Incidence and clinical characteristics of transient ST-T elevation during transseptal catheterization for atrial fibrillation ablation

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Aims

Transient ST-T elevation (STE) is a rare complication that occurs during transseptal catheterization. This study aims to delineate the incidence and characteristics of transient STE during transseptal catheterization for atrial fibrillation (AF) ablation.

Methods and results

Consecutive patients who underwent fluoroscopy-guided transseptal catheterization for circumferential pulmonary vein radiofrequency ablation in Beijing An Zhen Hospital from January 2006 to January 2013 were enrolled in this study. Out of 2965 patients with a total of 3452 transseptal catheterization procedures, 13 patients (0.38%, mean age 57 ± 8, 6 female, 12 paroxysmal AF, mean left atrial diameter 35.4 ± 3.8 mm) had STE. ST-T elevation occurred after transseptal puncture in 10 patients and after pulmonary vein venography in three patients. Systolic blood pressure (129 ± 10 vs. 104 ± 20 mmHg, P < 0.001), diastolic blood pressure (78 ± 6 vs. 64 ± 11 mmHg, P < 0.001), and heart rate (83 ± 19 bpm vs. 64 ± 23 b.p.m., P = 0.022) significantly decreased when STE occurred. Eleven patients complained of chest pain, one patient complained of dizziness, and one patient had no symptoms. Patients recovered in about 4.6 min (2–10 min) with dopamine or fast saline drip. Catheter ablation of AF was completed in all the 13 patients without sequelae or other complications. Four of the 13 patients (30.8%) had recurrence of AF after a mean follow-up of 21.7 months.

Conclusion

ST-T elevation is a rare complication associated with transseptal catheterization without sequelae. Catheter ablation of AF could be safely completed in these patients.

Keywords

Transseptal catheterization • ST-T elevation • Catheter ablation • Atrial fibrillation

Introduction

Catheter ablation has been a mainstream therapy for drug refractory atrial fibrillation (AF).¹ Transseptal catheterization is essential to gain access to the left atrium (LA) during catheter ablation of AF. Transient ST-T elevation (STE) during transseptal catheterization has been previously described in several case reports.²⁻⁵ However, the incidence and characteristics of transient STE during transseptal catheterization for AF ablation have not been well delineated. In the updated worldwide survey on case reports for human AF with more than 20 000 cases, STE was not reported either.⁶ This study aims to describe in detail the transient STE, which occurred during transseptal catheterization in a large observational study.

Methods

Study subjects

Consecutive patients who underwent fluoroscopy-guided transseptal catheterization for circumferential pulmonary vein radiofrequency ablation in Beijing An Zhen Hospital from January 2006 to January 2013 were enrolled. During this period, a total of 2965 patients underwent 3452 procedures.¹
procedures of transseptal catheterization for AF ablation. All the patients were entered into a prospectively established database to explore the outcome of catheter ablation of AF. Aiming to detect the complication of transient STE during transseptal catheterization was prospectively specified after the first case occurred. Totally, 13 patients had transient STE during transseptal catheterization. This study was approved by the Beijing An Zhen Hospital review board and a written informed consent was obtained from all the patients.

