Cirugía Cardiovascular 32 (2025) 295–298

Special Article

Transapical beating-heart septal myectomy, a game changer in the treatment of obstructive hypertrophic cardiomyopathy: The Wei operation

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ARTICLE INFO

Article history:
Received 5 March 2025
Accepted 16 April 2025
Available online 9 May 2025

Keywords:
Hypertrophic obstructive cardiomyopathy
Septal reduction therapy
Transaortic septal myectomy
Transapical beating heart myectomy

ABSTRACT

The gold standard in the treatment of hypertrophic obstructive cardiomyopathy is transaortic surgical myectomy, a technique with a proven 60-year track record, which eliminates obstruction and improves symptoms and, therefore, functional capacity and with established cost-effectiveness. Newer pharmacological agents such as myosin inhibitors are now being tested in clinical practice. A surgical alternative has recently been introduced, transapical beating-heart septal myectomy. This approach has the same goals as transaortic myectomy and offers additional advantages such as its minimally invasive nature, as no cardiopulmonary bypass and cardiac arrest are needed, together with a real-time assessment of resection with intraoperative transesophageal echocardiography. Time is needed, however, surgical treatment of patients with an appropriate indication for septal myectomy will benefit from this newly introduced procedure.

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La miectomía septal transapical a corazón latiente, un cambio de paradigma en el tratamiento de la cardiomiopatía hipertrófica obstructiva: la operación de Wei

Palabras clave:
Cardiomiopatía hipertrófica obstructiva
Terapia de reducción septal
Miectomía septal transaórtica
Miectomía transapical a corazón latiente

RESUMEN

El patrón-oro en el tratamiento de la cardiomiopatía hipertrófica obstructiva es la miectomía septal transaórtica, una técnica con 60 años de seguimiento, que elimina la obstrucción y mejora los síntomas y, por tanto, la capacidad funcional. Tiene, además, un coste-eficiencia establecido. Nuevos agentes farmacológicos como los inhibidores de la miosina, esta, siendo evaluados en clínica. Una alternativa quirúrgica recientemente introducida, es la miectomía apical a corazón latiente. Este abordaje persigue los mismos objetivos que la miectomía transaórtica pero ofrece ventajas adicionales como ser una técnica de mínima invasión, sin requerir circulación extracorpórea ni oclusión aortica y con el añadido de una evaluación inmediata del efecto de la resección muscular con ecocardiografía transesofágica intraoperatoria. Se necesita tiempo, si bien el tratamiento quirúrgico de los pacientes con una indicación apropiada para miectomía septal se beneficiarán de este nuevo procedimiento.

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Introduction

The gold standard in the treatment of hypertrophic obstructive cardiomyopathy (HOCM) is transaortic surgical septal myectomy (SM) in all its variants.[1,2] Since the first cases reported by Morrow et al.,[3] and although the basic process of the disease was initially considered not amenable to surgical correction,[4] SM has become the most effective approach to treat these patients with obstruction of the left ventricular outflow tract (LVOT) across the spectrum of ages.[5–7] Furthermore, its cost-effectiveness is also clearly established considering that SM is very likely the cheapest operation ever designed and practiced in cardiac surgery which offers fewer hospital readmissions and lower follow-up mortality, especially in comparison with the other widely accepted septal reduction therapy, alcohol septal ablation.[8] Furthermore, this operation achieves the relief of left ventricular outflow tract and, subsequently, relief

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https://doi.org/10.1016/j.circv.2025.04.003
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of symptoms.[1,2] The goal of this brief communication is to summarize the key aspects of this novel surgical approach and placing it in the current context of surgical septal reduction therapy for HCOM.

