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Gold-Tip Electrodes. Radiofrequency (RF) catheter ablation is widely used to induce focal myocardial necrosis using the effect of resistive heating through high-frequency current delivery. It is current standard to limit the target tissue–electrode interface temperature to a maximum of 60–70 °C to avoid char formation. Gold (Au) exhibits a thermal conductivity of nearly four times greater than platinum (Pt–Ir) (3.17 W/cm Kelvin vs 0.716 W/cm Kelvin), it was therefore hypothesized that RF ablation using a gold electrode would create broader and deeper lesions as a result of a better heat conduction from the tissue–electrode interface and additional cooling of the gold electrode by “heat loss” to the intracardiac blood. Both mechanisms would allow applying more RF power to the tissue before the electrode–tissue interface temperature limit is reached. To test this hypothesis, we performed in vitro isolated liver and pig heart investigations comparing lesion depths of a new Au-alloy-tip electrode to standard Pt–Ir electrode material.

Mean lesion depth in liver tissue for Pt–Ir was 4.33 ± 0.45 mm (n = 60) whereas Au electrode was able to achieve significantly deeper lesions (5.86 ± 0.37 mm [n = 60; P < 0.001]). The mean power delivered using Pt–Ir was 6.95 ± 2.41 W whereas Au tip electrode delivered 9.64 ± 3.78 W indicating a statistically significant difference (P < 0.05). In vitro pig heart tissue Au ablation (n = 20) increased significantly the lesion depth (Au: 4.85 ± 1.01 mm, Pt–Ir: 2.96 ± 0.81 mm, n = 20; P < 0.001). Au tip electrode again applied significantly more power (P < 0.001).

Gold-tip electrode catheters were able to induce deeper lesions using RF ablation in vitro as compared to Pt–Ir tip electrode material. In liver and in pig heart tissue, the increase in lesion depth was associated with a significant increase in the average power applied with the gold electrode at the same level of electrode–tissue temperature as compared to platinum material. (J Cardiovasc Electrophysiol, Vol. 16, pp. 770-772, July 2005)

Background

Radiofrequency (RF) catheter ablation is currently the therapy of choice in a broad range of symptomatic cardiac arrhythmias.1 Catheter-induced tissue temperature rise is the result of resistive heating through high-frequency current delivery. A minimum temperature of around 48–50 °C is required to induce cell death and persistent necrosis.2 In the clinical scenario, RF catheter ablations are performed in a temperature-controlled manner regulated by thermistor or thermocouple elements imbedded in the energy delivering electrode. To avoid electrode–tissue interface temperatures approaching 100 °C with consecutive coagulum and possible char or crater formation, temperature limits during ablation procedures are usually set between 50 °C and a maximum of 70 °C. Knowing that lesion depth is significantly influenced by the amount of current which passes through the tissue,3–5 successful attempts have been made to apply more power to the tissue before a critical tissue–electrode temperature is reached as compared to the conventional 4-mm-tip electrode design. Thus, the use of large-tip electrodes or cooling of the tip electrode are now widely exercised techniques to increase lesion depth and significantly improve the clinical ablation procedure. This is achieved in the treatment of atrial flutter by significantly reducing RF energy deliveries, fluoroscopy, and procedure time required to generate a bidirectional isthmus block by using an 8-mm-tip electrode as compared to a conventional 4-mm size.6

As gold (Au) exhibits a thermal conductivity of nearly four times greater than platinum (3.17 W/cm Kelvin vs 0.716 W/cm Kelvin), it was hypothesized that RF ablation using a gold electrode would be able to create broader and deeper lesions as a result of two mechanisms: (1) better heat conduction from the tissue–electrode interface using a gold electrode should result in a lower electrode–tissue interface
Lesion Analysis—In Vitro Ablation

After the ablation all samples were cut to determine the lesion depth. A microscope with incident light and a magnification of 1 × 0.7 (Olympus, Hamburg, Germany) and a digital camera (KAPPA opto-electronics, Gleichen, Germany) were used to first magnify and then digitalize the lesions. The camera was connected to a personal computer running the “Image Base” software (KAPPA opto-electronics), which allowed the saving of real time pictures of the magnified section planes and—after being calibrated to a 1 × 0.7 optic—the lesions depth. Viewing the circular lesion from above, the line of the maximum surface lesion width was identified and was used as the guide to cut vertically into the tissue. The lesion depth was determined by measuring from the deepest lesion point on the tissue surface to the deepest point of lesion formation as seen in the cross-sectional view.

