VIA MEDICA

ORIGINAL ARTICLE

Folia Morphol.
Vol. 60, No. 4, pp. 281–284

ISSN 0015–5659
www.fm.viamedica.pl

The anatomy of the tendon of infundibulum

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[Received 10 September 2001; Accepted 1 October 2001]

The heart, as we know, is a muscular tissue supported by collagenous structures forming the fibrous skeleton of the heart. A structure by the name of the tendon of infundibulum appeared in the literature with no definite information about its structure or even its existence. The tendon of infundibulum was described as a strip of fibrous tissue structure situated between the aortic root and pulmonary trunk. Our study involved 30, formalin fixed, adult human hearts ranging from 18 to 81 years. Classical macroscopic anatomical methods were applied to observe macroscopically all the connections between the aorto-pulmonary trunk, together with serial transverse histological sections, through roots of the aorta and pulmonary trunk, using eosin-hematoxylin and van Gieson staining. All the hearts seemed to encompass many fascial bands attended by connective tissue. However these fascial bands are not concrete structures and cannot be termed tendons. In our investigation we have been unable to demonstrate macroscopically or histologically any structure which could be significantly approximating to the initial description of the literature. However, as far as we are able to judge, the term tendon of infundibulum has erroneously been introduced into many medical textbooks since the literature cannot still prove its existence.

key words: aortic-pulmonary roots, fibrous skeleton, heart

INTRODUCTION

Knowledge of normal cardiac anatomy is indispensable for the proper understanding of cardiac disease, however many anatomical structures within the heart still remain inadequately investigated. One of these structures is the tendon of infundibulum. There have been many references revealing its presence and location between the aortic and pulmonary roots. Strangely enough, the presence or absence of such a tendon or ligament (conus tendon) has not been confirmed macroscopically or histologically nowadays and furthermore the function of such a tendon has not been yet established.

Interestingly, many medical textbooks and atlases [2, 6, 7] still keep using such terminology but on the other hand the presence or absence of such a structure has never been mentioned in the context of surgical procedures taking place on the ventricular outflow tracts. The aim of our study, therefore, was to determine the presence or absence of any fibrous structure, corresponding to the literature, between the aortic and pulmonary roots.

MATERIAL AND METHODS

We studied 30 human hearts collected at autopsies at the department of Forensic Medicine of Warsaw Medical University, from female and male subjects who died of no cardiovascular causes and in which no macroscopic pathological changes were found. The age of death ranged from 18 to 81 years. All the

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specimens were prosected and fixed in 10% formalin solution. All 30 specimens were examined externally prior to removing the perivascular fatty tissue where necessary to visualise the space between the aorta and pulmonary trunk. All specimens were afterwards dissected from the level of the sinutubular junction [8] and between the aortic and pulmonary roots, to detect the tendon of infundibulum. Special care was taken during the dissection to be able to visualise the space between the aortic and pulmonary roots from different planes.

Serial transverse histological sections were made through the roots of the aorta and pulmonary trunk, starting from the sinutubular junction to a few cm above the junction. Sections were stained with van Gieson stain and also eosin-hematoxylin stain to detect any fibrous band or structure connecting the aortic and pulmonary roots.

RESULTS

In all of our specimens no discrete fibrous structure could be identified either macroscopically or histologically in the space between the aortic and pulmonary roots (Fig. 1). However, fascial bands were demonstrated (Fig. 2) in almost all the specimens. The fascial bands were very well visualised between the aorta and pulmonary roots without any particular location or manner. In the histological examination, small tissue bands were identified by van Gieson and eosin-hematoxylin method (Fig. 3), extending from adventitia, running from the aorta or pulmonary trunk and interconnecting with each other. Furthermore the dissection between the aorta and pulmonary artery was taking place even deeper below the sinutubular junction, just at the level of the aortic annulus. The investigation to this point still did not reveal any fibrous structure connecting the aortic and pulmonary roots.

