Cryoablation of junctional tachycardia at high risk of atrio-ventricular block

Cryoablation des tachycardies jonctionnelles à haut risque de bloc auriculo-ventriculaire

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KEYWORDS
Cryoablation; Nodal reentrant or accessory pathway tachycardia.

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Summary
Introduction. — Transcatheter cryoablation is an alternative option for the treatment of supraventricular tachycardia, due to its very low risk of permanent atrio-ventricular block. However, the overcost of cryocatheter and the high recurrence rate of this emerging technology braked its large use. This study reports the results of an approach using cryoablation for the treatment of junctional tachycardia (JT) in selected patients at high risk of atrio-ventricular (AV) block.

Patients and methods. — Out of a series of 199 patients with JT treated by catheter ablation, 26 benefited from cryoablation (mean age 32.8±15 years, 15 males). The indications were the presence of an accessory pathway with a high risk of atrio-ventricular block (n=7), a slow pathway difficult to ablate, with a risk of atrio-ventricular block (n=7), a recurrence after a RF procedure, during which a transient atrio-ventricular block has occurred (n=4), and finally patients at young age (n=8).

Results. — The primary success rate was 92%. No permanent AV block has been reported, neither with RF nor with cryoablation. The recurrence rate at 9±10 months was at 29% after cryoablation and 8.6% after RF. In case of AV nodal reentrant tachycardia, the additional cost of cryotherapy catheter has been avoided in 76.85% of cases. The use of a cryotherapy catheter and RF catheter has been necessary for the remaining cases.

Conclusion. — This study demonstrates that an approach, reserving cryoablation in selected patients at high risk of AV block is an alternative strategy to “the systematic use” of cryotherapy in the ablation of JT with a high efficacy, an excellent safety and a reduced cost.

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Résumé
Introduction. — Le très faible risque de bloc auriculo-ventriculaire permanent lors de la cryoablation place cette technique comme une alternative à la radiofréquence. Sa diffusion semble freinée par son coût et par une efficacité moindre. Ce travail rapporte les résultats d’une approche réservant la cryoablation au traitement des tachycardies jonctionnelles à haut risque de bloc auriculo-ventriculaire.

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Introduction

Since more than 15 years, catheter ablation using radiofrequency (RF) has been considered as the gold standard for the management of junctional tachycardia (JT) [1]. This technique has however its limits when the arrhythmogenic substrate is close to structures at risk such as the atrioventricular (AV) node or the His bundle [2-4]. With the development of specific catheters, the cryoablation technique has been developed. This technique appears to be adapted for the ablation of structures close to the AV conduction pathways. Its progressive effect permits to assure a definitive lesion ablation with no risk for the AV conduction pathways [5]. In consecutive patients with nodal reentrant tachycardia or tachycardia due to a slow pathway, the efficacy of cryotherapy has been demonstrated, with primary success rates.
close to RF [6-8]. However, the number patients enrolled in these studies was small, and they were seldom randomized [6-8]. The high rate of long-term recurrence and the material cost led some medical teams to restrict its use in a selected population, at risk of conductive blocks or in younger patients [9]. Others use cryotherapy systematically in order to avoid any risk of AV block [10]. In this observational and retrospective study, we report the results of a strategy reserving cryoablation to selected patients at high risk of conductive blocks or those in the youth (figures 1 and 2).

Methods

From 2004 to 2006, 199 patients benefited from percutaneous intracardiac ablation for nodal reentrant tachycardia (NRT, n=121) or related to an accessory pathway (n=78) in our electrophysiology laboratory. Cryotherapy has only been used in a selected population. Among these 199 patients, 173 benefited from RF, while 26 benefited from cryoablation. We included these 26 patients treated by cryoablation for NRT (n=19) and accessory pathway-related tachycardia (n=7) in this study.

The selection criteria for the use of cryoablation were:
- the presence of an accessory pathway with a high risk of AV block, documented during EP and after RF failure;
- a slow pathway difficult to ablate, with a risk of AV block;
- a recurrence after a RF procedure, during which a transient AV block has occurred;
- systematically for patients under 25 years of age and following the referent physician’s request.

![Flow chart of the reciprocating tachycardia intracardiac ablation procedure.](image-url)
The ablation of the accessory pathway was defined at high risk of AV block in case of mid-septal or para-Hisian preexcitation [4].

The patients were informed of the risks of the procedure during a prior consultation and signed an informed consent. Patients who were going to benefit from RF were informed of the possibility of use of cryoablation in case of high risk of AV block. During the RF procedure, the decision of switching to the cryoablation technique was taken in case of failure of ablation of the slow and/or the accessory pathway and the anatomic proximity of the AV node or the His bundle (Hisian potential recorded on the ablation catheter) or in case of occurrence of transient conduction abnormalities.

