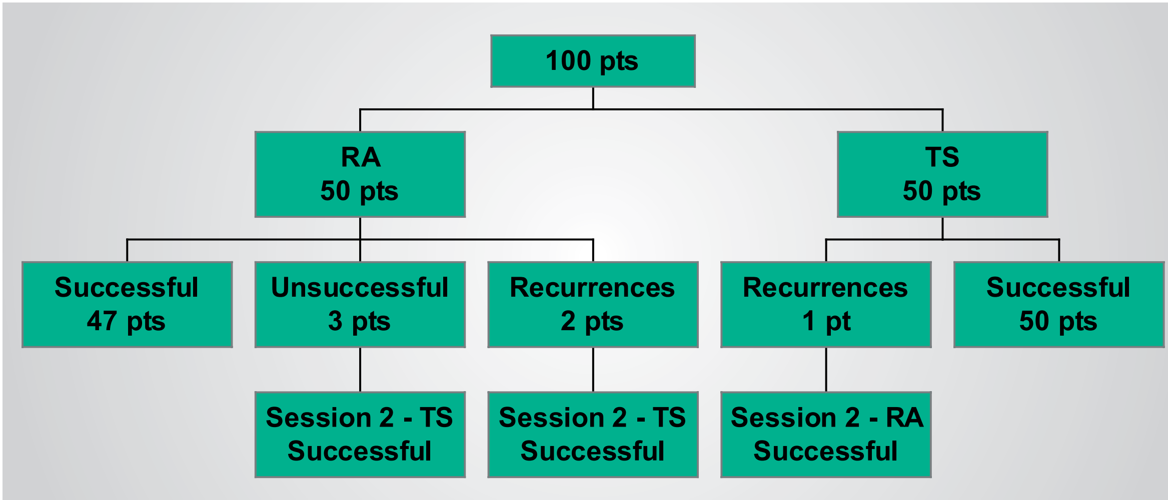

Fig. 1 *- Second session: unssuccessful procedures and recurrences (cross-over)*

Table 2 – Results

	RAA Group	TSA Group	p
Success rate (%)	94	100	0,24
Recurrence (%)	4	2	1,0
PT (min)	5,5 ± 5,5	15,9 ± 9,8	<0,0001
AT (min)	39,5 ± 51,2	18,7 ± 20,2	0,01
FT (min)	36,1 ± 24,2	33,9 ± 16,2	0,63
TT (min)	121,9 ± 52,7	115,2 ± 35,8	0,47
A/V ratio	0,53 ± 0,6	2,2 ± 1,7	<0,0001
RF applications	4,04 ± 3,1	2,5 ± 2	0,003

PT- puncture time; AT- ablation time; FT- fluoroscopy time; TT- total time of procedure

characteristics, we observed a smaller number of RF applications in concealed APs when the TSA technique was used (p = 0.047). The results were not influenced by the catheter operator.

Complications - One patient of the TSA group presented a femoral pseudoaneurysm which resolved spontaneously (thrombosis) within a week. The approach of this patient had to be changed to RAA during the procedure (failure in TS puncture) and the complication presented was related with the arterial puncture. No complications were observed which were directly related with the transeptal puncture. No complications occurred in the RAA group.

Discussion

In a set of 100 patients we prospectively compared the TSA technique with the conventional RAA used for catheter ablation of APs located in the left atrioventricular ring to test its efficacy and safety. The results showed that the TSA technique is as safe and effective as the RAA technique. We also demonstrated that when used in a complementary fashion, they considerably increase the final success rate (100% final success rate).

Some studies compared both techniques in a retrospective manner[5-13]. Natale et al[5] achieved a higher success rate in TSA ablation (100% as compared to 88%; p < 0.03) in a series with 80 patients. Lesh et al[6] reported similar success rates (85% as compared to 85%; p = NS) for 106 patients, just like Manolis et al[9] (86% as compared to 87%; p = NS) in 82 patients. In Brazil, Sternick et al[11] found a trend of better results with the TS approach (92% as compared to 73%; p = 0.)

With the TS approach we had shorter ablation times (p = 0.01) and the number of applications was smaller (p = 0.003); however, the fluoroscopy times (FT) and the total time of procedure (TT) were similar. This may be explained by the longer time spent in the transeptal puncture (PT) as compared with the arterial puncture as was confirmed by the study (p < 0.0001) and as had been observed in a previous study[6]. In the latter the authors reported a higher success rate with the TSA method in left anterolateral and posterolateral APs, but with no statistical support; the comissures of the mitral valve in these locations supposedly make the ring less accessible through the ventricular surface according to the authors[6]. Natale et al stated their preference for TSA for concealed APs since it is easier to map them in the atrial electrogram, when this technique is used, during tachycardia or ventricular stimulation[5].

