Flutter ablation with remote magnetic navigation: comparison between the 8-mm tip, the irrigated tip and a manual approach

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INTRODUCTION

Radiofrequency catheter ablation of the isthmus between the tricuspid annulus and the inferior vena cava has become a first-line treatment for patients suffering from recurrent atrial flutter. Since the introduction of the concept of bidirectional block over the isthmus, this method has evolved into a highly effective procedure.

New treatment strategies are being developed with as major goals to further improve efficiency, efficacy and safety of this procedure.

Remote magnetic navigation (RMN) has proven its feasibility in a large group of arrhythmias such as atrial fibrillation, AV-node re-entry tachycardia, congenital heart disease and ventricular tachycardia. The advantages of RMN are the very precise and accurate navigation possibilities and the reduced radiation exposure for the operator. The soft catheter makes cardiac perforation unlikely. The most often used catheter types, the 8-mm tip and the irrigated tip, are also available for RMN. Recently, Vollmann et al. reported longer procedural and ablation times with the 8-mm RMN guided catheter compared to a manual approach. There has been much hope that these results could be improved with the use of an irrigated RMN-guided catheter.
was positioned in the coronary sinus. All patients were ablated while pacing the os of the coronary sinus.

All procedures were carried out by a junior and senior electrophysiologist. Procedural times were measured from the puncture till 30 minutes after the last applications.

Manual group

Ablation in the conventional group was performed with an 8-mm Blazer catheter (Boston Scientific, Inc.). The isthmus between the tricuspid valve and the vena cava inferior was carefully mapped and the highest peak-to-peak bipolar atrial electrograms were searched for. Ablation was first directed to the highest potential. If the ablation lesion did not result in bidirectional block, the next largest atrial electrogram was subsequently targeted for ablation until bidirectional block was present. Catheter settings were 60 s, 60 W, 60°C. We used standard pacing manoeuvres to verify bidirectional block. If bidirectional block could not be achieved within 15 applications a switch to a cooled-tip catheter was allowed (Thermocool, Biosense Webster, settings: 60 s, 35 W, 48°C, cooling 20 ml/min).

RMN 8-mm tip group

All patients in the magnet group were ablated with the Navistar DS 8-mm catheter (Biosense Webster). The cavotricuspid isthmus was mapped with the aid of RMN (Stereotaxis, Niobe) and an electro-anatomical mapping system (CARTO, Biosense Webster). This was not used for activation mapping, but to tag the ablation line: the highest peak-to-peak bipolar electrograms were indicated on the map. Ablation was first directed to the highest potential. If the ablation lesion did not result in bidirectional block, the next largest atrial electrogram was subsequently targeted for ablation until bidirectional block was present. The magnetic navigation system was used to store the vectors into the system which allowed us to easily redirect the magnet catheter to the highest atrial electrogram, after the map of the cavotricuspid isthmus was made. The settings of the ablation were 60 s, 60 W, 50°C. If we did not succeed in reaching bidirectional block within 15 applications a switch to a cooled-tip catheter was allowed (Thermocool, Biosense Webster, settings cfr. supra).

RMN irrigated tip group

The same protocol was used as for the RMN 8-mm tip group, but with a Thermocool (Biosense Webster) tip catheter with 60 s, 55 W, 48°C, 20-ml cooling.
Patients treated in the magnet group (both 8-mm and irrigated tip) needed overall significantly more applications to obtain bidirectional block compared to the conventional group. The median number of applications was 10 in the RMN 8-mm tip group, 13 in the RMN irrigated tip group and 8 in the manual group ($P = 0.03$) (figure 1). The median application time was 570 seconds (RMN 8-mm tip group), 692 seconds (RMN irrigated tip group) and 465 seconds (manual group) ($P = 0.03$). Five or less applications were needed in 12% of the patients in the RMN 8-mm tip group, 7% in the RMN irrigated tip group versus 17% in the conventional group ($P = 0.69$). In 5 patients from the RMN 8-mm tip group (29%), the magnet catheter was switched to a conventional guided cooled-tip catheter. In 2 patients bidirectional block could be achieved after 1 extra application; in another 2 patients after 4 and 15 extra applications with the cooled-tip catheter, while in 1 patient we could not create bidirectional block at all. In 1 patient of the