Statistical Analysis

For the in vitro testing the Student’s t-test was performed. A P value of less than 0.05 was considered as statistically significant.

Results

In Vitro Pig Heart Tissue

The mean lesion depth in liver tissue when using the Pt–Ir tip electrode was 4.33 ± 0.45 mm (n = 60) ranging from 3.0 to 6.7 mm. The Au electrode was able to achieve significantly deeper lesions with a mean lesion depth of 5.86 ± 0.37 mm (n = 60) ranging from 4.2 to 8.0 mm (P < 0.001). The mean power delivered to the tissue using Pt–Ir-electrodes was 6.95 ± 2.41 W whereas ablation with Au-tip electrodes allowed to apply an average power of 9.64 ± 3.78 W indicating a statistically significant difference of 38.7% in power delivery at the same temperature level (P < 0.05).

Ablation with Au-tip electrode in pig heart (n = 20) increased statistically significant the lesion depth as compared to Pt–Ir electrodes (n = 20) by 63.9% (Au: 4.85 ± 1.01 mm, Pt–Ir: 2.96 ± 0.81 mm; P < 0.001). Mean power application while ablating with the Pt–Ir electrode catheter was 6.2 ± 2.41 W whereas Au-tip electrode ablation enabled to deliver a mean of 13.2 ± 4.2 W again, indicating significant difference of 112% higher power application using Au electrodes as compared to Pt–Ir (P < 0.001) (Fig. 2).

Discussion

Gold-tip electrode catheters were able to induce deeper lesions in vitro as compared to Pt–Ir tip electrode material. The relative increase in vitro of 35.3% in liver tissue and of 63.9% in pig heart in lesion depth is the primary outcome measurement of this study and might be explained by the following mechanisms: Due to the higher thermal conductivity of gold as compared to platinum, a more efficient heat and power transmission from the electrode to the tissue and to the blood is possible. Both would lead to a higher cooling of the electrode, resulting in the opportunity to apply more power via gold before the target electrode–tissue interface temperature is reached. Fortunately, in the liver and in the pig heart tissue we were able to demonstrate that the increase in lesion depth was associated with a significant increase in the average power applied with the gold electrode at the same level.

Methods

In Vitro Experimental Setting

A special examination chamber was constructed, which enabled us to gain both almost physiological cardiac flow-through conditions and constant standardized experimental setting (Fig. 1). Each out of the 60 tissue samples made of fresh porcine liver and 20 made of porcine heart was trimmed to a size of approximately 60 × 25 × 15 mm with a scalpel and fixed on the counter electrode placed in the center of the chamber. An inclination angle of 20° due to a quoin beneath the sample guaranteed optimal stream conditions. The ablation electrode was inserted through an aperture on the top of the chamber; constant orthogonal pressure with approximately F = 0.6 N was applied on the tissue sample by the unadjusted, frictionless guided electrode. The closed chamber could be shifted laterally in one axis to two different measuring points on one sample. The first measuring point was used to perform one ablation procedure with a common 4-mm Pt–Ir tip electrode (AlCath, BIOTRONIK, Berlin, Germany). Afterwards the chamber was shifted to the second measuring point for one ablation with a 4-mm gold alloy (99.99% Au) electrode (AlCath Gold, BIOTRONIK). All procedures were proceeded temperature controlled with a catheter tip target temperature of 60°C, a maximum power output of 30 W and duration of 60 seconds (AbControl MDS, Version 2.0, BIOTRONIK).

Figure 1. Flow chamber. This hemispheric examination chamber with a volume of 100 mL, which is comparable to an average human heart volume capacity was put in a polymethylmethacrylate basin containing a guiding construction for stable catheter placement. Both were filled with a physiological sodium chloride solution at 38°C. The temperature was kept constant via a heating rod (THERMAL Compact 230 V/50Hz/200 W Model L-09200). The chamber was provided with an inflow and a draining tube representing the entry and exit of the heart valves. The inflow tube was connected to a pump operated by direct current, achieving a pulsed volume flow through of 3.5 L/minute (1 = catheter; 2 = flow pump; 3 = piece of tissue).
of electrode–tissue temperature as compared to platinum material. In summary, one can state that the observed increase in lesion depth using gold electrode tip material is most likely caused by the opportunity to deliver a higher amount of power at the same temperature.

