Antecubital Transmission of Mechanical Aortic Valve Closure Sounds: Recognition of a Potential Source of Error During Blood Pressure Measurement

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Manual blood pressure measurement may be compromised by device malfunction, inadequate cuff size, improper technique, auscultatory gap, and arterial disease. This report describes a case in which blood pressure measurement was complicated by the presence of audible transmitted sounds from a mechanical aortic valve prosthesis.

CASE REPORT

A 55 year-old Caucasian male patient was referred for evaluation of “marked systolic hypertension” noted on routine examination. The patient had a history of chronic essential hypertension (requiring medication), as well as history of congenital aortic stenosis, having undergone aortic valve commissurotomy for severe stenosis at age 10, with recurrence of severe stenosis, leading to aortic valve replacement (# 23 St Jude Medical Regent) 1 year before exam. The patient was maintained with chronic warfarin (target International Normalized Ratio 2.0 to 3.0), as well as antihypertensive therapy (lisinopril 40mg daily, carvedilol 25 mg twice daily, and hydrochlorothiazide 12.5 mg daily).

At the time of exam, the patient was asymptomatic and in no distress. Cardiac auscultation revealed a regular heart rate of 65, with a grade 2 systolic murmur heard along the aortic listening area, followed by a prominent aortic valve closure sound, consistent with normally functioning prosthesis. Manual blood pressure measurement was performed in both arms. Before cuff inflation, the patient was noted bilaterally to have an easily audible sound during each cardiac cycle, persisting to maximal cuff inflation (300 mm Hg). A bifid sound became audible at the point of cuff deflation to 132 mm Hg, persisting to deflation to 72 mm Hg, with a single sound present with further deflation. Automated blood pressure measurement immediately following manual measurement elicited a digital reading of 132/76 mm Hg.

Using a recording stethoscope (Thinklabs ds32a, Thinklabs, Centennial, CO) and digital recorder (Olympus WS-100; Olympus, Tokyo, Japan), audio files were created during manual antecubital blood pressure measurement, and during auscultation of the aortic listening region (upper right sternal border). Graphic display of recorded files was performed by sound editing program (Audacity).

Sound recording during cardiac auscultation (Figure 1 and Supplementary Video S1 online) displays a pattern of systolic flow murmur, followed by intense closure sound of the aortic prosthesis. Recorded display of antecubital auscultation during cuff deflation is shown in Figure 2 and Supplementary Video S2 online. At cuff inflation greater than automated systolic pressure measurement, a single sound per cardiac cycle corresponds to the occurrence of aortic prosthetic closure, representing transmission of the closure sound to the antecubital region. As cuff deflation reaches the level of automated systolic pressure, an additional sound becomes audible immediately before the aortic valve closure sound, consistent with the first phase 1 of Korotkoff sounds. With further deflation, the additional sound transitions to a relatively prolonged, turbulent noise which somewhat obscures the transmitted aortic closure (Korotkoff phase 2), then to a focal sound during late systole (Korotkoff phase 3). As cuff...
deflation approaches the automated measurement of diastolic pressure, the additional sound intensity decreases (Korotkoff phase 4), followed by disappearance of the additional sound at cuff inflation below diastolic pressure (Korotkoff phase 5).

DISCUSSION
In contrast to native and bioprosthetic heart valves, mechanical valve prostheses give rise to sounds which are normally loud and widely transmitted. A previous published report notes audible transmitted sounds from mechanical aortic valve prosthesis during antecubital auscultation to resemble Korotkoff sounds, leading to potential inaccuracy or uncertainty during auscultatory blood pressure measurement. Although this phenomenon (to my knowledge) is not documented in additional published studies, it is likely to be relatively common, due to the magnitude of sounds generated by currently implanted mechanical valve prostheses.

Because mechanical valve sounds are transmitted primarily via extravascular tissue and are thus unaffected by cuff pressure, audible transmitted valve sounds (in contrast to Korotkoff sounds) would persist throughout the entire process of cuff inflation and deflation. As a result, prosthetic aortic valve sounds (audible at cuff inflation levels greater than systolic pressure) may in particular lead to inaccurate diagnosis of systolic hypertension, or may conversely mask the presence of hypotension if incorrectly identified as Korotkoff sounds.

Accurate manual blood pressure measurement in patients with mechanical aortic replacement thus requires appreciation of the possibility of prosthetic sound transmission by healthcare professionals. In particular, this involves careful auscultation (in order to correctly detect Korotkoff sounds within the background of transmitted valve sounds), preceded by estimation of systolic pressure by arterial palpation during cuff deflation. As bileaflet tilting disks (currently representing the vast majority of implanted mechanical aortic prostheses) exhibit a predominant closure sound, blood pressure auscultation in such patients would exhibit a pattern of appearance, progression, and disappearance of a “second sound” (Karktokoff sound) immediately before the sound of aortic valve closure during cuff deflation in the event that audible valve sound transmission is present.

Supplementary material is linked to the online version of the paper at http://www.nature.com/ajh

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