ORIGINAL ARTICLE

Functional Anatomy of Aortic Regurgitation. Role of Transesophageal Echocardiography in Aortic Valve-Sparing Surgery

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Introduction and objectives. The aim was to evaluate the usefulness of transesophageal echocardiography (TEE) for the preoperative functional anatomical assessment of patients with aortic regurgitation (AR) to identify those eligible for valve-sparing surgery (VSS).

Methods. We determined the accuracy and diagnostic value of TEE for identifying underlying lesions and mechanisms in 66 patients who underwent surgery for severe AR by comparing TEE findings with those obtained on surgical inspection. The usefulness of TEE for predicting the feasibility of VSS was determined.

Results. The overall diagnostic accuracy of TEE was excellent (87%, kappa=0.82), with valve prolapse being the principle cause of discrepancy between the methods (in 23/27 cases; 85%). Three anatomical forms of dilatation of the ascending aorta (AA) were correctly classified (accuracy >88%; kappa 0.83): supratubal aneurysm (19 patients), aortic root aneurysm (4), and annuloaortic ectasia (24). The mechanism underlying AR was identified with an accuracy of 85% (kappa 0.8) and there was a significant association between the type of mechanism identified by TEE and the success of VSS (*P*<.001): VSS was successful in 73% of patients with dilatation of a functional annulus (i.e. with tethering), but aortic valve replacement was required in 78% with prolapses, 90% with thickened leaflets with restricted movement, and 100% with perforation. There was also a relationship between the type of aneurysm and the technique required for AA replacement (*P*=.004).

Conclusions. Use of TEE enabled the mechanism underlying AR to be accurately identified. There was a high level of agreement with surgical inspection and the technique was useful for predicting the feasibility of VSS and the surgical procedure for AA replacement.

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Anatomía funcional de la insuficiencia aórtica. Papel de la ecocardiografía transesofágica en la cirugía conservadora de válvula aórtica

Introducción y objetivos. Intentamos determinar el papel de la ecocardiografía transesofágica (ETE) en la descripción preoperatoria de la anatomía funcional de la insuficiencia aórtica (IAo) para identificar candidatos a cirugía conservadora (CCVAo).

Métodos. En 66 pacientes intervenidos de IAo severa se determinan precisión y valores diagnósticos de la ETE en la descripción de lesiones y mecanismos, empleando la observación quirúrgica como referencia. Se valora la utilidad de la ETE para predecir aplicabilidad de técnicas de CCVAo.

Resultados. La exactitud diagnóstica general de la ETE es excelente (87%, índice kappa = 0,82); el prolapso presenta la principal discrepancia (23/27 casos; 85%) entre los métodos. Tres formas anatómicas de dilatación de aorta ascendente (AA) fueron correctamente clasificadas (precisión, > 88%; kappa = 0,83): aneurisma de AA supratubular (19), aneurisma de raíz (4) o anuloectasia aórtica (24). La precisión en el diagnóstico del mecanismo fue del 85% (kappa = 0,8) y éste presentó una asociación significativa con el éxito de la CCVAo (p < 0,001) en el 73% de los casos de dilatación de los anillos funcionales *(tethering).* El 78% de prolapsos, el 90% de movimiento restrictivo de velos engrosados y el 100% de perforaciones requirieron sustitución valvular aórtica. Las formas de aneurisma también se relacionaron con el procedimiento de sustitución de AA (p = 0,004).

Conclusiones. La ETE permite una descripción precisa de los mecanismos de la IAo, tiene una elevada tasa de acuerdo con las observaciones quirúrgicas y predice adecuadamente la aplicabilidad de la CCVAo y el procedimiento de sustitución de AA.

