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Videoscope-assisted transaortic myectomy in patients with hypertrophic cardiomyopathy with complex left ventricular anatomy

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Abstract

Background: The transaortic approach is the most common method of septal myectomy. However, difficulties arise due to a limited view of the surgical field. Here, we report our experience with videoscope-assisted transaortic myectomy.

Methods: We reviewed myectomy operations that were performed between July 2015 and June 2019 at Chung-Ang University Hospital, Seoul, South Korea. Patients who previously had cardiac surgery, alcohol septal ablation, or concomitant disease which required combined surgery, were excluded. Among the 21 patients included, 10 patients underwent videoscope-assisted transaortic myectomy (VA group), and 11 patients underwent myectomy in a conventional manner (CO group). The preoperative data, echocardiographic images, operative records, and postoperative outcomes of these patients were reviewed.

Results: There were no differences in baseline characteristics between groups VA and CO. The main indications for videoscope-assisted transaortic myectomy in group VA were midventricular septal muscle resection (70%), abnormal papillary muscle resection (40%), and abnormal chordal connection resection (30%). Eight (80%) patients had multiple indications for videoscope-assisted transaortic myectomy. There was no surgical mortality in either group. Postoperative patients showed less than moderate mitral regurgitation and a New York Heart Association class either III or IV. There were no differences in hospital days (9.5 vs. 12.0 days; $p = .383$), nor postoperative pressure gradient (14 vs. 15 mmHg; $p > .99$).

Conclusions: Videoscope-assisted transaortic myectomy is an effective surgical technique in selective hypertrophic cardiomyopathy patients with complex intraventricular anatomy, diffuse hypertrophy, and midventricular obstruction.

KEYWORDS

hypertrophic cardiomyopathy, transaortic myectomy, videoscope-assisted surgery

1 | INTRODUCTION

Septal myectomy is the gold standard for treating patients with medically refractory obstructive hypertrophic cardiomyopathy (HCMP).[1,2] There are various types of HCMP based on the shape and location of the left ventricular thickening,[3] and the surgical approach differs accordingly.[4,5] The transaortic approach is the most common method of septal myectomy. However, technical difficulties can arise because of a limited surgical field view. This generally occurs when a transaortic myectomy operation is performed to resect the septal muscle wider than usual and/or more distal to the midventricle towards the apex.[5–8]

Abnormalities in the intraventricular anatomy, such as an abnormal muscle bundle, papillary muscle, and chordae, contribute to the pathophysiology of left ventricular outflow tract (LVOT) obstruction, mitral regurgitation, and midventricular obstruction. However, these abnormalities cannot be easily identified using the transaortic approach. Hence, some centers have started performing the transapical[9,10] or transmitral[7,8] approach. However, these approaches have disadvantages as well.

We need an improved technique to visualize the left ventricle's internal anatomy when we perform a transaortic myectomy on patients with diffuse and/or midventricular obstruction and abnormal intraventricular structures. Here, we report on our experience with videoscope-assisted transaortic myectomy (VATAM) and conventional myectomy.

2 | PATIENTS AND METHODS

The Chung-Ang University Hospital Institutional Review Board (IRB No. 2009-001-19330) approved this study.

Patients who were older than 16 years and underwent a myectomy between July 2015 and June 2019 at Chung-Ang University Hospital, Seoul, South Korea, were included in this study. Patients who underwent combined cardiac surgeries for intrinsic disease not related to HCMP, such as coronary artery disease other than myocardial bridge, valvular disease other than mitral regurgitation due to systolic anterior motion, were excluded. Patients who had undergone alcohol septal ablation before myectomy surgery were excluded. For the included patients, we reviewed their electronic medical records and image studies. We performed a telephone survey to determine the survival and functional class of patients who were not followed at our center.

A total of 21 patients were included in the study and the mean follow-up period was 34 months. A total of 10 patients underwent VATAM (group VA), and the other 11 patients underwent conventional myectomy (group CO).