The patients under the age of 25 who had the indication of cryoablation as the first procedure were informed of the possibility of use of RF in case of cryoablation failure, upon their request.

The procedure was performed under sedation with dose titration of midazolam or propofol. Medical treatment was discontinued 4 days prior to the procedure. A quadripolar catheter was introduced in the femoral vein and positioned in the right atrium or right ventricle per requirements. A decapolar catheter was introduced in the right jugular vein and positioned in the right coronary sinus. A conventional ablation catheter was positioned next to the nodo-Hisian junction. A standard EP exploration was performed in order to confirm the diagnosis prior to ablation [11]. A decrement atrial stimulation using extra-stimuli was performed in to study the refractory periods, the anterograde and retrograde conduction locations, and to trigger a reciprocating rhythm. In case of triggering failure, we used isoprenaline and/or atropine and repeated the triggering procedure. The diagnosis of NRT or tachycardia related to an accessory pathway was made after the retrograde atrial activity cartography and triggering procedures. An approach revealing the slow pathway potentials and anatomic marks permitted the identification of the NRT ablation site. The ablation site of accessory pathways was determined after the determination of first-activation of the anterograde or retrograde pathway. The cryoablation was performed using a 7F cryocatheter (Cryocath Technologies Inc.) with a 4-mm (accessory pathway) or 6-mm (NRT) electrode. In a first step, a cryocartography was performed by lowering the cryoelectrode temperature down to -30°C during 60 seconds, in order to obtain the conduction suppression of the slow or the accessory pathway, in sinus rhythm or reciprocating tachycardia. In case of failure or the occurrence of AV block, the cryocartography was stopped and another site is explored. In case of success, a cryo-ablation was performed by lowering the temperature down to -70°C during 4 minutes. In case of PR prolongation, cryoablation was discontinued and a new site was explored. At the end of procedure, the absence of tachycardia re-induction was verified. In the absence of re-induction, the procedure was considered primarily successful after an observation period of 30 minutes. In case of technical difficulties and/or failure, cryoablation could be completed by RF during the same procedure.

After cryoablation, patients were reassessed in our center, one month after the procedure, with ECG and Holter recording or R-Test if needed. We looked systematically for the recurrence of symptoms or arrhythmia. Four patients were followed by their usual cardiologist. Patients not seen in our center were systematically contacted by phone.

No follow-up lost is reported. Quantitative variables are reported as mean ± standard deviation.

Taking into account that in reentrant nodal tachycardia the cost of a cryoablation catheter is twice as expensive as a RF catheter, the additional cost of a systematic cryoablation strategy is calculated as follows: additional cost = [N-(n+p)] rf (see appendix).

### Appendix

- The cost of the systematic use of cryoablation (SystCryo) = Nc, with “N” corresponding to the number of patients who should have benefited from ablation and “c” the cost of cryoablation catheter.
- The cost of a selective approach (SelectCryo) = (N-n) rf + nc + prf with:
  - rf: cost of RF catheter,
  - N: the number of patients who should have benefited from ablation,
  - n: number of patients treated by cryoablation,
  - N-n: number of patients treated by RF,
  - p: number of patients with cryoablation who would also benefit from RF.

- Taking into account the cost of a cryoablation catheter is twice as expensive as an RF catheter: 2rf SelectCryo = (N-n) rf + 2 n rf + prf = [(N-n) + 2n + p] rf = (N + n + p) rf,
- SystCryo = 2Nrf

The additional cost of the systematic cryoablation strategy = SystCryo - SelectCryo

= 2Nrf - (N+n+p) rf = (2N-N- n-p) rf = (N-n-p) rf

The additional cost rate = N - n - p /N

For example, for NRT: 121 - 19 - 9 /121 = 76.85%

### Results

Out of 199 patients, 26 (13%) benefited from cryoablation (table 1). Among these 26 patients, 19 had a NRT and 7 presented an accessory pathway-related tachycardia. After EP exploration, 6 additional patients had a first-intention cryoablation for mid-septal Kent bundle and one patient for a para-Hisian Kent bundle. Cryoablation has been performed straightaway in 8 patients <25 years of age (mean age =16.8±5 years). Cryoablation has been used at second intention in 4 patients who had a recurrence after a first RF complicated by AV block, and during RF procedure in 7 patients because of a high risk of AV block. Thus, 14 patients had a cryoablation alone, 8 had an RF procedure completed by cryoablation and 4 had a cryoablation completed by RF.