Transseptal catheterization

Low-molecular weight heparin (Enoxaparin, Sanofi-aventis) 0.5—1 mg/kg was subcutaneously injected twice a day instead of warfarin or antplatelet drugs from the start of admission. Prior to AF ablation, transoesophageal echocardiography was performed to exclude LA thrombus. Through the left femoral venous access, a quadripoal catheter (Cordis, Biosense Webster) or a decapolar catheter (Daig, St J Med) was positioned in the coronary sinus. An 8 French transseptal sheath and dilator (SL1; St. Jude Medical) was advanced over a 0.032 inch guidewire to the coronary sinus. An 8 French transseptal sheath and dilator (SL1; St. Jude Medical) or a decapolar catheter (Daig, St J Med) was positioned in the coronary sinus. An 8 French transseptal sheath and dilator (SL1; St. Jude Medical) was advanced over a 0.032 inch guidewire to the superior vena cava via right femoral vein access. After the guidewire was removed, a Brockenbrough transseptal needle (BRK1; St. Jude Medical) was introduced into the dilator, and then the sheath, dilator, and transseptal needle as an entire system was gradually withdrawn down from the superior vena cava to interatrial septum until a drop-off sign was observed on fluoroscopy. With right anterior oblique view, the Brockenbrough transseptal needle was advanced out of the dilator. When the Brockenbrough transseptal needle was advanced into LA, a slight breakthrough could be felt by the physician. After injecting 3–5 mL contrast to confirm that the needle was in the LA, the dilator was advanced over the needle into the LA. The needle was pulled out of the dilator, and the bolus of 6000 IU heparin was injected. A 0.032 inch guidewire was advanced into the left superior pulmonary vein through the dilator. The dilator and long sheath were advanced into left superior pulmonary vein over the wire. Then the dilator was drawn out of the sheath. After left and right venographies were performed with the long sheath, a 3.5 mm saline-irrigated ablation catheter (Navistar ThermoCool; Biosense Webster) was advanced through the sheath for mapping and ablation. The long sheath was flushed with 1‰ heparin saline at a rate of 20 mL/h. Activated clotting time was monitored every 30 min to achieve an activated clotting time of 300–350 s after the transseptal procedure. Non-invasive blood pressure was monitored every 10 min or measured at any time if needed. Electrocardiogram (ECG) was monitored by EP monitoring system (EP workmate St J Med).

Statistical analysis

All analyses were performed using the SPSS software version 13.0. Continuous data were presented as mean ± standard deviation. Unpaired independent samples t test was analyzed for continuous variables and the chi-square test or Fisher exact test if necessary for categorical variables. All probability values were two sides, a P value of < 0.05 was considered significant.

Results

Incidence and baseline patient characteristics

Out of the 3452 procedures performed in 2956 patients, 13 patients (0.38%) had STE during transseptal catheterization. As shown in Table 1, there were no significant differences in age, gender, AF type, and repeat ablation procedure between the patients with STE and those without STE during transseptal procedures. However, patients with STE had a smaller LA diameter (35.4 ± 3.8 vs. 39.4 ± 6.2 mm, P = 0.021). The characteristics of all the 13 patients are shown in Table 2. The mean age was 57 ± 8 (45–73). Six of the 13 patients were women. One patient had long-standing persistent AF, and the other 12 patients had paroxysmal AF. Three of these 12 patients with paroxysmal AF had atrial flutter. Cases 5 and 10 had coronary artery disease with left anterior descending artery stenosis (50%) identified by angiography performed 10 and 18 months before the ablation, respectively. Six patients had hypertension; none of the patients had diabetes mellitus.