Transaortic septal myectomy

Transaortic SM is performed through median sternotomy and on cardiopulmonary bypass under cardioplegic arrest. The classical Morrow operation and its variants allow for a resection of the subaortic septum, being the subaortic the most common phenotype of HOCM. Although this approach may be not enough to address midventricular obstruction and apical obliteration, or associated abnormalities of the mitral valve.[9] Furthermore, other concomitant procedures are necessary in the presence of atrial fibrillation.[10] Notwithstanding, excellent outcomes have been reported with transaortic SM in midventricular obstruction.[11] Although with a track record of six decades, transaortic SM has also some drawbacks such as a restricted operating field which may be challenging in small aortic roots and that in the arrested heart, as it is not possible to check under real-time the outcome of resection. This is why a second pump may be required for additional muscular resection or for the correction of residual mitral insufficiency. Besides all this, SM is not an easy operation to teach precisely because of the restrictive transaortic access. The learning curve for transaortic SM is usually long and aims at avoiding major complications that are infrequently seen such as complete heart block, ventricular septal defect, or injury to the aortic or mitral valves.[12] This has rendered septal myectomy an operation poorly disseminated worldwide, leaving many patients not receiving optimal treatment.[13] In addition to the limited surgical expertise, the advent new pharmacological therapies further impact the survivability of this great operation.

Despite the documented success of SM for relief of obstruction and improvement of symptoms, a variety of obstructive phenotypes and apical aneurysms need an additional ventriculotomy approach. Although in centers of excellence morbidity and mortality are also in the low range when using this more aggressive approach, complications are slightly more frequent but extended resection also achieves optimal results with regards functional status after resection.[14,15] As of today, SM continues to be the gold standard in the treatment of HOCM. Other established septal reduction therapies such as alcohol septal ablation or even heart transplantation have specific indications and achievements.[16] The role of the newer myosin inhibitors in obstructive forms needs to be tested over time.[17]

Transapical beating-heart myectomy

With all this in mind, a newer surgical approach is being tested now. After its feasibility was confirmed in the pig model,[18] transapical beating-heart septal myectomy (TA-BSM) was introduced in clinical practice very recently. The first series of 47 patients was published in 2023[19] with excellent outcomes with regards relief of obstruction, no persistent obstruction and very low complication rate and functional status at three postoperative months. In the past couple of years, the experience of this Chinese group, the Tong Ji Hospital from Wuhan led by Wei Xiang, has rapidly progressed and the clinical experience is currently over a thousand operations. The indications have slowly expanded and currently include recurrent LVOT obstruction after previous septal reduction therapy[20] or apical hypertrophic cardiomyopathy.[21]

Transapical beating-heart myectomy is performed through a small left thoracotomy through the fifth intercostal space. Transthoracic echocardiography is always performed to accurately locate the apex of the heart. The thoracotomy may be occasionally performed through the six interspace (Fig. 1a, b). The apex

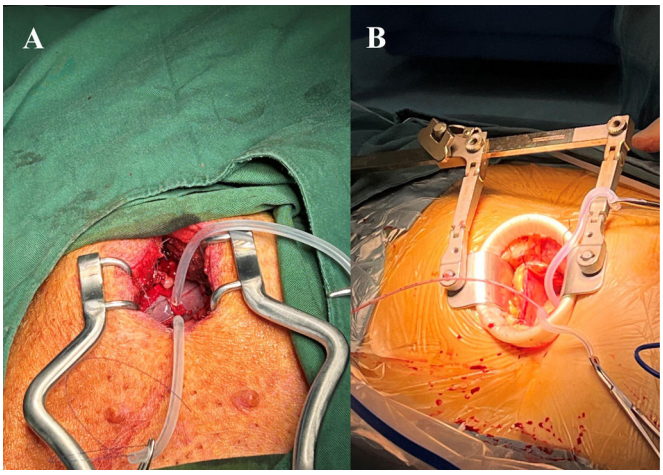

Fig. 1. (A) Subxyphoid approach. Pig model. (B) Small left thoracotomy. Clinical case. Transapical guidewire.

is approached and a double circumferential 3/0 polypropylene purse-string pledgeted sutures placed in the apex and secured with snares. This will ensure the introduction of a pressure line, the dilatation of the apex for insertion of the resection device and procedural hemostasis. Myectomy is performed using a specifically designed surgical instrument, called the BMD device (Wuhan Weixintan Medical Technology Co Ltd, Wuhan, PRC). This instrument is based on the length of the resection window and the diameter of the sleeve tube and is manufactured in a variety of sizes 11/30, 11/40, 13/30, and 13/40 mm according to length and diameter. Its characteristics have been described.[20,21] Due to its design, the resected muscle is unlikely to embolize as it is retrieved from the ventricular cavity in a closed chamber (Fig. 2a–c). This is another major difference with transaortic SM due to the specifics of the operation.