2.1 | Operative technique

Transoesophageal echocardiography was performed for all patients. With median sternotomy, a cardiopulmonary bypass was established with two-staged venous cannulation and ascending aortic cannulation. The left ventricular vent was inserted through the right superior pulmonary vein. Histidine–tryptophan–ketoglutarate cardioplegia solution was delivered through the root cannula. A hockey stick-shaped aortotomy incision was made slightly lower than that made for aortic valve surgery. If the patient was indicated for VATAM, a videoscope (5-mm diameter, 30° angle, 35 cm) was introduced into the left ventricle through the aortic valve to inspect the anatomical structures and to make a precise operative plan, and then the scope was taken out (Figure 1A). If there was no indication for VATAM, conventional myectomy surgeries were performed under direct vision only (Figure 1B). The myectomy incision was made just right to the nadir of the right coronary cusp extending towards the left using a number 10 surgical blade. Then, the excised piece of the septal muscle was taken out. Whenever there were intraventricular structures that could not be exposed easily through the aortic valve, the scope was used repeatedly. The mitral valve and aortic valve were carefully inspected for any unintentional injury. After deairing, the aorta was closed. The ventricular pacing wires were placed, the aorta cross-clamp was taken out, and cardiopulmonary bypass was gradually weaned off. The outcome of myectomy was evaluated using intraoperative transoesophageal echocardiography and direct pressure measurement. Cardiopulmonary bypass was resumed when an additional procedure was required to relieve HCMP's pathophysiology (Figure 2, Video S1).

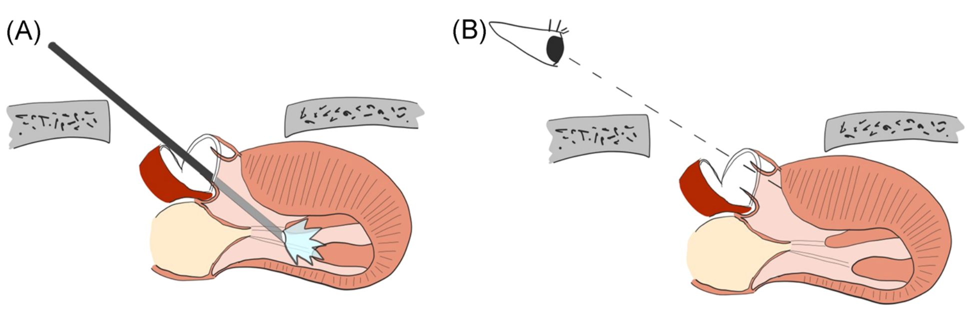

FIGURE 1 (A) Videoscope is used to observe mideventricular septum and subvalvular apparatus of mitral valve. (B) Surgical view of conventional myectomy through aortotomy is limited due to sternum, aorta, and hypertrophied basal septum itself

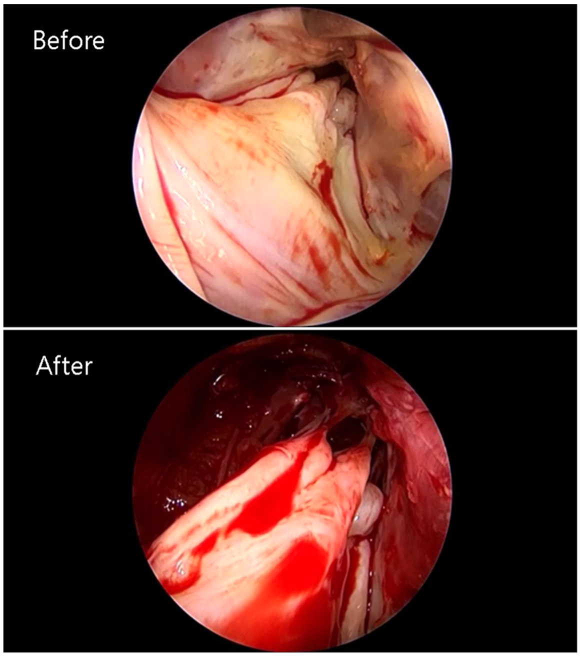

FIGURE 2 Before and after videoscope-assisted transaortic myectomy

TABLE 1 Preoperative characteristics

Characteristics	Group VA	Group CO	*p*
Age (years)	44.7 ± 12.5	37 ± 13.0	.18
Gender			.075
Female	3 (30%)	2 (18.2%)	
Male	7 (70%)	9 (81.8%)	
BSA (m^2/kg)	1.76 ± 0.25	1.83 ± 0.18	.49
NYHA			.214
<III	0 (0%)	3 (27.3%)	
≥III	10 (100%)	8 (72.7%)	
Peak pressure gradient (mmHg)			
Resting	52 ± 47	66 ± 29	.43
Valsalva	93 ± 74	97 ± 33	.85
MR grade			1.000
<3	5 (50%)	5 (45.5%)	
≥3	5 (50%)	6 (54.5%)	
Indication for VATAM			
Midventricular septal resection	7 (70%)	0 (0%)	
Abnormal papillary muscle resection	4 (40%)	0 (0%)	
Abnormal chordae resection	3 (30%)	0 (0%)	
Diffuse hypertrophy	3 (30%)	0 (0%)	
Thick papillary muscle shaving	1 (10%)	0 (0%)	

Note: Values are expressed as mean ± standard deviation or number (%).
Abbreviations: BSA, body surface area; MR, mitral regurgitation; NYHA, New York Heart Association; VATAM, videoscope-assisted transaortic myectomy.

