Value of Radiographic Esophageal Imaging in Determining an Optimal Atrial Septal Puncture Site for Percutaneous Balloon Mitral Valvuloplasty

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Key Words

Radiographic esophageal imaging · Transseptal catheterization · Percutaneous balloon mitral valvuloplasty

Abstract

Objective: To investigate the value of radiographic esophageal imaging in facilitating transseptal catheterization in patients undergoing percutaneous balloon mitral valvuloplasty. **Subjects and Methods:** A total of 468 patients were randomized into either the study group (n = 234), in which radiographic esophageal imaging by the oral administration of a contrast media took place, or the control group (n = 234), in which the Ross technique was used. Of the 468 patients, 203 were males and 265 were females. The average ages of the study and control groups were 53 ± 16 and 51 ± 17 years, respectively. The patients had severe left atrial enlargement, as measured using 2-dimensional echocardiography. **Results:** In the study group, the left atrial impression on the esophagus was clearly seen, and was used to identify the puncture site on the right atrial side for the passage of the transseptal catheter. In the control group, the left atrial silhouette was not clearly shown by fluoroscopy in 112 patients (47.5%). The success rate of transseptal catheterization in the study group was higher than in the control group (99.6 vs. 45.7%, $p = 0.0001$). There were no complications in the

study group, but pericardial tamponade occurred in 1 patient in the control group. **Conclusion:** Radiographic esophageal imaging facilitates the identification of an optimal atrial transseptal puncture site, and improves the success rate of transseptal catheterization in patients undergoing percutaneous balloon mitral valvuloplasty.

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Introduction

Percutaneous balloon mitral valvuloplasty (PBMV) is one of the most important therapeutic modalities in the management of mitral valve disease caused by rheumatic heart disease [1]. There are several methodologies for performing PBMV, but the transvenous or antegrade method is the most widely used approach [1]. This method involves the identification of a puncture site from the right atrial side of the interatrial septum, the positioning of a large transseptal cannula to enable the passage of a balloon catheter, and the dilation of the mitral valve. A similar transseptal procedure has been used to perform catheter ablation of atrial fibrillation in other types of tachycardias [2, 3]. This invasive transseptal procedure is associated with 2 major complications: (1) cardiac perforation, which may lead to cardiac tamponade, and (2) the

Fig. 1. When the left atrial diameter is <45 mm, the puncture site is determined between the middle and the lower third of the esophageal impression. ☆ = Puncture site.

Fig. 2. When the left atrial diameter is >45 mm, the puncture site is determined between the middle and the lower quarter of the esophageal impression. ☆ = Puncture site.

puncture of an inappropriate atrial septal site, which may result in difficulties in maneuvering the balloon catheter across the mitral orifice [4].

Transseptal techniques and the use of instrumentation in humans were developed initially by Cope [5] and later by Ross [6]. Since then, the transseptal puncture technique for diagnostic left heart catheterization or PBMV has been extensively described [7–14]. The purpose of this study was to assess the value of using the left atrial impression on the esophagus as a landmark for the atrial septum puncture site.

Subjects and Methods

Subjects

This study was approved by the Institution's Review Board of Guangzhou Red Cross Hospital. After informed consent was obtained, 468 patients (203 males, aged 38–72 years, mean 56 ± 16 years) were recruited between January 2002 and June 2006. Patients were randomized into either a study group ($n = 234$), in which radiographic esophageal imaging was used to aid the transseptal puncture, or the control group ($n = 234$), in which transseptal punctures were performed with the Ross technique [6–8]. In the control group, if the transseptal procedure failed, patients were transferred to the study group (crossover design), where radiographic esophageal imaging was used to aid the transseptal catheterization.

Transseptal Procedure

In the study group, patients drank approximately 20 ml of meglumine and diatrizoate 5 min before the transseptal catheterization, while lying supine. This was followed by fluoroscopic examination immediately after the administration of the contrast agent to view and record the esophageal impression by the left atrium, as described previously in patients with a moderate enlargement of the left atrium [7]. In the present study, patients had severe left atrial enlargement, measured by 2-dimensional echocardiography that was used in conjunction with the esophageal impression to determine the transseptal puncture site. In 122 patients with a left atrial diameter of <45 mm, an imaginary horizontal line was drawn between the middle and the lower third of the impression; the intersection of the horizontal line and the point between the middle and the right third of the corresponding thoracic vertebra was defined as the site of the atrial septum puncture (fig. 1). If the left atrial diameter was >45 mm ($n = 112$), a horizontal line was drawn between the middle and the lower quarter of the esophageal impression; the intersection of the horizontal line and the point between the middle and the right quarter of the corresponding thoracic vertebra was defined as the site of the atrial septum puncture (fig. 2).