**Clinical Implications**

To evaluate the clinical relevance of the herewith described effects of gold on lesion depth, a prospective multicenter trial is currently underway randomizing patients with isthmus-dependant atrial flutter for ablation using either an 8-mm platinum- or a gold-tip electrode and thus analyzing the ablation time to bidirectional isthmus conduction block as the primary endpoint. When gold electrodes will generate deeper lesions also in the clinical setting, this technology may allow to conduct quicker ablation procedures at a lower recurrence rate with less char formation as a relevant benefit for the ablated patients.

**References**

6. Tsai CF, Tai CT, Yu WC, Chen YJ, Hsieh MH, Chiang CE, Ding YA, Chang MS, Chen SA: Is 8 mm more effective than 4 mm tip electrode catheter for ablation of typical atrial flutter? Circulation 1999;100:768-771.
7. Simmons WN, Mackey S, He DS, Marcus FI: Comparison of gold versus platinum electrodes on myocardial lesion size using radiofrequency energy. PACE 1996;19:398-402.
To the Editor:

I would like first to congratulate you and your co-authors for the exquisite case reported in the June issue of the Journal of Cardiovascular Electrophysiology, regarding a 56-year-old man with heart failure and a paroxysmal wide QRS tachycardia with VA dissociation. I have one question and one comment, which are as follows: You described that a transient RBBB due to catheter manipulation was observed. Was tachycardia induced in the setting of the RBBB? If it was, did the cycle length change? I am asking this because if tachycardia cycle length was unaltered either during LBBB or RBBB, the accessory pathway would most likely be a nodo-His fiber, with the distal end above the bifurcation of the His bundle, as reported by Haissaguerre et al.2

The diagnosis of a concealed Mahaim fiber was achieved when you reset the tachycardia by a premature ventricular beat during His bundle refractoriness. However, you wrote that an interfascicular reentry was ruled out as the tachycardia mechanism because the QRS morphology was identical during tachycardia and sinus rhythm. I disagree with that assertion. Crijns et al.3 reported a case in the Journal of Cardiovascular Electrophysiology having an interfascicular reentrant tachycardia with an identical QRS complex during sinus rhythm and tachycardia. Similarity of the QRS morphology suggests that anterograde conduction occurs exclusively over one of the fascicles of the left bundle. In addition, a bundle branch reentrant tachycardia may also show identical QRS complex during sinus rhythm and tachycardia.4

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Response to Letter to the Editor

To the Editor:

We appreciate Dr. Sternick’s kind remarks with regard to our case report. Right bundle branch block did occur during catheter manipulation while tachycardia was ongoing. The cycle length of the tachycardia was indeed unchanged. Although a figure demonstrating this (originally intended for inclusion) was removed, we note that an errant reference to such a figure remains in paragraph 5. We thank Dr. Sternick for providing insight into the possible lower insertion point of the accessory pathway. We also appreciate his comments with regard to interfascicular and bundle branch reentry. We were discussing these mechanisms in general terms and we feel that the case report describes the most likely situation. We acknowledge inevitable exceptions, however, to any assertion that we might be so bold as to declare a “rule”!

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To the Editor:

I was very interested by the article in the July issue of Journal of Cardiovascular Electrophysiology entitled “Gold-Tip Electrodes—A New ‘Deep Lesion’ Technology for Catheter Ablation? In Vitro Comparison of a Gold Alloy Versus Platinum-Iridium Tip Electrode Ablation Catheter” by Lewalter et al.1 The authors carried out in vitro experiments to test the hypothesis that radiofrequency (RF) ablation using a gold electrode would create deeper lesions. They concluded that gold-tip electrodes were able to create deeper lesions as compared to Pt-Ir tip electrodes, and they suggested some possible causes to explain their result. I would like to congratulate the authors for their significant contribution. There are some issues about which I wish to comment.

The use of electrodes of high thermal conductivity (k) for RF heating is not a new concept. Simmons et al.2 compared experimentally the performance of gold versus platinum electrodes (using constant-power ablation), and Berjano et al.3 studied the theoretical performance of electrodes with different k values (using constant-voltage heating). The current study of Lewalter et al. provides new data on the benefit of gold-tip electrodes, but they suggested some possible causes to explain their result. I would like to comment on the possible causes.