DISCUSSION

Mall [4] was the first author to describe the tendon of infundibulum as a part of the fibrous skeleton of the heart. He described it as a structure occupying the region between the right side of the aorta, opposite the right coronary cusp of the aortic valve below the right coronary artery, and the facing wall of the pulmonary trunk. However, the tendon of infundibulum, even before, was variously termed the conus tendon of Krehl, as described by Mall. Zimmerman and Bailey [8], in their paper of the surgical significance of the fibrous skeleton of the heart, said that the "Ligamentum of Conus" serves as a rope between the aortic and pulmonary roots, which permits a certain degree of torsional movement between them, while preventing them from being torn asunder by differentially directed ejaculatory forces of the

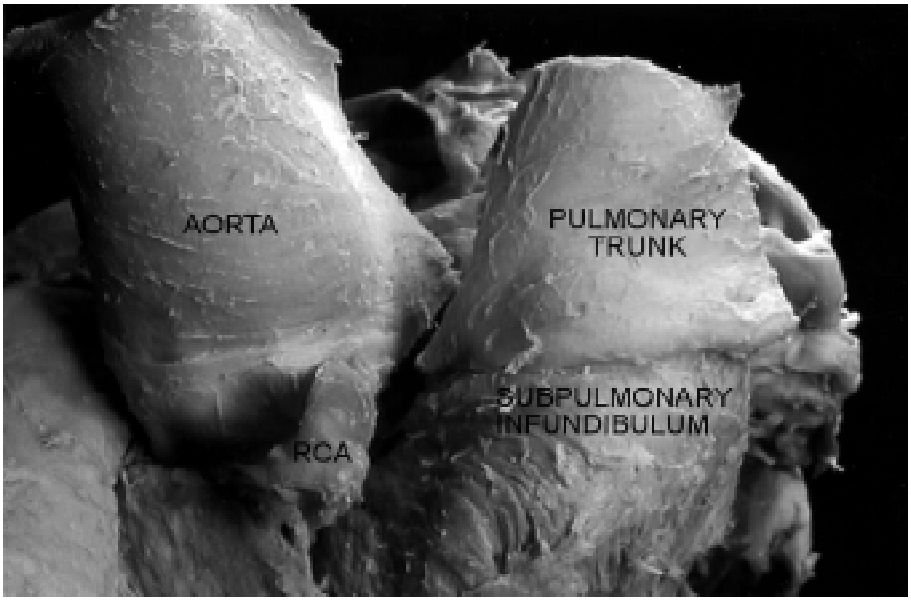

Figure 1. Aorta and pulmonary trunk as could be seen after the removal of all epicardial fat. Notice the space between the aorta and pulmonary trunk which appears to be undisturbed by any kind of tissue or tendon; RCA — right coronary artery, which has been dissected for dissection and better visualisation purposes.

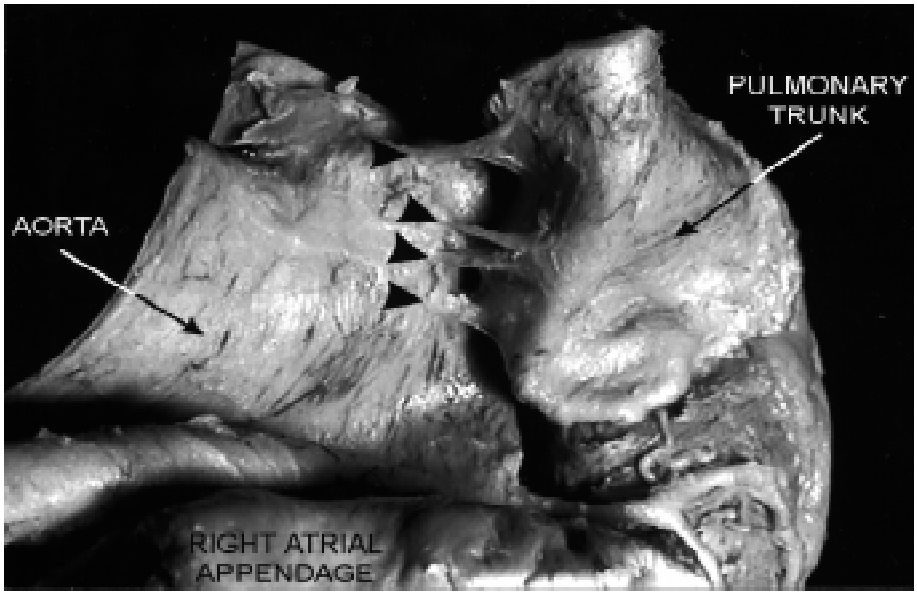

Figure 2. Aortic roots are viewed from superior. Notice the small arrows indicating the fascial bands, connecting with various attachments of aorta and pulmonary trunk.