3 | RESULTS

There were no surgical mortalities nor postoperative conduction blocks requiring a permanent pacemaker in either group. There were no differences between group VA and group CO with respect to age (44.7 ± 12.5 vs. 37 ± 13.0 years; $p = .18$), body surface area (1.76 ± 0.25 vs. 1.83 ± 0.18 m^2; $p = .49$), resting pressure gradient (52 ± 47 vs. 66 ± 29 mmHg; $p = .43$), or Valsalva pressure gradient (93 ± 74 vs. 97 ± 33 mmHg; $p = .85$). The New York Heart Association class was equal to or greater than III in 10 patients (100%) in group VA and 8 patients (72.7%) in group CO ($p = .214$). Mitral regurgitation grade was equal to or greater than three in five patients (50%) in group VA and six patients (54.5%) in group CO ($p = 1.000$). In group VA, the main indications for VATAM were midventricular septal muscle resection (seven patients), abnormal papillary muscle resection (four patients), abnormal chordal connection resection (three patients), and diffuse hypertrophy (three patients), requiring wide myectomy. Eight (80%) patients had multiple reasons for VATAM. No one in group CO had an indication for VATAM (Table 1).

There were no differences between group VA and group CO in median cardiopulmonary bypass time (126 [88–158] vs. 137 [87–218] min; $p = .398$), median hospital days (9.5 [8.0–10.3] vs. 12.0 [8.0–14.0] days; $p = .383$), mean postoperative pressure gradient (19 ± 16 vs. 22 ± 26 mmHg; $p = 1.000$). Three patients each in group VA (30%) and group CO (27.3%) had to undergo repeated cardiopulmonary bypass ($p > .99$). No one needed a mitral valve procedure in group VA. However, in the CO group, one patient required a mitral valve repair, and another required a mitral valve replacement ($p = .476$). Myocardial bridge unroofing was done in four patients (40%) in group VA and two patients (18.2%) in group CO ($p = .361$). No patient in either group had a mitral regurgitation grade equal to or greater than 3, or New York Heart Association class equal to or greater than III at the last follow-up (Table 2).

4 | DISCUSSION

Our center has an HCMP program and, as a result, patients with relatively complex HCMP are referred to us for myectomy operation. Most of them underwent VATAM in this study. Even though there were no significant differences between group VA and group CO, with operative results suggesting VATAM is safe and effective in operating patients with complex abnormalities, it is difficult to treat conventional myectomy.

Heredia Cambra et al.[11] reported a similar method of myectomy using a rigid videoscope in all myectomy cases. However, in our opinion, there are downsides to VATAM. The operating room could be more crowded, the staff has to perform additional work, and the

TABLE 2 Operative and postoperative data

	Group VA	Group CO	*p*
Pump time (min)	126 (70)	137 (131)	.398
Repeated bypass	3 (30%)	3 (27.3%)	1.000
Mitral valve procedure	0 (0%)	2 (18.2%)	.476
Myocardial bridge unroofing	4 (40.0%)	2 (18.2%)	.361
Hospitalization period (days)	9.5 (2.3)	12.0 (6.0)	.383
Mitral regurgitation grade			1.000
<3	10 (100%)	11 (100%)	
≥3	0 (0%)	0 (0%)	
Pressure gradient (mmHg)	14 (18)	15 (25)	1.000
NYHA			1.000
<III	10 (100%)	11 (100%)	
≥III	0 (0%)	0 (0%)	

Note: Values are expressed as mean ± standard deviation, median (interquartile range) or number (%).
Abbreviation: NYHA, New York Heart Association.

operative field gets busier. Inserting one more instrument into the left ventricle through the aortic valve can also increase the risk of aortic valve injury. Therefore, we do not suggest VATAM for all patients.

