**Mitral annular disjunction : a ubiquitous finding with or without mitral valvar prolapse**

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As is shown in the study of 224 hearts with so-called mitral annular disjunction,1 the wheel has now come full circle. Although now usually credited to having first been seen by Henle as long ago as 1876, it was Hutchins and his colleagues who brought the feature to attention as a potential harbinger of pathological change.2 The investigators working at Johns Hopkins Hospital had noticed the anatomical arrangement in their investigation of over 900 hearts coming to autopsy, and being examined using a standardised technique. They defined the feature as “a wide separation between the atrium-valve junction and the atrial aspect of the left ventricular wall”. Although they had examined a very large number of hearts, they had ascertained the presence or absence of their chosen feature by taking a solitary section “at the level of the obtuse margin of the left ventricle”. Disjunction at their chosen site was found in 23 of 25 hearts with mitral valvar prolapse, but in only 37 of the 664 hearts they deemed to be normal. One of us was then involved in a more detailed study,3 in which we examined histologically the entirety of the atrioventricular junction supporting the mural leaflet of the mitral valve. We found disjunction, as defined by Hutchins and colleagues,2 in similar proportions, and at similar sites, in both the hearts we studied with mitral valvar prolapse and the normal hearts. The group of morphologists working at the Jagiellonian University of Krakow, in Poland, have now extended their previous investigation of the normal mitral valve to assess the prevalence of such disjunction.1

As they comment, debates continue regarding the morphology of the mitral valvar complex, although to our eyes there is little difference in the accounts provided by the works they have referenced to support this statement. They cite two of their own works, and two recent works in which one of us was involved. We are now in agreement that the valvar complex is made up of the atrioventricular junction, the leaflets, the valvar tension apparatus, the papillary muscles, and the supporting left ventricular myocardium. We also agree that, when assessing the leaflets of the valve, it is possible to distinguish between the aortic and mural leaflets, although it is more usual to find these entities described as being “anterior” and “posterior”. When examined in attitudinally appropriate fashion, the adjectives “anterior” and “posterior” are not intriely accurate. In most, but not all, instances the mural leaflet is divided into three scallops, with additional areas of leaflet tissue to be found at the ends of the zone of apposition between the leaflets, these areas usually described as the commissures (Figure 1A). It is encouraging to note that, in their latest work, the Polish investigators now use attitudinally appropriate terminology, as had been recommended in one of our works cited by them.4 As we had emphasised, it is the use of terms describing the components of the valve as seen by clinicians during life that will best facilitate the correlations that will now be necessary to evaluate the significance of the findings on which the Polish investigators have focussed.1

Their study involves only normal hearts. Depending on longitudinal sections across the atrioventricular junction, as had Hutchins and colleagues, but sampling a larger number of sites, the Polish investigators have identified disjunction, which they defined as “a spatial displacement of the leaflet hinge

line toward the left atrial wall”, in one-fifth of their hearts. They conclude that the feature can be considered “an anatomical variant and a potential risk factor for adverse events”. This was exactly the same conclusion reached by Hutchins and colleagues.2 Hence our own comment that the wheel has turned full circle, and that we are revisiting old discussions. In their conclusions, the authors suggest that their study has provided “an in-depth morphometric (macroscopic and microscopic) analysis”. Is this strictly true? As was the case with Hutchins and colleagues, they have examined a large number of hearts. But how deep was their investigation, and did they identify all instances in which there was “a spatial displacement of the leaflet hinge towards the left atrial wall”?

In fact, they defined cases as showing disjunction only when the displacement was greater than 2 millimeters. They also cited the recent studies in which, using computed tomography, Toh and colleagues had identified disjunction in 96% of patients,5 and another study in which, using magnetic resonance, the same feature had been identified in 76% of almost 2,000 individuals.6 They explained the difference on the basis that both studies had used a cut-off point of 1 millimeter to identify disjunction. The Polish investigators justified the difference on the basis that, in their opinion, a distance of 1 millimeter was too small to be used “for imaging studies”. But surely disjunction, as defined, is disjunction irrespective of its length? Should they not also have informed us of the number of their hearts in which they found separation of at least 1 millimeter? They also argued that problems might arise in distinguishing between the aortic and mural leaflets of the mitral valve in the commissural areas. This is not a problem, however, that would have confronted those using the three-dimensional clinical imaging techniques. The authors also suggest that disjunction can only be identified during diastole. As was pointed out in one of the recent reviews in which one of us was involved, the feature described as “disjunction” is an anatomical entity, and as such will always be present. It is the relationship of the atrial wall relative to the area of disjunction that varies during the cardiac cycle.4

The investigators from Poland, nonetheless, are undoubtedly correct when making one of their comments in discussion. As they emphasise, the feature known as disjunction is interspersed around the circumference of the junction supporting the mural leaflet of the valve, and is also present in the commissural areas. Hence, as they rightly comment, three-dimensional imaging modalities are required accurately to examine the entirety of the mural leaflet and its commissures. As was pointed out in the review authored by one of us, the burgeoning technique of fusion of computed tomography with transesophageal echocardiography will provide such a technique.4 Additional techniques are at hand further to enhance the anatomical investigation of the mitral valve. One of us, along with teams at University College London and the European Synchrotron Radiation Facility, at Grenoble in France, is involved in the analysis of synchrotron images of the heart using hierarchical phase-contrast tomography, abbreviated to HiP-CT. This technique now makes it possible to provide three-dimensional reconstructions of whole adult hearts without the need to dissect them. The technique, furthermore, has the resolution to show the dimensions and arrangements of the junction not in terms of millimeters, but rather in terms of microns.7 The new technique could also prove invaluable in assessing the hearts from adults dying suddenly. Two of us have, over the past 15 years, established a national database with over 8000 hearts referred for investigation of sudden cardiac death.8 We can identify cases in which there is minor degrees of mitral valvar prolapse (Figure 1B). As yet, we have not assessed in detail the potential role of disjunction in underscoring the prolapse. We have noted, nonetheless, the presence of elongated tendinous cords supporting the prolapsing scallops, another potential substrate. The ability to analyse these hearts using HiP-CT would greatly enhance our efforts to establish the potential causes of sudden death.

We congratulate the Polish authors, therefore, on their extensive research. The time and effort involved in their assessment of over 200 hearts is impressive. It would seem that we have now resolved our debates regarding the overall morphology of the mitral valve. As regards the significance of so-called disjunction, however, there is still much to be done.

**Statement**

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**Legend to Figure**

Figure 1. The images show opened mitral valves, with panel A showing a normal valve, and panel B showing a heart from an individual dying suddenly, with minimal prolapse of the middle and supero-lateral scallops of the mural, or posterior, leaflet. The assessment of the valves is in keeping with the approach recommended by the Polish investigators.1 Note the presence of disjunction as shown by the chevrons in panel A, and the elongated cords supporting the prolapsing scallops in panel B (white arrows with red borders).