CASE REPORT
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Ozaki procedure. Initial experience in a Mexican Pediatric Heart Center

Procedimiento de Ozaki. Experiencia inicial en un Centro Mexicano de Cardiología Pediátrica en México

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ABSTRACT

This article reviews the Ozaki procedure, its surgical indications, a description of our surgical technique, and the clinical outcome in a pediatric patient. The objective is to report the first case of the Ozaki procedure in a pediatric patient at our institution.

Keywords: aortic valve repair, Ozaki procedure, autologous pericardium, aortic valve neocuspidization (AVNeo).

RESUMEN

El presente artículo realiza una revisión del procedimiento de Ozaki, sus indicaciones operatorias, la descripción de nuestra técnica quirúrgica y el resultado clínico en un paciente pediátrico. El objetivo es reportar el primer caso del procedimiento de Ozaki en un paciente pediátrico en nuestra institución.

Palabras clave: *reparación de la válvula aórtica, procedimiento de Ozaki, pericardio autólogo, neocuspidización de la válvula aórtica (AVneo).*

Abbreviation:
AVNeo = aortic valve neocuspidization

INTRODUCTION

Aortic valve disease in the pediatric group presents several surgical challenges in order to preserve the valve as long as possible until adulthood. Techniques such as commissurotomy, annuloplasty, cusp free edge unfolding, and supra-aortic crest enhancement have yielded promising results in adult populations.[1] However, balloon valvuloplasty and the Ross procedure are well-established options for pediatric patients. The Ross procedure is criticized for converting single-valve disease into two-valve pathology and causing neo-aortic dilatation and technical complexity. Consequently, a reproducible procedure that maintains optimal hemodynamics without anticoagulation and mitigates the challenges associated with the Ross procedure is warranted.

In 2011, Shigeyuki Ozaki pioneered the aortic valve neocuspidization (AVNeo) procedure, initially describing its

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application in a cohort of adult patients with diverse etiologies, including aortic stenosis, infective endocarditis, prosthetic valve endocarditis, and annulo-aortic ectasia.[2] In contrast, pediatric aortic valve disease poses distinct challenges due to its often-congenital origin, necessitating consideration of the dynamic interplay between the developing aortic root and leaflets as the child grows. This ontogenetic factor critically influences the selection of an optimal procedure, tailored to the patient's age and aortic anatomy. Notably, the Ozaki procedure's utilization of autologous pericardium confers several advantages, including enhanced tissue durability, reduced immunogenicity, and a mitigated risk of calcification, thereby underscoring its potential benefits in pediatric patients.

These factors collectively contribute to the durability and resilience of the reconstructed valve, thereby enhancing its long-term functionality.[3] The standard technique can be tailored to accommodate diverse patient profiles, including those with prior aortic valve replacement, pediatric patients, and individuals with congenital aortic valve disease, encompassing a range of valve morphologies, such as unicuspid, bicuspid, and quadricuspid valves. Notably, the predominant pathology in older adults is typically acquired calcific aortic stenosis, often associated with bicuspid valves, whereas in young pediatric patients, congenital aortic valve stenosis with regurgitation secondary to balloon aortic valvuloplasty is more prevalent. Irrespective of the patient population, thorough excision of existing leaflets and fibrotic calcification or previously implanted valves enables the unrestricted application of the AVNeo procedure, unencumbered by native commissural architecture, cusp number, size, or position.[4] A crucial aspect of the procedure involves the utilization of glutaraldehyde, a potent aldehyde with fixative and preservative properties, which facilitates effective cross-linking of collagen, the primary structural component of valvular tissue, thereby conferring enhanced stability and durability.[5]

In an *ex-vivo* porcine model study conducted in Germany, researchers investigated the hydrodynamic performance and cusp kinematics of the Ozaki aortic valve in comparison to native and prosthetic aortic valves. The results demonstrated that both the Ozaki and native aortic valves exhibited comparable and significantly larger orifice areas than all prosthetic valves tested, particularly at high flow rates, with no discernible difference between the Ozaki and native valves. Moreover, the native aortic valve and Ozaki valve displayed a similar increase in effective orifice area in response to increasing flow rates, whereas prosthetic valves showed a notably weaker response. Cusp kinematics were also comparable between native and Ozaki valves, whereas prosthetic valves exhibited distinct differences. These findings led to the conclusion that the Ozaki valve exhibits physiological behavior in multiple aspects, which may potentially contribute to favorable clinical outcomes.[6]