In a more recent prospective and randomized study comparing the RAA and TSA techniques and using only one catheter, Katritsis et al[17] observed shorter procedure time, smaller exposure to radiation and number of RF applications with the TSA technique.

In our cases, when we analyzed the subgroups, we observed that the benefits (shorter ablation time and smaller number of RF applications) of the TSA technique were expressive only for APs located on free walls and not for septal APs.

As demonstrated by the A/V ratio measurement in the sites of application, the APs were approached preferably in their atrial insertions with the TSA technique and in their ventricular insertions with the RAA technique ($p < 0.0001$). Although we may reach the AP atrial insertion using both techniques with high efficacy[8,10], the mapping of the AP ventricular insertion using the RAA technique was preferred since this approach provides greater stability to the catheter. In a subjective analysis, the operators found more difficulty in positioning the catheter via RAA in the anterolateral pathways.

With respect to children two studies stand out: Vora et al[12] obtained a 100% success rate in the ablation of left APs in their atrial insertions using the RA access in 36 patients and the TS access in thirteen. They reported a shorter FT for the RAA technique ($p = 0.05$)[12]. Law et al[13] studied 136 children and obtained shorter FT, TT and smaller numbers of catheters used with the TSA technique, but without differences relative to success rates and complications[13].

Overall the studies suggest that the differences found between the techniques may be related to the learning curve and to the experience of the operator, rather than to the specific technique used[12,13]. When we began this study the group was more experienced with procedures via RA, and only one operator had received training in TS puncture. Even so the general trend was towards better results with the TSA approach. The transeptal puncture failed in only two patients. These results may be more expressive if a new study was carried out in the present, since the team now has a similar amount of experience with both approaches.

There is a consensus that the skill in the use of both techniques increases the final rate of success as compared to the use of each technique isolatedly[5,6,9,10]. However, it is important to plan the procedure beforehand; Lesh et al[6] suggest that TS puncture should be avoided in patients during systemic anticoagulation (initiated via RA), but it may be performed depending on the operator's prior experience and, if possible, after the anticoagulation effect has been reversed (protamine and control of coagulation time activated in the room). This is the strategy currently used in our laboratory in case of failure in the RA approach.

And lastly it is worth considering economic aspects when choosing the technique. The TSA procedure entails higher costs in connection with the specific material to be used. This factor, in combination with the technical difficulty associated with the TS puncture may limit its use on a routine basis.

Complications - Isolated cases of complications have been described for both techniques, thus preventing a statistical analysis. The most common are vascular complications in connection with the arterial puncture[5,9,13] and pericardial effusion resulting from the puncture of the atrial wall during the TS puncture[9,10]. Minich et al[18] detected 30% new mild aortic regurgitation cases after procedures via RA. Kessler et al[19] demonstrated the presence of left-to-right shunt through the interatrial septum following ablation via TS in six out of twelve patients. However, the clinical significance of these findings has not yet been determined.

Formation of thrombus in the right atrium in the site of the transeptal puncture following left AP ablation has been recently reported in a patient[20].

Greater complications were described by Calkins et al[3] in six out of 158 patients submitted to the RA technique, including vascular complications, coronary thrombosis and aortic valve perforation Lesh et al[6] reported a case of dissection of the left coronary artery during the RA technique followed by myocardial infarction. It is speculated that RF lesions in the ventricular insertion of an AP in children may be arrhythmogenic, which however remains unproven to date. Saul et al[8] reported the sudden death of a five-week old child two weeks after the ablation of a left AP, which was attributed to ventricular arrhythmia. In our study only one patient presented vascular complications in connection with the arterial puncture (in the TSA group), and it resolved spontaneously, leaving no sequelae.

We therefore conclude that catheter ablation of left APs using the TSA technique is as effective as the conventional approach (RAA). When used in a complementary fashion (*cross-over*) they may increase the final success rate of ablation of left APs, which suggests that mastery of both on the part of the electrophysiologist is important for his/her daily practice. The TS approach was better than the RA approach as regards the ablation time and the number of RF applications, which may translate into less morbidity for the procedure. The absence of major complications confirms that both techniques are safe.

No potential conflict of interest relevant to this article was reported.

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