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References


protocol, solution used). Theoretical modeling offers a powerful tool for studying the temperature distributions created by different designs of electrode. On this subject, on the basis of our previous modeling study, it is possible to offer various conclusions:

1. When low power is used, and the temperature in the tissue therefore does not reach \( \approx 100^\circ C \), electrodes of low \( k \) value are less capable of removing the heat generated in the tissue, cause a higher temperature value, and are consequently able to create larger lesions.\(^2,3\)

2. In contrast, when the applied power is high enough, electrodes of low \( k \) value cause temperatures close to \( 100^\circ C \) sooner than high \( k \) value electrodes. This excessive temperature value is associated with desiccation phenomena, which rapidly increases impedance, and impedes the subsequent energy delivery. In this case, electrodes of high \( k \) value are able to create larger lesions because impedance does not increase. Since a temperature-constant protocol (such as that used by Lewalter et al.) tries to maintain the tissue temperature around a preset value (always less than \( 100^\circ C \)), the results presented by them match this second case.

3. Finally, our modeling study\(^3\) also showed that when high \( k \) value electrodes are used, the location of the maximal temperature reached in the tissue is moved toward a deeper zone as compared to the case of electrodes of low \( k \) value. It seems that the higher capacity of the former to remove the heat excess in the tissue pushes the maximum temperature toward a deeper zone. I think that this is the key mechanism that explains the results of Lewalter et al. In addition, this same mechanism should be specially taken into account in zones of the heart with very high blood flow (i.e., high thermal cooling on the endocardium). In these zones, a temperature-constant protocol with a high-value preset temperature could provoke overheating in the tissue by the RF underestimating the actual temperature in the deeper zone of the tissue. Once again, I congratulate the authors for their study and promising results.

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References


First clinical experience and acute results in a European multicenter register with a catheter with a gold tip electrode

E. Mittmann-Braun, T. Lewalter, A. Yang, L. Lickfett, S. Wurtz, W. Haverkamp, E. Vester, B. Luderitz on behalf of Al Cath Gold-Register. University of Bonn, Department of Cardiology, Bonn, Germany; Biotronik Inc., Berlin, Germany; University Hospital Charite, Berlin, Germany; Evang. Hospital, Dusseldorf, Germany.

During the ablation of tachycardias both depth and volume of a lesion may be of importance. A European multicentre register was established to analyze the results achieved with an ablation catheter (4 and 8 mm tip) with a gold tip electrode catheter. The high capacity of this catheter to transduce thermal energy could cause a higher temperature in the tissue compared to catheters coated with conventional (platin-iridium) material. It is conceivable that a faster success could be achieved. 66 patients with different kinds of tachycardias were recruited (W: 33, M: 33, older: 55 ± 17 years old) during one year. 14 patients had a heart disease. The indication for the ablation procedures were: Atrial flutter (AF), AV nodal reentry tachycardias (AVNRT), AV nodal ablation and right ventricular outflow tract tachycardias. All these patients were successfully treated with a gold coated tip ablation catheter (4 or 8 mm tip). The ablation data are summarized in the table. So far no clotting, increased impedance or severe intraprocedural complications were reported.

<table>
<thead>
<tr>
<th></th>
<th>No. of patients</th>
<th>Duration of ablation (sec)</th>
<th>No. of RF-applications</th>
<th>X-ray time (min)</th>
<th>Procedure time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFI</td>
<td>25</td>
<td>390 ± 245</td>
<td>10 ± 5</td>
<td>13 ± 5</td>
<td>58 ± 20</td>
</tr>
<tr>
<td>AVNRT</td>
<td>35</td>
<td>93 ± 114</td>
<td>5 ± 4</td>
<td>7 ± 4</td>
<td>50 ± 23</td>
</tr>
<tr>
<td>AVN</td>
<td>3</td>
<td>163 ± 92</td>
<td>4 ± 1</td>
<td>4 ± 4</td>
<td>48 ± 9</td>
</tr>
<tr>
<td>RVOT</td>
<td>3</td>
<td>273 ± 231</td>
<td>8 ± 2</td>
<td>10 ± 0</td>
<td>57 ± 24</td>
</tr>
</tbody>
</table>

Conclusion: Ablation procedures with a gold tip electrode catheter (4 and 8 mm) showed a high success rate in the treatment of different tachycardias. In this multicentre register so far no intraprocedural complications or clotting on the tip of the ablation catheter were observed. This could be explained by a cooling effect of gold on the tip of the ablation catheter, analogous to the cooling-tip technology.