Palabras clave: *Insuficiencia aórtica. Aorta. Ecocardiografía transesofágica. Reparación valvular.*

ABBREVIATIONS

AA: ascending aorta
AoR: aortic root
AR: aortic regurgitation
STJ: sinotubular junction
SV: sinuses of Valsalva
TEE: transesophageal echocardiography
VSS: valve-sparing surgery

INTRODUCTION

The past twenty years have seen the growing range of valve lesion etiologies turn nonvalvular conditions into the primary causes of aortic regurgitation (AR) in Spain.[1] Valves present relatively small lesions of the leaflets and concomitant dilatation of the ascending aorta (AA) with AR that can be explained thanks to our improved knowledge of the aortic root's (AoR) role in valve function.[2] The geometric relations and dynamic behavior of AoR components have been seen to ensure valve competence when leaflets have no structural lesions.[3] The sinuses of Valsalva (SV), sinotubular junction (STJ), and commissures are highly specialized structures: a genuine "supravalvular" aortic apparatus.[4,5] Consequently, in AA aneurysms that have evolved over a lengthy period, when geometric changes that distort the insertions of the leaflets occur, the conditions under which these open and close are modified rendering them incompetent.[6] In response to this, valve-sparing surgical (VSS) techniques have been developed in aortic aneurysm surgery. Furthermore, interest in AR repair has increased to the point when it is currently offered as an alternative to valve replacement with prostheses.[7,8] Until now, decisions on VSS and/or valve repair in AR have been based on the anatomical lesions found by the surgeon in the operating theater, with the patient in induced cardiac arrest and the aorta empty. However, the development of intraoperative transesophageal echocardiography provides a real-time view of the aortic root and valve before thoracotomy.[9] Our objective is to conduct in vivo analysis of AR functional anatomy using transesophageal echocardiography (TEE). We aim to describe the underlying lesions and mechanisms, study the diagnostic precision of TEE by comparison with direct surgical inspection, and establish its value in identifying optimal candidates for aortic VSS.

METHODS

Study Population

We operated on 335 consecutive patients diagnosed with aortic valve disease and/or AA dilatation at our center between January 2002 and January 2005. In the present study, we have included 66 who met the following criteria: *a)* isolated grade ≥2 AR with <25 mm Hg mean transvalvular aortic gradient measured by Doppler echocardiography; *b)* indication for surgery on the grounds of severe AR or proximal aorta dimensions; *c)* surgical exploration with aortotomy and direct, independent surgical inspection of lesions; and *d)* availability of the customary preoperative or intraoperative transesophageal echocardiography study. We excluded patients undergoing urgent surgery for AR or presenting acute aortic syndrome. We excluded no patients on grounds of age, left ventricular dysfunction, chronic AR cause or concomitant mitral valve or coronary artery surgery.

Surgical Anatomy of Aortic Regurgitation

Anatomical lesions were diagnosed according to previously established criteria for direct and macroscopic inspection.[10] Descriptions of lesions and mechanisms were transcribed, unaltered, from surgeon's reports or by one of the authors (PGG) based on personal communications provided by the surgeon when conducting a surgical inspection.

Systematic inspection of the AoR was conducted in all cases. Surgeon's reports provided data on: the anatomical form of AA dilatation, number of cusps, leaflet lesions (calcification, commissural fusion and thickening indicating rheumatic disease, lineal fenestrations and thickening of the free border of the commissures, vegetations or perforations, absence of structural lesion and prolapse), flap or dissection and aorta wall rupture.

The surgeon classified underlying mechanisms of regurgitation in four groups: *a)* functional, if there is no organic lesion or prolapse but functional aortic annulus (STJ and/or annulus) dilatation exists, as in patients with AA or AoR aneurysm; *b)* restrictive leaflet movement with quite extensive macroscopic structural lesions; *c)* perforations; and *d)* prolapse, defined by differences in the free border length of each leaflet, when 1 or 2 of these exceed the rest. Prolapse is subclassified as absolute (the leaflet free border is below its insertion in the SV wall) and relative (the leaflet free border is at the same level as its insertion in the SV wall but below the level of the free border of the remaining leaflets).

Although surgeons knew echocardiographic studies were being conducted they were unaware