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The relationship between the membranous part of the interventricular septum and the septal part of the attachment of the tricuspid valve in adult human hearts

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The membranous septum is a difficult structure to demonstrate in vivo. *It is possible to measure its dimensions in a cadaver after the introduction of light into the aorta, but difficult to do so otherwise. The present study was performed on a group of 107 formalin-fixed adult hearts from both sexes and 18–90 years of age. The hearts were divided into groups depending on sex and age. The length of the septal part of the attachment of the tricuspid valve was divided by the length of the supravalvular part of the membranous interventricular septum.* (Folia Morphol 2008; 67: 251–254)

Key words: tricuspid valve, membranous septum, human heart, morphometry

INTRODUCTION

The tricuspid valve is heterogeneous [6] and is topographically related to the atrioventricular junctional area [3]. The shape of the right atrioventricular orifice evolves during life from a triangular to a more elliptical shape [7]. Novel techniques in invasive cardiology and cardiosurgery demand more precise study of the topographical relationships between the macroscopically invisible cardiac atrioventricular part of the conductive system and the clearly visible structures such as the tricuspid valve. The membranous septum is a structure which is difficult to recognise *in vivo*, and measuring these dimensions is only possible after introduction of light into aorta.

MATERIAL AND METHODS

The study material consisted of a group of 107 formalin-fixed adult human hearts: 30 female and 77 male, between 18 and 90 years of age. All were found to be without macroscopic developmental failures and pathological changes. The hearts were divided into groups depending on sex and age: those of Group I were in the range of 18 to 40 years (39 male and 9 female hearts), those in Group II were in the range of 41 to 65 years (25 male and 14 female hearts) and those of Group III were over 65 years of age (5 male and 4 female hearts). Dissection of the hearts was performed according to standard autopsy techniques. Each heart was opened along the path of blood flow, from the inferior vena cava orifice to the right atrioventricular orifice. Right chambers were opened with a V-shaped cut along the right margin and across the anterior wall of the right ventricle. Afterwards, using a nonius scale for each heart, we took the following six measurements:

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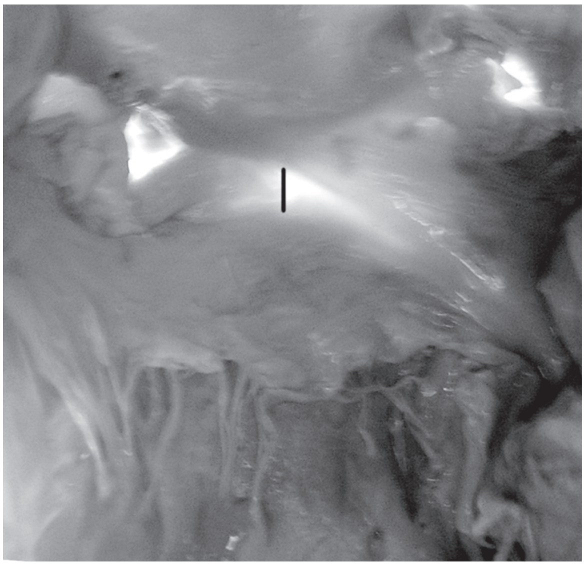

Figure 1. The line shows the path of measurement of the membranous septum.

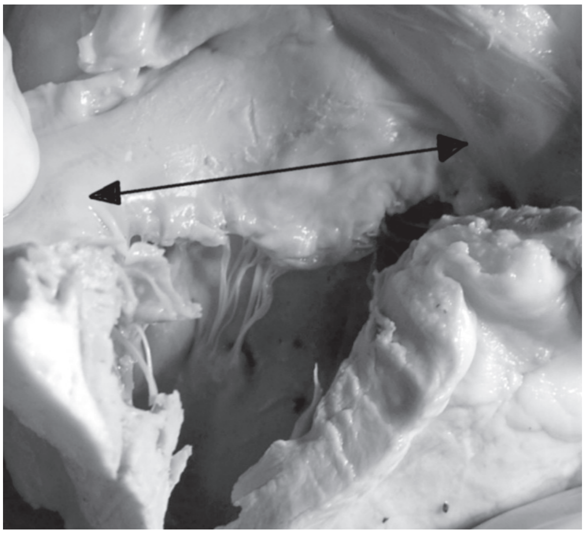

Figure 2. The length of the septal part of the attachment of tricuspid valve.