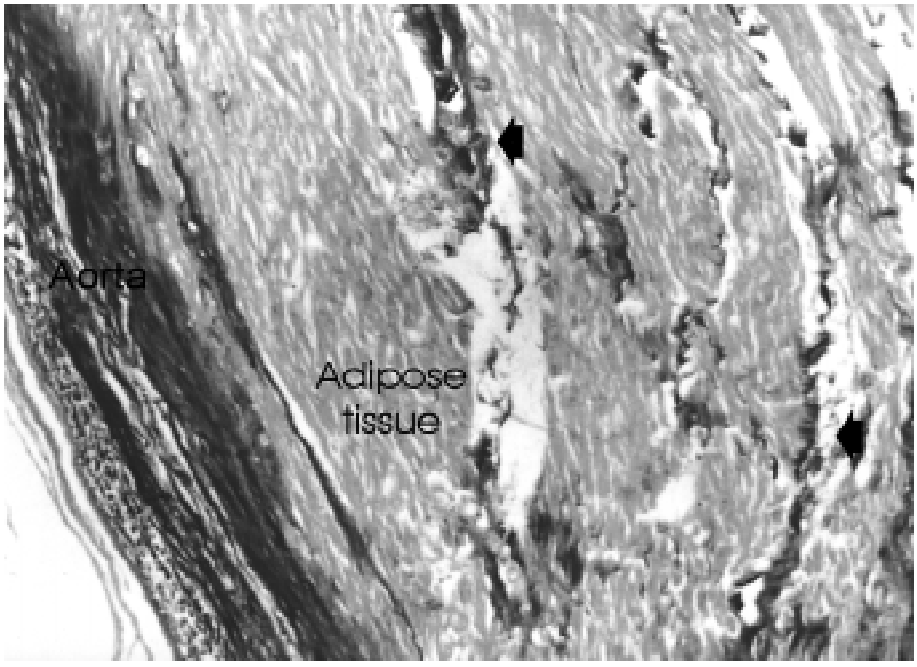

Figure 3. Arrows are indicating the fascial bands, stained red due to collagen content in van Gieson method. Adipose tissue is mostly occupying the space between aorta and pulmonary trunk at the level of sinutubular junction (van Gieson method, magnification 40 ×).

ventricles. However, in their paper no macroscopic or histological picture was shown to prove their findings. The same with Walmsley and Watson [9] in their review illustrating the fibrous skeleton of the heart that contains the conus ligament, a strip of tendinous-like fibrous tissue. Interestingly Gray's Anatomy [2] still retains two illustrations of the fibrous skeleton of the heart (pp. 715–716).

McAlpine [5] was the first to describe that he was unable to demonstrate the tendon of infundibulum

in his dissections, and according to him he prefers to term a fascia, the connective tissue between the aortic and pulmonary roots. The term fascial or more accurately fascial bands is fully supported by our findings, which reveal fascial bands in all 30 specimens examined. Furthermore Lal et al. [3] were also unable to detect any fibrous structure connecting the aortic and pulmonary roots. However they were able to identify only one specimen showing the so-called fascia or fascial bands. Finally our findings support the results of McAlpine [5] and Lal et al. [3] with the total number of specimens, 40 and 11 respectively, examined by these two authors.

In addition these fascial bands do not correspond to the initial description of the tendon of infundibulum and furthermore they cannot be defined as the tendon of infundibulum.

Subsequently, however, the illustration of the tendon of infundibulum and its description still remains in many medical textbooks and also in the mind of morphologists and surgeons. On the basis of the studies of McAlpine [5] and Lal et al. [3], endorsed by our findings, it would be interesting for the tendon of infundibulum to be rechecked and reconfirmed and subsequently expunged from medical textbooks describing the anatomy of the heart. We believe that further attention should be given to such a structure as the tendon of infundibulum because its erroneous existence in the medical textbooks can bring, maybe, confusion in the future. To borrow from Churchill [1], a distinguished author, our study and similar ones, such as those performed by McAlpine [5] and Lal et al. [3], are not the end, nor are they the beginning of the end. They are, perhaps, the end of the beginning.

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