Preoperative imaging studies and a comprehensive understanding of surgical anatomy are key to a successful myectomy[12] and the rationale behind using a videoscope. For subaortic hypertrophy cases, we prefer performing transaortic myectomy under direct vision,[13] as done for group CO in this study. However, when patients have complex abnormalities such as abnormal papillary muscle, abnormal chordal connection, and abnormal muscle bundle, which potentially contribute to LVOT obstruction's pathophysiology, observed on preoperative imaging studies, VATAM is recommended. If the target location for myectomy is far from the LVOT beyond the midventricle, videoscope-assisted myectomy surgery can extend the operative view distally towards the apex. Midventricular septal resection was the most common indication for videoscope-assisted myectomy in our study.

During transaortic myectomy, it is difficult to introduce surgical instruments together with the videoscope through the aortic valve because of limited space. Therefore, we used the videoscope to confirm which intraventricular structure required resection, and it was then pulled out to perform resection under direct vision in many cases. Hence, our method cannot be considered "true" videoscope-assisted myectomy. However, in our experience, this surgical technique is easier, safer,[11] and does not pose an additional risk.

Although the demand for minimally invasive cardiac surgery (MICS) is growing more than ever, experiences of surgical repair for HCMP with a minimally invasive approach have been limited due to technical aspect. In the limited visual field and workspace, approaches such as mini-sternotomy could not have been earnestly considered so far, as sufficient muscle resection has been regarded as a top priority. However, we believe that VATAM technique may play a role in the general acceptance of MICS in the surgical repair of HCMP. Recently, reports on transaortic septal myectomy through mini-sternotomy have been published.[14,15] According to the authors, about 5% of patients converted to full sternotomy for better septal exposure. Although we have very limited experience of the mini-sternotomy approach yet, it would be very interesting to see if VATAM plus mini-sternotomy can decrease the conversion rate to full sternotomy.

The VATAM technique was not indiscriminately used for all comers undergoing septal myectomy, rather selectively applied for patients with complicated anatomy that are deemed to be unamenable to the conventional aortotomy approach. Apicoseptal hypertrophy or midventricular hypertrophy may require a separate incision at the LV apex as well as a conventional aortotomy. Through this VATAM technique, however, we believe that we smartly and efficiently eliminated the possible risks posed by a separate LV apex incision. Furthermore, the VATAM technique allowed a visual check whether the septal muscle resection was adequately performed.

Some groups have advocated using transaortic and/or transapical myectomy for midventricular HCMP.[4,5,9] We agree that patients with apical hypertrophy require the transapical approach.[4,16] However, this operation might be challenging to be performed in centers without extensive experience. Moreover, there is a possibility of occurrence of complications, such as postoperative apical akinesia,[10] from the ventricular scar at the apical incision site. We managed to approach the midventricular septum and reach further towards the apex with the assistance of the videoscope. Additionally, patients with diffuse left ventricular hypertrophy who require an extended resection to relieve the LVOT obstruction and increase the left ventricular diastolic and stroke volumes are eligible to undergo a videoscope-assisted myectomy.

Reports on transatrial and transmitral myectomy[7,8] suggest that the transmitral approach has potential advantages over the transaortic approach. These advantages include a panoramic view of the septum, accessibility to the mitral valve subvalvular apparatus, and the ability to perform concomitant mitral valve procedures, if necessary. Reports on transatrial myectomy also advocate that the transmitral approach is much better than the transaortic approach, owing to a better view of the surgical field, which helps in training. In our opinion, videoscope assistance can help counteract the disadvantages of transaortic myectomy. As the surgeon and trainee can observe the left ventricular cavity very clearly with a videoscope, the process of training becomes more manageable. In our opinion, as the transmitral approach involves a long incision and suture line on the left atrium and the anterior leaflet of the mitral valve, it can cause unwanted complications.[17] Thus, it should be performed in pediatric patients with a small aortic annulus and patients with combined intrinsic mitral valve abnormalities.[13]

This report is a nonrandomized comparative study with a small study group and relatively short-term follow-up. Further studies are required, with a more extensive study group and long-term follow-up with comparisons to other surgical techniques, such as the transapical or transmitral approaches, in cases with similar characteristics.

5 | CONCLUSION

VATAM is an effective surgical technique in patients with midventricular obstruction, diffuse left ventricular hypertrophy, and complex intraventricular abnormalities, such as an abnormal papillary muscle, abnormal chorda, and abnormal muscle bundle. In our opinion, using VATAM, the transapical or transmitral approach can be avoided in many cases.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

ETHICS STATEMENT

The Chung-Ang University Hospital Institutional Review Board (IRB No. 2009-001-19330) approved this study, and the requirement for written informed consent was waived because of the minimal risk of this observational study.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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