Presentation of ST-T elevation

ST-T elevation occurred after transseptal puncture in 10 patients (76.9%) and after pulmonary vein venography in three patients (23.1%). ST-T elevation was observed in inferior wall leads (Figure 1). The ratio of STE in Lead III/Lead II was more than one in all the 13 patients. Five patients complained of chest pain, and six patients complained of mild chest pain when the physician observed STE and asked if they had any discomfort. Case 8 complained dizziness and Case 3 did not have any symptoms. Case 6 had sinus pause and Adams-stroke. Systolic blood pressure (129 ± 10 vs. 104 ± 20 mmHg, P < 0.001) and diastolic blood pressure (78 ± 6 vs. 64 ± 11 mmHg, P < 0.001) were significantly lower than baseline when STE occurred. The mean heart rate during STE was significantly lower than baseline (83 ± 19 vs. 64 ± 23 b.p.m., P = 0.022). However, Cases 5 and 11 had higher heart rate during STE than
<table>
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<tr>
<th>Pt</th>
<th>Age/ M</th>
<th>Type of AF</th>
<th>Combined disease</th>
<th>LAD (mm)</th>
<th>Medicine</th>
<th>When STE was observed</th>
<th>Leads of STE</th>
<th>Symptom</th>
<th>Baseline BP (mmHg)</th>
<th>STE BP (mmHg)</th>
<th>HR (bpm)</th>
<th>STE HR (bpm)</th>
<th>Duration</th>
<th>Treatment</th>
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<td>Chest pain</td>
<td>135/80</td>
<td>80/50</td>
<td>75</td>
<td>68</td>
<td>10 min</td>
<td>Dopamine Dexamethasone</td>
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<td>II, III, aVF</td>
<td>Chest pain, slight sweating</td>
<td>130/70</td>
<td>100/50</td>
<td>78</td>
<td>50</td>
<td>3 min</td>
<td>Saline drip</td>
</tr>
<tr>
<td>3</td>
<td>53/F</td>
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<td>HTN</td>
<td>31</td>
<td>Irbesartan + HCT, amlodipine</td>
<td>When sheath was advanced into PV</td>
<td>II, III, aVF</td>
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<td>140/76</td>
<td>117/70</td>
<td>91</td>
<td>85</td>
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<td>When sheath was advanced into PV</td>
<td>II, III, aVF</td>
<td>Chest pain, slight sweating</td>
<td>120/72</td>
<td>108/66</td>
<td>73</td>
<td>64</td>
<td>5 min</td>
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<td>CAD, HTN</td>
<td>44</td>
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<td>II, III, aVF</td>
<td>Mild chest pain</td>
<td>123/84</td>
<td>112/82</td>
<td>66</td>
<td>70</td>
<td>7 min</td>
<td>Saline drip</td>
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<td>None</td>
<td>36</td>
<td>Metoprolol</td>
<td>After transseptal puncture</td>
<td>II, III, aVF</td>
<td>Chest pain, Adams-stroke</td>
<td>124/77</td>
<td>77/54</td>
<td>78</td>
<td>0</td>
<td>5 min</td>
<td>Saline drip, pacing</td>
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<td>II, III, aVF</td>
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<td>110/67</td>
<td>71/50</td>
<td>140</td>
<td>70</td>
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<td>HTN</td>
<td>39</td>
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<td>After transseptal puncture</td>
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<td>Mild chest pain</td>
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<td>138/72</td>
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<td>76</td>
<td>2 min</td>
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<td>None</td>
<td>After transseptal puncture</td>
<td>II, III, aVF</td>
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<td>108/70</td>
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<td>After transseptal puncture</td>
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<td>Mild chest pain</td>
<td>135/80</td>
<td>130/80</td>
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<td>99</td>
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<td>HTN</td>
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<td>II, III, aVF</td>
<td>Chest pain</td>
<td>130/82</td>
<td>120/70</td>
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<td>2 min</td>
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<td>95/62</td>
<td>74</td>
<td>58</td>
<td>2 min</td>
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</tr>
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</table>

AF, atrial fibrillation; CAD, coronary artery disease; HCT, hydrochlorothiazide; HTN, hypertension; LAD, left atrial diameter; PV, pulmonary vein; STE, ST-T elevation.
baseline. On an average, STE lasted for about 4.6 min (2–10 min). When STE recovered, blood pressure returned to the normal range.

Management and outcome

Case 1 was the first case of the STE series. ST-T elevation occurred after pulmonary vein venography. Dexamethasone 5 mg was injected intravenously to relieve the possible contrast allergy. Dopamine was administered as an intravenous drip to elevate blood pressure. Angiography after ablation procedure did not reveal any stenosis, artery spasm, or air embolism. All the other patients had fast saline infusion to restore blood pressure. It should be pointed out that Case 6 had Adams-stroke due to sinus pause and recovered by cardiopulmonary resuscitation and coronary sinus pacing. Catheter ablation of AF was completed in all the patients without sequelae or other complications. Troponin I was arrayed in six patients with STE after 24 h after the procedure. Troponin I was arrayed in 12 randomized selected patients with age, gender, and AF type matched in the control group. There were no difference in Troponin I between the cases and the controls (5.96 ± 5.66 vs. 4.39 ± 3.97 ng/mL, P = 0.500). Four of the 13 patients (30.8%) had recurrence after a mean follow-up of 21.7 months.

Discussion

Transient STE during transseptal catheterization for AF ablation is a well-recognized phenomenon in several case reports. To the best of our knowledge, this is the first study to report the incidence, characteristics, management, and outcome of STE during transseptal catheterization performed in a large number of patients in a single centre.

On careful review of the literature, it was found that a total of 17 cases of transient STE were reported by nine authors from 2003 to 2010. Thirteen of the 17 patients had STE during or after transseptal catheterization, whereas in the other 4 cases, STE occurred during pulmonary vein isolation. However, the incidence and clinical characteristics of STE were not described in these case reports. As majority of the STE episodes occurred during or after transseptal catheterization, it is unlikely that STE have occurred due to damage to coronary arteries or vagal nerve stimulation caused by radiofrequency ablative energy.