Resection is always TEE-guided. Midesophageal long-axis and transgastric short-axis views are continuously swapped. The sequence of resection starts at the basal septum around 5 mm beneath the aortic valve to the midpoint of the septum. Further resections will follow under TEE with clockwise rotation from the first resection point. This entails rotation that may vary between 60 and 120°. Additional resection may be required and the number of resections will vary from patient to patient. Coordination between the surgeon and the anesthetist is key for success.

The LVOT gradient, the morphology of the septal bulge, the grade of mitral insufficiency, and the remaining thickness of the target septum are evaluated after every resection. This is why the role of TEE cannot be underemphasized as it allows real-time intraoperative assessment. A provocation test is finally performed and will indicate also if additional resections are required.

Similarities and differences

In essence, the goal of TA-BSM is exactly the same as of conventional transaortic SM. These are two different approaches to achieve the same goal which is the elimination of LVOT obstruction and of mitral regurgitation secondary to anterior leaflet motion of the mitral valve (SAM). This results in functional improvement and extended life expectancy.

There are differences between approaches. Transaortic myectomy is performed through median sternotomy with the aid of cardiopulmonary bypass and cardioplegic arrest, which allows for a thorough examination of the aortic valve and root and the subaortic septum and LVOT. Transapical beating-heart myectomy, just as its name indicates, is performed through a limited left anterior fifth interspace thoracotomy without cardiopulmonary bypass, with the

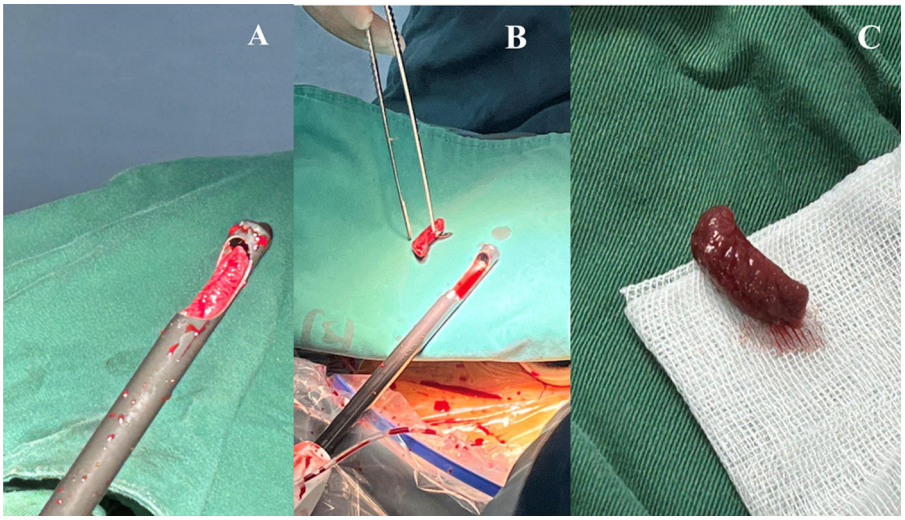

Fig. 2. (A) Resected muscle within the sleeve tube of the resection device. (B) Resected muscle removed from the sleeve tube. (C) Surgical specimen.

heart beating. There is nothing new in this access as the transpical approach has been used for more than one hundred years and for a variety of indications and procedures,[22–24] improving hemodynamics through a large unimpeded apical flow.[25] Transapical approach is safe and has been well analyzed.