The mean duration of cryocartography and cryoablation was 20 ± 19 minutes. The mean number of applications for cryocartography and cryoablation was 17±10. The mean ablation temperature was -65°±20°C.

Overall, an immediate success was obtained in 24/ 26 patients (92%). Thirteen out of 14 patients (93%) who had a cryoablation procedure alone were treated successfully. The primary success rates were at 100% for those 4 patients when cryoablation had been completed by RF,
and 87.5% for those 8 patients with RF completed by cryoablation.

A transient AV block is reported in 5 patients (2 first-degree AVB, 2 cases of 2/1 AVB and 1 complete AVB). No permanent AV block occurred among the 199 patients treated by RF and/or cryoablation.

**Table 2** reports the characteristics and results of the subgroups with NRT.

Among 19 patients with NRT, 18 (95%) were treated successfully. In this subgroup, at follow up, 4/18 patients had a recurrence.

**Table 3** displays the characteristics and results of patients who had an accessory pathway-related tachycardia. Among 7 patients in this case, 6 had a primary success (86%). At follow up, 3/6 had a recurrence of their tachycardia related to a accessory pathway.

The mean follow-up was 9±10 months. Among the 24 patients with primary success, 7 experienced a recurrence of their tachycardia. Two patients had a redo RF procedure and another one had a cryoablation redo procedure. The remaining patients were treated medically, due to the conduction risk. The recurrence rate in the RF procedure was 8.6%.

In case of NRT, cryoablation was only used in 19 out of 121 cases. Among these 121 patients, the cryoablation catheters-related additional cost avoided is 76.85%. If we take as count unit the cost of a RF catheter, the additional cost [N-(n+p)] rf of a systematic use of cryoablation strategy is around 93 times the cost of an RF catheter (see appendix).

**Discussion**

This observational study shows that cryoablation performed selectively can be used as a complement method to RF for treating NRT as well as accessory pathway-related tachycardia. The risk/effectiveness is favorable with a substantial cost reduction compared to a systematic use of cryoablation. Because of its efficacy, handiness and cost, RF is the first-line method in our EP laboratory for the management of junctional tachycardia. With a higher cost, cryoablation is reserved for a selected group of patients at high risk of AV block. Some authors [9] use systematically cryotherapy for the treatment of NRT as well those related to an accessory pathway, which is associated to a substantial additional cost. Parallel to this, no sustained AV block was recorded among our 199 treated patients, and the primary success rate reported when using RF is near those reported in the literature, between 91% and 98% [7, 8]. Our approach combining RF and cryoablation at a same procedure led to satisfying results without any permanent AV block. Our primary success in selected patients for NRT or accessory pathway-related tachycardia with high risk
of AV block is at 92%. Our approach appears as an alternative to "systematic RF" or "systematic cryoablation" strategies. The primary success rates for NRT treated by cryoablation vary between 91% and 99% in different series [7, 12-14]. When we consider only those patients with NRT, the primary success rate is at 95%. The ablation of septal accessory pathways by RF technique has a high rate of primary failure compared to other locations, with a high risk of AV or bundle branch block [15]. In some series in the literature, the primary success rate of cryoablation of these accessory pathways at high risk of conduction troubles is between 67% and 78% [15, 16]. In our study, the primary success rate in this group is at 86%, comparable to literature data.

We report no sustained AV block in our series. In the Topilski et al. report including 901 patients treated for NRT by RF, 8 cases required a definitive implantation of a pacemaker [17]. In a prospective multicenter study, Calkins et al. reported the implantation of a pacemaker in 10 patients [3]. Conversely to the RF technique which can quickly cause irreversible lesions, the cryoablation technique makes progressive and reversible lesions and can therefore limit the risk of AV block [18-20]. In some series [8, 9], the long-term recurrence rates for patients with NRT reach 29% to 38%. In our series, the overall recurrence rate is 29% for those treated by cryoablation and 8.6% for those treated by RF. In our selected population, the number and duration of applications is higher than in other series for all patients, probably due to the elevated risk of AV block in this subgroup.

Our study presents limitations. It is a small and retrospective observational series without randomization. Hence, selection bias might not be excluded. The population presented corresponds to the beginning of our experience.

**Conclusion**

Our study demonstrates that a selective approach, reserving cryoablation for high-risk patients or those at younger age is efficacious and safe. This is an alternative approach to the "systematic cryoablation" strategy in the management of junctional tachycardia, with a favorable risk/efficacy ratio and reduced cost.

**References**