### Table 1  Patient characteristics

<table>
<thead>
<tr>
<th>History of</th>
<th>Magnet 8 mm</th>
<th>Magnet irrigated tip</th>
<th>Conventional group</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>60 ± 12</td>
<td>6 ± 9</td>
<td>58 ± 9</td>
<td>ns</td>
</tr>
<tr>
<td>Sex (F/M)</td>
<td>4/13</td>
<td>5/9</td>
<td>6/18</td>
<td>ns</td>
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<tr>
<td>AF</td>
<td>12%</td>
<td>43%</td>
<td>50%</td>
<td>0.03</td>
</tr>
<tr>
<td>Hypertension</td>
<td>12%</td>
<td>14%</td>
<td>25%</td>
<td>ns</td>
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<tr>
<td>Ischaemic heart disease</td>
<td>6%</td>
<td>7%</td>
<td>8%</td>
<td>ns</td>
</tr>
<tr>
<td>Valvular heart disease</td>
<td>6%</td>
<td>14%</td>
<td>8%</td>
<td>ns</td>
</tr>
<tr>
<td>Pacemaker</td>
<td>12%</td>
<td>0%</td>
<td>4%</td>
<td>ns</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>0%</td>
<td>0%</td>
<td>4%</td>
<td>ns</td>
</tr>
<tr>
<td>Transient ischaemic attack</td>
<td>12%</td>
<td>0%</td>
<td>0%</td>
<td>ns</td>
</tr>
</tbody>
</table>

### Results

**Patient characteristics**

The mean age of the patients was 59 ±10 years (range 25-84 years) and 27% was female. Thirty-six percent suffered from AF and 18% from hypertension. Five patients had valvular heart disease, 3 patients had a pacemaker before ablation, 4 had known ischaemic heart disease, 1 patient peripheral vascular disease and 2 patients had a history of transient ischaemic attack (table 1).

**Procedural parameters**

There was no difference between the different groups concerning the primary end point. The proportion of patients who could successfully be treated within 15 applications was 59% for the RMN 8-mm tip group, 64% for the RMN irrigated tip group and 83% for the manual group ($P = 0.19$).
Remote magnetic navigation

RMN proved to be a feasible technique for ablation of the majority of arrhythmias and has shown superiority in some difficult arrhythmias, such as in congenital heart disease. The major advantages are that it is a safe procedure since perforation with a floppy catheter is highly unlikely and that the amount of radiation for the operator substantially decreases, as he can operate the catheter remote from the patient. However, it is not impossible that these measures compromise efficacy.

Recently the irrigated tip catheter for RMN was introduced, making the advantages of catheter tip cooling possible in the magnetic environment.

In atrial flutter we did not see a statistical difference in the primary end point (success within 15 applications) compared to manual ablation. Nevertheless, the results with the RMN 8-mm tip were disappointing. We needed more applications compared to a conventional approach, and we needed to switch 5 times to a manual irrigated tip catheter.

Our results with the RMN irrigated tip catheter were encouraging since fewer switches to a cooled-tip manual catheter were needed (5 versus 1). Newer technologies which are emerging, such as adjustable magnetic field strength, might help to achieve even higher acute success rates.

There are several possible explanations for these mixed results. First of all, there are many anatomical variants in the cavotricuspid isthmus: the isthmus can vary in length, there may be pouch-like recesses or a prominent Eustachian valve and the angle between the inferior vena cava and the isthmus have different degrees. Troublesome ablation of atrial flutter is associated with a longer cavotricuspid length and with a rectangular angle between the isthmus and the vena cava.
Magnetic navigation and atrial flutter ablation

Continuous lines as published before. The procedural time decreased as well in the historical control group from 170 ± 48 min to 106 ± 53 min, fluoroscopy time from 29 ±15 min till 20 ±11 min. The aid of magnetic navigation, however, did not add to a further decrease in the number of applications and fluoroscopy times as initially expected. This might be due to the fact that several of these procedures were done in a training programme, and because the set-up of the electromagnetic system required additional time in the RMN, which was shared with the intervention group.

LIMITATIONS

Whether a patient was appointed to the magnet group or the conventional group was based on the availability of the Stereotaxis room, and not on a randomization system. We did not perform angiography of the right atrium in order to assess the characteristics of the cavo-tricuspid isthmus. However, we have no reason to presume that the distribution of the different anatomical variants is different between the 3 groups. Unfortunately, no comparison was made with a conventional irrigated tip group.

CONCLUSIONS

The use of magnetic navigation for the ablation of atrial flutter with the maximum voltage technique is feasible but not superior to a manual approach. Overall, more applications are needed and procedure times are longer (unfortunately influenced by other equipment in the two groups). Nevertheless, RMN and irrigated tip technology, required fewer switching to manual catheters, which is promising. Hopefully, further improvements in the catheter design and the magnetic navigation system, such as an adjustable magnetic force, can make this safe approach also more performing.

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CONFLICTS OF INTEREST

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