The mechanism and underlying pathophysiology of STE have not been well established. There are two possible mechanisms that can explain the occurrence of STE during or after transseptal catheterization: (i) coronary artery air embolism and (ii) Bezold-Jarisch like reflex. The subjects in the previous studies had acute inferior ischaemia and/or heart block which were described as the classic presentation of air embolism in the recent expert consensus statement on AF ablation. It was also reported that serious air embolism occurred in patients with long apnoea under sedation during AF ablation. Air emboli can be introduced from transseptal sheath which migrates into the right coronary artery due to superior position of the right coronary artery ostium in the supine patient, which can partly explain the occurrence of STE in inferior leads. ST-T elevation in Lead III exceeding that in Lead II provided a clue that right coronary artery was the air embolism involved artery, which was consistent with our speculation. However, in our study, we did not observe air embolism of coronary artery in the first case of coronary angiography. Similar to our study, air embolism was not detected in the coronary artery angiography in the previous case reports. It should be pointed out that negative findings in coronary artery angiography cannot completely exclude the possibility of air embolism occurrence, as any delay in performing angiography might lead to the absorption of small air bubbles.

ST-T elevation was associated with hypotension and slower heart rate or heart block, indicating that Bezold-Jarisch like reflex might be another possible mechanism. It was previously reported by Arita et al. that two cases of STE in the inferior leads had sinus bradycardia and profound hypotension in spite of normal coronary artery angiography. Atrial septum is innervated profoundly by parasympathetic nerves. Passage of the catheter through these high-density nerve complexes of the septum during transseptal catheterization might irritate or damage the plexus inducing Bezold-Jarisch like reflex. ST-T elevation occurred mostly in the inferior wall because innervation of vagal fibres in right coronary artery is greater than that in left coronary artery. Because of this, when transseptal puncture irritates or damages the abundant vagal efferent fibres and...
ganglia at the interatrial septum, right coronary artery is more susceptible to cholinergic constriction and vasospasm which leads to inferior ischaemia. One can suppose that the density of vagal efferent fibres might be more abundant in patients with small LA size, which explains why patients with STE had smaller LA size. However, the hypothesis of Bezold-Jarisch like reflex leading to STE could not explain some of the findings. First, in our study (Case 1) and in previous studies, coronary artery spasm was never found in angiography. Second, after STE is resolved, it did not recur even though there is a continuous stimulation of septum from the sheath and catheter.

Cardiac tamponade should also be a differential diagnosis as the patients become hypotensive and experience slower heart rate during or after transseptal catheterization which can be ruled out by fluoroscopy or ultrasound. In this study, we did not use nitrates or calcium antagonists to relieve STE as they might worsen the hypotension and slower heart rate. Quick infusion of saline was done to correct hypotension. This might also help flush air bubble away to distal artery in case air embolism is the cause of STE. If saline infusion did not restore heart rate and blood pressure, atropine and dopamine were administered. Stimulator and a pacing catheter catheter should be kept reserved for any serious complications like sinus pause. We observed sinus pause in Case 6 which eventually leads to Adams-stroke. In all the cases, catheter ablation was safely completed without any further complications.

Limitations

A major limitation of this study was that coronary angiography was not performed in all the patients. However, in Case 1 of the current study and most of the cases previously reported in the literature, coronary angiography did not reveal any positive findings. We could not assess the coronary artery condition during STE. It is likely that the time delay from the onset of STE to coronary angiography might have exceeded STE duration in a few cases and thus resulted in small air bubble (if present) to be flushed away. Because coronary angiography has less sensitivity to detect air embolism in these cases, intracardiac ultrasound will be helpful to identify air embolism. However, intracardiac ultrasound is not routinely used in catheter ablation of AF in China. Another limitation was that transdiaphragmatic echocardiography was not routinely performed in this study. Ventricular wall motion abnormality detected by transdiaphragmatic echocardiography would have been helpful to find the affected coronary artery flow if any.

Conclusions

ST-T elevation during transseptal catheterization is a rare complication that occurs during transseptal catheterization. It is mainly characterized by (i) occurrence in the inferior wall, (ii) most patients had mild symptoms, (iii) hypotension and slower heart rate or heart block, and (iv) recovery after a few minutes. Most importantly, catheter ablation procedure was completed safely without any interruption.

Conflict of interest: none declared.

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