In the control group, a conventional transseptal puncture technique was used [6–8]. Under anterior-posterior fluoroscopic view, the left atrium was visually divided into 3 equal parts from the upper to the lower end. An imaginary horizontal line was drawn between the middle and the lower third of the left atrial silhouette; the intersection of the horizontal line and the point between the middle and the right third of the corresponding thoracic vertebra was defined as the site of the atrial septum puncture [7, 8]. If the diameter of left atrium was >45 mm, an imaginary

Table 1. Baseline characteristics of patients

	Study group	Control group	p
Age, years	53 ± 16	51 ± 17	0.74
Body height, cm	168 ± 12	169 ± 11	0.66
Body weight, kg	65 ± 6	64 ± 7	0.21
Left atrium, mm	45 ± 15	46 ± 17	0.42

horizontal line was drawn between the middle and the lower quarter of the impression; the intersection of the horizontal line and the point between the middle and the right quarter of the corresponding thoracic vertebra was defined as the site of the atrial septum puncture.

Transseptal catheterization was performed with a standard Transseptal Introducer Set (USCI, Billerica, Mass., USA). After the Brockenbrough needle and dilator were entered into the left atrium, 76% compound meglumine and diatrizoate was injected into the left atrium to confirm the position of the needle, followed by left atrial pressure measurement. In the study group, the size of the visualized left atrium was measured from the upper to the lower border to compare the lengths of esophageal impressions. Thereafter, the Brockenbrough needle and dilator were withdrawn, and an 8F Mullins sheath was positioned in the left atrium with constant monitoring of the left atrial pressure through the side arm of the sheath.

Statistical Analysis

Data are expressed as means ± SD. A paired Student's *t* test was used to examine the differences in the baseline patient data between the 2 groups. Categorical data were analyzed by the χ^2 test. A value of *p* < 0.05 was considered to be statistically significant.

Results

There were no significant differences in age, body height and weight, or echocardiographically determined left atrial diameter between the 2 groups (table 1). All patients had an enlarged left atrium, with an average left atrial diameter of 45 mm (table 1).

In the study group, the left atrial impression on the esophagus was clearly seen in all patients (fig. 1). Successful transseptal catheterizations were achieved all except one patient (*n* = 233, 99.6%), who had a huge left atrium due to a long-standing mitral valve disease and unstable hemodynamics. After the successful transseptal catheterization in these patients, a contrast injection showed the contour of left atrium correctly overlapped with the impression on the esophagus.

In the control group, the silhouette of the left atrium was blurred in 112 patients (47.5%) under fluoroscopic view. The transseptal puncture succeeded in only 107 pa-

tients (45.7%) during the first attempt, and, when compared to the study group, the difference was statistically significant (*p* = 0.0001). In the remaining 127 control patients, radiographic esophageal imaging was subsequently used for transseptal catheterization, which was successful in all patients. Cardiac tamponade occurred in 1 control patient, who was managed successfully with pericardial drainage for 2 days.

Discussion

The transseptal puncture procedure is vital for PBMV or radiofrequency catheter ablation of atrial fibrillation where pulmonary vein isolation is required. The key to a successful transseptal puncture is the accurate localization of an atrial puncture site to allow the passage of a catheter from the right to the left atrium without causing complications. The Ross method, or a modified version of it, has been widely used for this procedure. However, the Ross method largely depends on the quality of fluoroscopic displays of the left atrial silhouette, which is not always clearly seen in patients with mitral valve disease [7, 8].

Although the Ross method is simple to use, the left atrial silhouette could not be clearly identified in approximately 48% of the patients in this study. As a result, the identification of the atrial puncture site was difficult, and the success rate of transseptal catheterization in these patients was significantly lower than in the study group. The success rate of the control group is significantly lower than the 90% value reported previously [2, 3, 14]. The low success rate in the control group in our study is probably due to a combination of inexperienced operators and the suboptimal quality of the radiographic-imaging facility used in the early stage of the investigation.

The radiographic esophageal imaging approach used in the present study is relatively easy to perform. It clearly showed the left atrial impression on the esophagus, which is consistent with the actual size of the left atrium after a left atrial angiogram. Using this technique, transseptal punctures were successful in the vast majority of the study group patients, and in patients who had failed the first attempt using the Ross technique.

Radiographic esophageal imaging should be used cautiously in elderly patients and those with dilated or distorted thoracic aorta, which may cause an esophageal impression similar to that caused by an enlarged left atrium [7]. A chest X-ray before transseptal catheterization should be completed to assess the anatomy of thoracic aorta. If there is any doubt, an angiogram of the aorta

should be performed to ensure an accurate diagnosis, as we previously pointed out [7].

The other limitation of the esophageal imaging technique is that it may not be very helpful in patients with a normal left atrium. Transseptal catheterization is often required during catheter ablation of atrial fibrillation, and sometimes required in patients with left accessory-pathway-mediated atrioventricular reentrant tachycardia. In these patients, the anatomy of left atrium is less affected than in patients with significant mitral valve disease; less than one third of patients with lone atrial fibrillation have structural heart disease, and the enlargement of the left atrium is only mild to moderate [2].

Conclusion

The present study has shown that radiographic esophageal imaging clearly outlines the enlarged left atrium, and facilitates the identification of an optimum atrial septum puncture site during transseptal catheterization. This novel technique appears to be particularly useful in patients with a significantly enlarged left atrium due to severe mitral valve disease.

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