Isthmus Ablation With Gold Electrode for Treatment of Atrial Flutter

This study is currently recruiting patients.
Verified by Biotronik GmbH & Co. KG March 2007

Sponsored by: Biotronik GmbH & Co. KG
Information provided by: Biotronik GmbH & Co. KG
ClinicalTrials.gov Identifier: NCT00326001

Purpose
The purpose of this study is to demonstrate the advantage of using a gold alloy tip electrode over a platinum/iridium alloy tip electrode in ablation of the cavotricuspid isthmus in patients with atrial flutter.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Intervention</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial Flutter</td>
<td>Device: Ablation Catheter (ALCath LT8 G, ALCath LT8)</td>
<td>Phase IV</td>
</tr>
</tbody>
</table>

MedlinePlus related topics: Arrhythmia
Genetics Home Reference related topics: Arrhythmia

Study Type: Interventional
Study Design: Treatment, Randomized, Single Blind, Active Control, Parallel Assignment, Safety/Efficacy Study

Official Title: AURUM 8 - Ablation of the Cavotricuspid Isthmus in Patients With Atrial Flutter Using an 8 mm Gold Alloy Tip Electrode

Further study details as provided by Biotronik GmbH & Co. KG:
Primary Outcome Measures:
- Duration of energy application

Secondary Outcome Measures:
- Success rate
- Acute and long-term treatment success
- Comparison of ablation parameters

Total Enrollment: 450
Study start: June 2004; Expected completion: March 2007

Transvenous catheter ablation has become the therapy of choice for patients with recurring, isthmus-dependent right atrial flutter. Achieving bidirectional conduction block in the cavotricuspid isthmus is decisive for both acute and long-term therapy success and essentially depends on the selected ablation method and the lesion size. By using an 8 mm tip electrode instead of a conventional 4 mm electrode, deeper lesions can be made, thus significantly reducing the required number of energy applications for...
achieving a bidirectional conduction block. Experimental studies have proven that using an ablation electrode made of gold alloy allows the creation of deeper lesions than with conventional platinum-iridium electrodes. Due to the greater heat conductivity of the gold alloy as opposed to platinum-iridium, the cooling of the ablation electrode is improved and more electric energy can be transmitted to the tissue at identical temperatures.

The combination of both technologies in the form of an 8 mm-long gold electrode anticipates that the lesion depth required for an isthmus block can be achieved more quickly in comparison to the platinum-iridium electrode.

**Eligibility**

Ages Eligible for Study: 18 Years and above, Genders Eligible for Study: Both

**Criteria**

**Inclusion Criteria:**

- At least one electrocardiogram (ECG)-documented (can be older than 3 months), symptomatic, typical atrial flutter episode with either negative, sawtooth-shaped P-waves in leads II, III, and augmented voltage foot (aVF), or positive P-waves in leads II, III, and aVF
- At least one persistent, typical atrial flutter episode of over 2 hours that has been documented in the history in the patient file and/or ECG
- Signed informed consent form

**Exclusion Criteria:**

- Patient has recently undergone isthmus ablation
- Acute coronary syndrome or myocardial infarction within the last 3 months
- Acute reversible causes for atrial flutter (e.g. acute myocarditis)
- Severe cardiac valvular defects
- Tricuspid valve replacement
- Atrial septum defect
- Cardiovascular surgery scheduled within the next 6 months
- Unstable medication in the last 7 days before study inclusion
- New York Heart Association (NYHA) class IV
- Women who are breastfeeding
- Pregnancy
- Abuse of drugs or alcohol
- Patient is unable to participate in follow-up examinations
- The patient has only partial legal competence
- Participation in another clinical study
- The ablation procedure presents an above average risk to the patient as compared to the normal patient group (must be noted by the physician on the appropriate form).
- Right atrial thrombus

**Late Exclusion Criteria:**

- Patient included by accident
- Premature termination of the ablation procedure
- Atrial flutter not dependent on the posterior isthmus
- No conduction at the posterior isthmus before ablation

**Location and Contact Information**

http://clinicaltrials.gov/show/NCT00326001
Clinical Trial: Isthmus Ablation With Gold Electrode for Treatment of Atrial Flutter

Please refer to this study by ClinicalTrials.gov identifier NCT00326001
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Study chairs or principal investigators

http://clinicaltrials.gov/show/NCT00326001
More Information

Publications


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Health Authority: Germany: Federal Institute for Drugs and Medical Devices
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