— the length of the membranous septum — the longest dimension in which the ray was visible after introduction of light into the aorta;
— the length of the supravalvular part of the membranous septum — the longest dimension made visible by the ray of light on the atrial surface (Fig. 1);
— the length of the septal part of attachment of the tricuspid valve — the dimension measured between the anterior and posterior angles of the right ventricle (Fig. 2).

The length of the septal part of the tricuspid valve was divided by the length of the supravalvular part of the membranous septum in non-accidental pairs as a checking hypothesis in order to test whether this quotient differs in relation to age and sex.

Both supravalvular and subvalvular parts of the membranous septum were studied, as the subvalvular part is, according to other authors, not constant [2, 8] and the embryological origin of the two parts are different. The supravalvular part is more recognisable during surgery than the subvalvular. The results obtained were statistically analysed by one-way analysis of variance (ANOVA) for independent variables (means for three groups). Student's t-test was used for two independent variables.

RESULTS

The length of the supravalvular part of the membranous septum was smallest in Group I and greatest in Group III in both sexes (Table 1, 2). The quotient of the length of the septal part of the tricuspid valve and the length of the supravalvar part of the membranous septum in non-accidental pairs was higher in Group II than in the Group I age group in both sexes. In a comparison of Groups II and III this quotient was smaller in Group III in male hearts and higher in female hearts (Table 3, 4). The length of the whole membranous septum measured in Group I was ± 11.39 mm for female hearts and ± 9.54 mm for males, while in Group II it was ± 9.62 mm in female hearts and 10.1 mm in males. In Group III this parameter was found to be 10.75 mm in female heart and 9 mm in males.

The subvalvular part of the membranous septum occurred in 53 hearts (49.53% of the group studied). The length of the subvalvular part of the membranous septum measured 5.78 ± 3.66 mm. There was no correlation between the presence of the subvalvular part of the membranous septum and age or sex.

DISCUSSION

Measuring the dimension of the membranous septum in a cadaver is only feasible after the introduction of light into the aorta. The dimensions thus obtained and their correlation with the length of the septal part of the attachment of the tricuspid valve, which was simple to measure in hearts taken from cadavers, may be helpful in evaluating the topographical relationships between the tricuspid valve and the conductive system of the heart.

The measurement of the length of the supravalvular part of the membranous septum obtained in Group I was 7.59 mm in male hearts, and 8.26 mm in female hearts, in Group II it was 6.88 mm in male

Table 1. Length of the supravalvular part of the membranous septum

Parameter	Age group					
	18–40 years		41–41 years		Over 65 years	
	Male	Female	Male	Female	Male	Female
Mean	7.59	8.26	6.88	6.97	7.00	6.00
SD	1.79	2.56	1.00	2.12	1.71	0.82

Table 2. Statistical hypotheses showing differences in length of the supravalvular part of the membranous septum in particular age groups

Sex	Age groups (years)	Degree of freedom	x_1–x_2	s^2 (x)	t	False rejection of true hypothesis		False rejection of true hypothesis	
Male	18–40 *vs*. 41–65	62	0.71	2.347998	1.8078605	$\mu1 = \mu2$	8%	$\mu1 \leq \mu2$	4%
	41–65 *vs*. 65	28	–0.12	1.27881	0.2233929	$\mu1 = \mu2$	82%	$\mu1 \geq \mu2$	41%
	18–40 *vs*. 65	42	0.59	3.169109	0.6974059	$\mu1 = \mu2$	49%	$\mu1 \leq \mu2$	24%
Female	18–40 *vs*. 41–65	22	1.38	5.393434	1.4070442	$\mu1 = \mu2$	17%	$\mu1 \leq \mu2$	9%
	41–65 *vs*. 65	17	0.90	4.005882	0.7482952	$\mu1 = \mu2$	46%	$\mu1 \geq \mu2$	23%
	18–40 *vs*. 65	11	2.28	4.959596	1.7020322	$\mu1 = \mu2$	12%	$\mu1 \leq \mu2$	6%

Table 3. Quotient of the length of the septal part of the tricuspid and the length of the supravalvular part of the membranous septum

Parameter	Age group					
	18–40 years		41–41 years		Over 65 years	
	Male	Female	Male	Female	Male	Female
Mean	4.05	3.84	4.76	4.37	4.28	5.14
SD	1.13	1.31	1.16	1.09	1.34	1.87

The word "quotient" used in Tables 3 and 4 means the quotient of the length of septal part of tricuspid valve divided by the length of the supravalvular part of membranous septum.

