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# The topography of the subthebesian fossa in relation to neighbouring structures within the right atrium

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*The majority of anatomical structures within the heart during typical atrial flutters' ablation, right sided accessory pathway ablation or slow pathway ablation are invisible or blurred. Therefore it is very important to know in details interior right atrial structures during such procedures. In the neighborhood of coronary sinus orifice small concavity is visible. This area, called subthebesian fossa, is placed between the os of coronary sinus, the orifice of vena cava inferior and tricuspid annulus. The fossa is on the way of typical atrial flutters' reentrant circuit and is placed next to the isthmus area, which has become a target site for ablative therapy.*
*Regarding the facts mentioned above we decided to examine the topography of this concavity in relation to neighboring structures.*
*Research was conducted on material consisting of 45 human hearts of both sexes, from 19 to 71 years of age. The hearts came from patients whose death was not cardiologic in origin. The topography of the fossa was examined in relation to coronary sinus orifice (diameter A), vena cava inferior orifice (diameter B) and the attachment of the posterior leaflet of the tricuspid valve (diameter C). Besides we measured two perpendicular sizes in the inlet plane of the fossa. There were the longest size (diameter D) and the shortest size of the fossa (diameter E). We also defined deepness of the fossa (diameter F).*
*Diameter A was from to 2 to 7 mm (avg. 4.9 ± 1.4 mm), diameter B from 2 to 8 mm (avg. 4.0 ± 1.6 mm) and diameter C from 5 to 9 mm (avg. 7.0 ± 1.5 mm). The longest size in inlet plane of the concavity (diameter D) was from 12 to 18 mm (avg.14.1 ± 1.7 mm) and shortest size (diameter E) was from 7 to 14 mm (avg. 9.0 ± 1.7 mm). The deepness of the fossa (diameter F) was from 2 to 7 mm (avg. 4.8 ± 1.2 mm).*
*The subthebesian concavity is inconstant anatomical structure, occurring in all forty five examined hearts (100%).*
*The shape and sizes of the subthebesian fossa were variable in examined group of hearts. Our data suggest that differences in diameters between subthebesian fossa and neighboring structures may have clinical importance during ablation procedure.*

**key words: inferior right atrial wall, isthmus area, ablation procedures**

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## INTRODUCTION

The introduction of catheter ablation procedures has changed the approach to the anatomy of the heart. Before the development of clinical electrophysiology, surgery was the most effective method of treatment of supraventricular dysrhythmias (e.g. atrial flutter, atrial fibrillation, preexcitation syndromes) [9, 10]. Despite its effectiveness and accuracy, surgery was blamed because many complications were present during procedure. The transcatheter ablation, especially using radiofrequency current, is a much safer method than surgery, but even during such a procedure complications can occur [2]. Until now the problem has been that during ablation procedure one can only notice catheter electrodes on a roentgenoscopic screen. However new ablation methods based on electroanatomical mapping, e.g visualisation, are still developing (CARTO-System, ENSITE-System, LOCALISA-System). The majority of anatomical structures within the heart during ablation are invisible or blurred [1, 14]. Therefore, it is very important to know in detail the interior right atrial structures during ablation (typical atrial flutters' ablation, right-sided accessory pathway ablation or slow pathway ablation).

In the neighbourhood of the coronary sinus orifice a small concavity is visible. This area, called the subthebesian fossa [13], is situated between the os of the coronary sinus, the orifice of the vena cava inferior and the tricuspid annulus. The subthebesian concavity was noticed for the first time by Koch [4, 5], but he did not undertake any research into this structure. The fossa is on the way of typical atrial flutters' reentrant circuit and is placed next to the isthmus area [6]. The isthmus is bordered anteriorly by the tricuspid valve and posteriorly by the inferior vena cava, coronary sinus and eustachian ridge [3]. This narrow isthmus has become a target site for ablative therapy [6], which is the treatment of choice in typical atrial flutter. This procedure is performed by linear lesion in the isthmus mentioned above, which allows stopping of the macroreentrant circuit running within the walls of the right atrium [12].