CASE REPORT

We present the case of a 14-year-old female patient with Turner syndrome. She had a history of a heart murmur, detected at age seven. A diagnosis of aortic stenosis was made, and she underwent two balloon dilations via cardiac catheterization at ages 7 and 9. At follow-up, the patient presented with both stenosis and insufficiency. She was followed by endocrinology and was managed with somatropin. Clinically, she presented with dyspnea on heavy exertion. Her weight was 39.7 kg, height was 144 cm, and saturation was 96%. Physical examination revealed an expulsive systolic murmur in a IV/VI aortic foci. Chest X-ray showed a cardiothoracic ratio of 0.43. The electrocardiogram was in sinus rhythm, showing evidence of left ventricular hypertrophy. The echocardiogram reported bicommissural aortic valve with a mean gradient of 55 mm Hg, mild to moderate aortic regurgitation, aortic annulus 18.8 mm, and dilated coronary sinus *(Fig. 1)*. Surgical treatment was decided for aortic valve repair versus mechanical prosthesis implantation. A median sternotomy and central

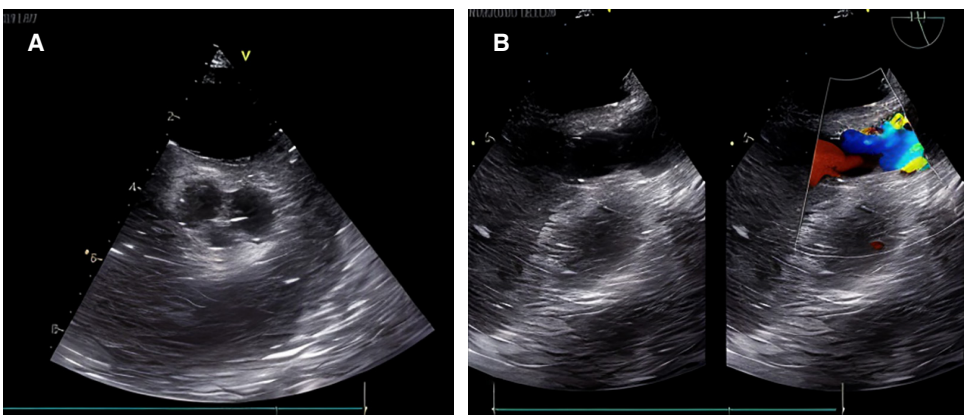

Figure 1:

A) Preoperative short axis echocardiogram of the aortic valve. **B)** Preoperative parasternal long axis of aortic valve.

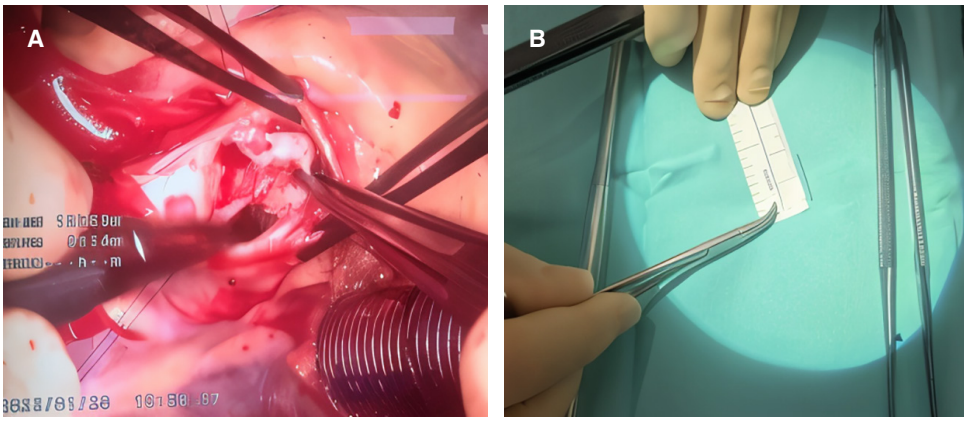

Figure 2:

A) Aortic valve stenosis with commissural fusion. **B)** Measuring cusps and commissures with silk.

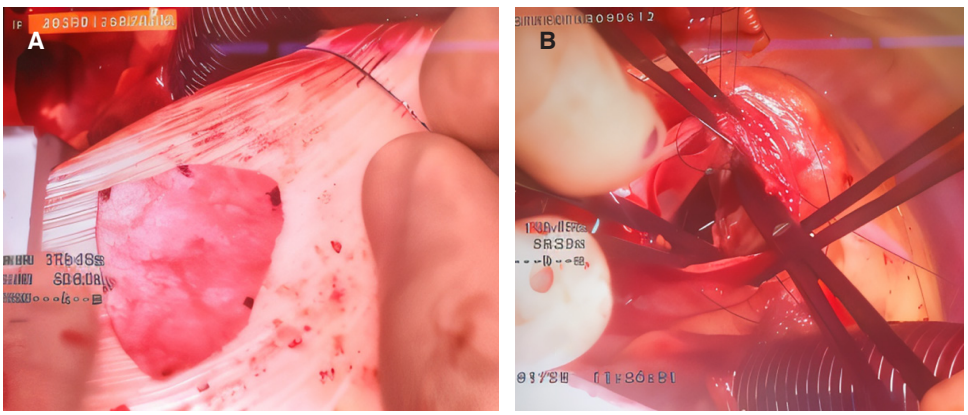

Figure 3:

A) Construction of neo-leaflet with autologous pericardium. **B)** Anastomosis of neo-leaflet to the aortic ring.

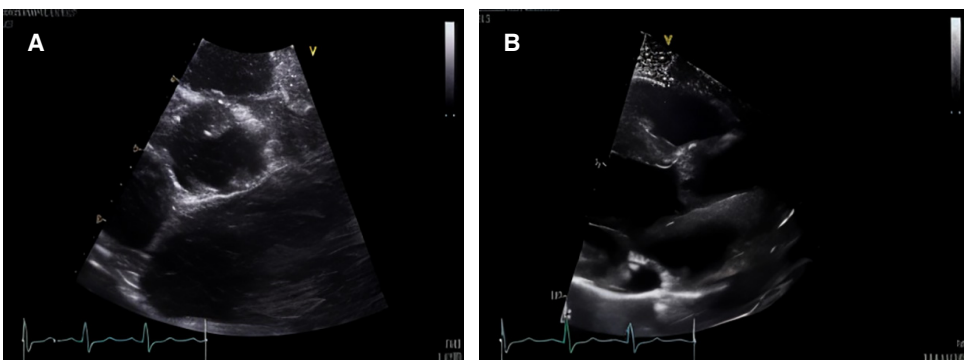

Figure 4:

A) Final result, short axis echocardiogram. **B)** Long axis without evidence of insufficiency on Doppler.

aortic and right atrial appendage cannulation were performed, cardiopulmonary bypass at 32 degrees Celsius, aortic cross-clamping was performed and cold blood cardioplegia was infused. An aortotomy was performed and a bileaflet aortic valve was observed, with fusion of the right coronary and non-coronary leaflets, finding a thick raphe between them. The edge of both leaflets was thickened with very little mobility *(Fig. 2A)*. A commissurotomy was performed, the edges were thinned, and the left coronary leaflet rupture site (caused by balloon dilation) was repaired with an autologous pericardial patch. The result was examined and found to be suboptimal. The leaflets were resected, and the distance between the commissures, cusps, and nadir of the annulus was measured individually with 2-0 silk *(Fig. 2B)*. Subsequently, the cut points on the pericardium were marked, and each neo-leaflet was constructed with glutaraldehyde-treated pericardium *(Fig. 3A)*. A pericardial template was not available at our institution, and the neocusp was sutured to the aorta with 5/0

monofilament *(Fig. 3B)*. The postoperative echocardiogram showed preserved biventricular systolic function, without residual aortic stenosis or valvular regurgitation, and a velocity of 1.6 m/s *(Fig. 4)*. Cardiopulmonary bypass time was two hours 49 minutes. Aortic clamping time was two hours 14 minutes. Protamine was administered and the cannulas were removed, the sternum was closed, and atrial and ventricular pacemaker leads and mediastinal drainage were placed. The patient was transferred to intensive care and extubated within the first 24 hours without complications. The patient was discharged from the hospital on the 6th postoperative day.

COMMENT

The Ozaki procedure has yielded promising outcomes in pediatric patients to date. The AVNeo technique entails the complete excision of anomalous cusps and their individualized replacement with autologous pericardium. However, the long-term behavior of these neocusps in growing individuals remains uncertain, particularly with regard to the potential for progressive aortic regurgitation in patients with conotruncal anomalies who lack annular stabilization.[7] A meta-analysis conducted by Halder et al.[8] reported a notable absence of reoperation or moderate to severe aortic regurgitation in pediatric patients who underwent the Ozaki procedure. In contrast to the Ross procedure and other interventions for aortic valve disease, the Ozaki procedure appears to confer a lower risk of reoperation and mortality. Nonetheless, further longitudinal data are warranted to comprehensively assess the durability and efficacy of the Ozaki procedure in children.

CONCLUSIONS

The Ozaki procedure should be considered in the surgical treatment of aortic valve disease in children, as it offers very favorable hemodynamics with excellent postoperative results. Long-term results remain to be evaluated to determine the durability of the procedure.

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