Table 4. Statistical hypotheses showing differences in the quotient of the supravalvular part of the membranous septum and the septal part of the attachment of the tricuspid valve in particular age groups

Sex	Age groups (years)	Degree of freedom	x_1–x_2	s^2 (x)	t	False rejection of true hypothesis		False rejection of true hypothesis	
Male	18–40 *vs*. 41–65	62	–0.71	1.3039	2.417673	$\mu1 = \mu2$	2%	$\mu1 \leq \mu2$	1%
	41–65 *vs*. 65	28	0.48	1.417848	0.820342	$\mu1 = \mu2$	42%	$\mu1 \geq \mu2$	21%
	18–40 *vs*. 65	42	–0.23	1.320419	0.419115	$\mu1 = \mu2$	68%	$\mu1 \leq \mu2$	34%
Female	18–40 *vs*. 41–65	22	–0.56	1.429257	1.107243	$\mu1 = \mu2$	28%	$\mu1 \leq \mu2$	14%
	41–65 *vs*. 65	17	–0.75	1.662081	1.029488	$\mu1 = \mu2$	32%	$\mu1 \geq \mu2$	16%
	18–40 *vs*. 65	11	–1.31	2.200431	1.463992	$\mu1 = \mu2$	17%	$\mu1 \leq \mu2$	9%

hearts and 6.97 mm in female hearts, while in Group III it was 7.00 mm in male and 6.00 mm in female hearts.

The quotient of the length of the septal part of the tricuspid valve and the length of the supravalvular part of the membranous septum was dependent on age and sex. In our results this were as follows: in female hearts 3.84 ± 1.31 for the first age group, 4.37 ± 1.09 for the second age group and 5.14 ± 1.87or the third age group; in male hearts 4.05 ± 1.13 for the first age group, 4.76 ± 1.16 for the second age group and 4.28 ± 1.34 for the third age group. The quotient was higher in Group II than in Group I for both sexes. When Groups II and III were compared this quotient was smaller in Group III in male hearts and higher in female hearts. The difference between male and female groups may be casual and one of the causes could be the small number of hearts in these groups. It seems that calculations of this proportion, referred to above, can be helpful in locating the supravalvular part of the membranous septum *in vivo* (when it is impossible to highlight the membranous septum by means of a light located in the aorta) because of the topographical relationship between the membranous septum and the conductive system of the heart [1].

Studies are known of the morphology of the membranous septum from the side of the left ventricle, described with respect to its topographical relationship to the valve of the aorta, but it is hard to compare these results with those presented here [8]. The less compact structure, as well as length of longitudinal axis of the membranous septum and arrangement of fibres in membranous septum confirm that this structure is enlarged during life as observed here [2]. Studies of the membranous septum and its region have shown that the tendon of Todaro it is not always present or single; double or multiple tendons were found in equal proportion. This author, basing his findings on the histology of this region, showed the membranous septum as a potential anatomical landmark [4]. The shape of the right atrioventricular orifice evolves during life from a triangular shape to a more elliptical shape [7], and this may be another argument for seeking more novel anatomical landmarks.

Subvalvular parts of the membranous septum occurred in 53 hearts (49.53% of the group studied). Our results are concordant with the results of Restivo et al. [5]. According to this author this part of the membranous septum occurs in 52% of hearts. The length of the subvalvular part of membranous septum was 5.78 ± 3.66 mm and the standard deviation testifies to the high degree of heterogeneity in the studied group, with two thirds of the results ranging from 2.13 mm to 9.44 mm. There was no correlation between the occurrence of the subvalvular part of the membranous septum and age or sex.

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