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CLINICAL RESEARCH

Usefulness of 3-Tesla cardiac magnetic resonance imaging in the assessment of aortic stenosis severity in routine clinical practice

Apport de l'IRM cardiaque 3-Tesla pour l'évaluation de la sévérité de la sténose aortique en pratique clinique

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KEYWORDS
Aortic stenosis;
3-Tesla cardiac magnetic resonance

Summary
Background. — Recently, 1.5-Tesla cardiac magnetic resonance imaging (CMR) was reported to provide a reliable alternative to transthoracic echocardiography (TTE) for the quantification of aortic stenosis (AS) severity. Few data are available using higher magnetic field strength MRI systems in this context.
Aims. — To evaluate the feasibility and reproducibility of the assessment of aortic valve area (AVA) using 3-Tesla CMR in routine clinical practice, and to assess concordance between TTE and CMR for the estimation of AS severity.
Methods. — Ninety-one consecutive patients (60 men; mean age 74 ± 10 years) with known AS documented by TTE were included prospectively in the study.

Abbreviations: AS, aortic stenosis; AVA, aortic valve area; CMR, cardiac magnetic resonance imaging; CMRhk, CMR using Hakki's formula; CMRp, CMR with planimetry; TTE, transthoracic echocardiography.

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Results. — All patients underwent comprehensive TTE and CMR examination, including AVA estimation using the TTE continuity equation ($0.81 \pm 0.18\,cm^2$), direct CMR planimetry (CMRp) ($0.90 \pm 0.22\,cm^2$) and CMR using Hakki's formula (CMRhk), a simplified Gorlin formula ($0.70 \pm 0.19\,cm^2$). Although significant agreement with TTE was found for CMRp ($r = 0.72$) and CMRhk ($r = 0.66$), CMRp slightly overestimated (bias = $0.11 \pm 0.18\,cm^2$) and CMRhk slightly underestimated (bias = $-0.11 \pm 0.17\,cm^2$) AVA compared with TTE. Inter- and intraobserver reproducibilities of CMR measurements were excellent ($r = 0.72$ and $r = 0.74$ for CMRp and $r = 0.88$ and $r = 0.92$ for peak aortic velocity, respectively).
Conclusion. — 3-Tesla CMR is a feasible, radiation-free, reproducible imaging modality for the estimation of severity of AS in routine practice, knowing that CMRp tends to overestimate AVA and CMRhk to underestimate AVA compared with TTE.
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MOTS CLÉS
Sténose aortique ;
Imagerie par résonnance magnétique à 3 Tesla

Résumé
Contexte. — L'imagerie par résonance magnétique cardiaque à 1,5-Tesla a récemment été proposée comme alternative à l'échocardiographie transthoracique (ETT) dans l'évaluation de la sévérité de la sténose aortique (SA). Peu de données sont actuellement disponibles utilisant des IRM avec champs magnétiques plus intenses.
Objectifs. — Évaluer la faisabilité et la reproductibilité de la mesure de la surface aortique en utilisant l'IRM à 3-Tesla en pratique clinique, et la concordance entre la surface aortique estimée grâce à l'IRM 3-Tesla et en ETT.
Méthodes. — Quatre-vingt-11 patients consécutifs (60 hommes, d'âge moyen 74 ± 10 ans) porteurs d'une SA documentée en ETT ont été inclus prospectivement dans cette étude.
Résultats. — Tous les patients ont bénéficié à la fois d'une ETT permettant l'évaluation de la surface aortique par l'équation de continuité ($0{,}81 \pm 0{,}18\,cm^2$), d'une IRM 3-Tesla permettant une planimétrie directe (IRMp) ($0{,}90 \pm 0{,}22\,cm^2$) et une estimation de la surface aortique par la formule de Hakki (IRMhk) ($0{,}70 \pm 0{,}19\,cm^2$). Malgré des corrélations significatives avec l'ETT pour IRMp ($r = 0{,}72$) comme pour IRMhk ($r = 0{,}66$), IRMp surestimait significativement (biais = $0{,}11 \pm 0{,}18\,cm^2$) et CMRhk tendait à sous-estimer (biais = $-0{,}11 \pm 0{,}17\,cm^2$) la surface aortique par rapport à l'ETT. La reproductibilité inter-et intra-observateur étaient excellentes pour les mesures en IRM ($r = 0{,}72$ et $r = 0{,}74$ for IRMp, $r = 0{,}88$ et $r = 0{,}92$ pour le pic de vélocité aortique, respectivement).
Conclusions. — L'IRM à 3-Tesla est une modalité non irradiante, fiable et reproductible pour l'évaluation de la sévérité d'une sténose aortique en pratique clinique, en sachant que l'IRMp a tendance à surestimer la surface aortique et IRMhk à la sous-estimer par rapport à l'ETT.
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Background

Aortic stenosis (AS) is the most common form of acquired valvular heart disease, and its prevalence is expected to increase in Western populations. Transthoracic echocardiography (TTE) classically confirms the diagnosis and assesses the severity of AS. Proper visualization of aortic valve anatomy, including calcification and opening, together with haemodynamic measurements are mandatory to assess the severity of AS [1]. Nevertheless, the accuracy of a TTE examination may be limited in patients with poor acoustic windows (mostly patients who are obese or have chronic pulmonary disease). Moreover, recent studies have reported discrepancies between mean transvalvular gradient and aortic valve area (AVA) in some patients [2], underlining the need for a multimodal approach in difficult cases.

Other imaging modalities, such as multidetector computed tomography and cardiac magnetic resonance imaging (CMR) might be helpful to complement or confirm the information obtained by TTE [3—10]. CMR provides unique morphological and functional information in this setting. Recently, CMR was reported to be a reliable alternative to TTE for the quantification of AS severity, using either direct planimetry of the aortic valve orifice or velocity-encoded CMR techniques. These previous studies [3—10] were all performed using 1.5-Tesla CMR systems. Magnetic resonance imaging systems with higher magnetic field strengths have become widely available, and 3-Tesla has become the favoured field strength for brain magnetic resonance imaging in clinical practice. 3-Tesla magnetic resonance imaging, with the use of parallel imaging, allows an increased signal-to-noise ratio, with faster acquisition, leading to potentially

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