As cardiopulmonary bypass and cardiac ischemia are avoided, this signals a less aggressive surgical trauma with its associated expected advantages. One of the most significant features of TA-BSM is the ability to assess the immediate outcome of septal resection in real life. Transesophageal echocardiography is a fundamental tool for success as the coordination between the operating surgeon and the anesthesiologist or sonographer is of critical value for the outcome of the procedure. Real-time echocardiographic guidance allows for an individually tailored septal resection. The benefits are obvious as the number of resections required and the immediate assessment of hemodynamics and mitral valve function is performed before the patient leaves the operating room.

Furthermore, TA-BSM has the advantage that it can deal with all HOCM septal phenotypes, subaortic, midventricular and apical, especially when no abnormalities of the mitral valve are present. This makes this approach an appealing alternative for a substantial proportion of patients suffering from HOCM.[26-28]

Outcomes and prospects for the future

As of today, surgical experience with TA-BSM is confined to the institutional experience of the Tong Ji group led by Wei. Current reported experience yields promising outcomes in relation to intraventricular gradient and subsequent improved hemodynamics and low perioperative complications with morbidity and mortality comparable to that of classical SM. The initial experience confirms device success is reported at almost 98%, an average resected muscle of 4.1 g with 4 resections. As expected, around 40% of the patients had a postoperative pattern of left bundle branch block. Mortality and major complications such as ventricular septal defect, valve injury or permanent pacing and apical complications are all in the range of 1% or less.[19,20] The currently reported outcomes have shown that through this novel approach guideline desired outcomes for septal reduction therapy are fulfilled, if not improved.[26-28]

The still scanty cumulative experience, likely over one thousand patients at the moment, suggest that this procedure that we can term the Wei Operation, is likely to have an impact on practice worldwide, targeting a substantial proportion of HOCM patients and not restricted to the classical subaortic phenotype. A nationwide prospective randomized trial is currently ongoing in China, with the participation of 10 large-volume HOCM centers. Once the outcomes are released and regulatory issues overcome, this may open the door for European and American approval. Until then, all the information confirms TA-BSM as a solid alternative to classical transaortic SM.

Although the concept of TA-BSM sounds comprehensible and easy, and as in the case of transaortic SM, it is not to be neglected that both operations are not easy operations due to their characteristics. Transaortic SM evolves around a restricted intraoperative access with issues of space in the operating room that frequently precludes an appropriate vision for assistants and trainees, although one may argue that video assistance may help in improving visualization. On the other hand, TA-BSM is not an easy operation, requiring also substantial knowledge of the pathophysiology of the disease and familiarity with classical transaortic SM. The surgeon-anesthesiologist coordination is critical during the procedure and requires manual and intellectual skills to avoid inappropriate or incomplete resection. The value of the real-time assessment of the outcome is of major advantage for the operators and the patient.

Considering these issues, both operations are not easy to teach and a variety of approaches to teach them are already described.[14] The transaortic SM and TA-BSM have an associated non-neglectable learning curve. Selection of patients and selection of morphology might have an impact on early departmental outcomes. At the moment, recently published data suggest that for TA-BSM and an appropriate low-risk morphology, the minimum competence level can be estimated in the range of 44 cases, as it has been the case of single Spanish surgeon who has been monitored with this regard.[29] This looks as an achievable cutoff value in experienced centers and may help to disseminate such a novel surgical approach in the future. Whichever options available, and with the exception of venting the left ventricle, basic commandments should be followed in TA-BSM aiming at achieve the most benefit for the patient.[30] Transaortic SM and TA-BSM support the evidence that contrary to the widespread misconceptions regarding surgery for HOCM, SM in these variants is an extremely safe and effective operation.[18]

It is still too early for a widespread adoption of this transapical approach but it seems that the surgical treatment of patients with an appropriate indication for SM will benefit from this newly introduced procedure, TA-BSM or the Wei Operation.

Authors' contribution

The authors are responsible for conceptualization and writing.

Ethics committee approval

This contribution did not require Ethics Committee approval as it does not deal with patients.

Human and animal rights statements

Not applicable.

Generative AI

This article was written without the help of Artificial Intelligence.

Funding

No funding required for this contribution.

Conflicts of interest

No conflicts of interest with this contribution.

Data availability

All what is disclosed in this contribution is publicly known.

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