Regarding the facts mentioned above, it seems that becoming closely acquainted with the detailed topography of the subthebesian area could be very interesting, especially for invasive cardiologists. Therefore, we decided to examine the topography of this concavity in relation to neighbouring structures. We think it could be helpful during moving and fixation of ablative electrodes in the procedures mentioned earlier. Besides detailed knowledge of the topography of subthebesian region and its variants could make easier orientation within the right atrium and may help understanding of difficulties during invasive procedures.

## MATERIAL AND METHODS

Research was conducted on material consisting of 45 human hearts of both sexes from the age of 19 to 71 years. Hearts were fixed in a 10% formalin and 98% ethanol solution. The hearts came from patients whose death was not cardiologic in origin and there were no cardiac dysrhythmias according to accessible hospital documentation. In these hearts also no pathological changes or congenital disorders were macroscopically found.

The classic macroscopic methods of anatomical evaluation were used. The topography of the subthebesian fossa was examined in relation to coronary sinus orifice, vena cava inferior orifice and the attachment of the posterior leaflet of the tricuspid valve. We measured the shortest distance between the edges of the subthebesian fossa and the coronary sinus orifice (diameter A), the subthebesian fossa and the vena cava inferior orifice (diameter B) and the shortest distance from the fossa to the attachment of the posterior leaflet of the tricuspid valve (diameter C) (Fig.1). As the edge of the fossa, the change in the degree of sloping of the inferior right atrial wall was considered. Besides, we decided to check the size and depth of the subthebesian fossa in the examined group of hearts. We measured two perpendicular sizes in the inlet plane of the subthebesian fossa, which were going by the middle of this structure. There were the longest size (diameter D) and the shortest size of the fossa (diameter E). We also defined the depth of the fossa. It was the deepest place in the fossa from the inlet plane (diameter F). We also checked the thickness of the right atrial wall in the subthebesian area (diameter G). All the above-mentioned diameters (D, E, F and G) are demonstrated in Figure 2.

Statistical analysis was supported by F-Snedecor and t-Student tests for odd number data. In the situation where distribution was not normal, the differential significance was tested using Mann-Whitney-Wilcoxon test. Statistically, $p < 0.05$ was considered to be the level of significance.

## RESULTS

On the basis of our study we found that the subthebesian concavity is an inconstant anatomical structure, occurring in all forty-five examined hearts

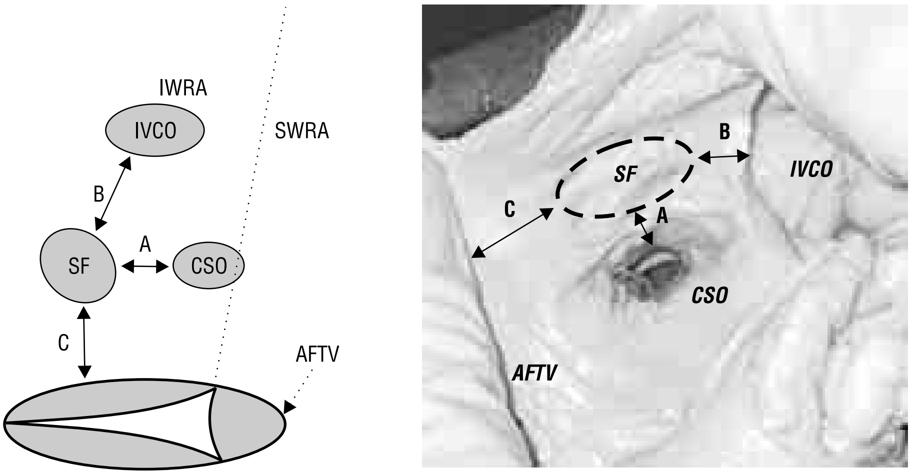

**Figure 1.** Topography of the subthebesian fossa and its distances (A, B, C) from neighbouring structures. For better visualising the subthebesian area was protruded in the opposite direction; IVCO — inferior vena cava orifice, CSO — coronary sinus orifice, AFTV — annulus fibrous of the tricuspid valve, SF — subthebesian fossa, IWRA — inferior wall of the right atrium, SWRA — septal wall of the right atrium, dotted line represents the border between two atrial walls.

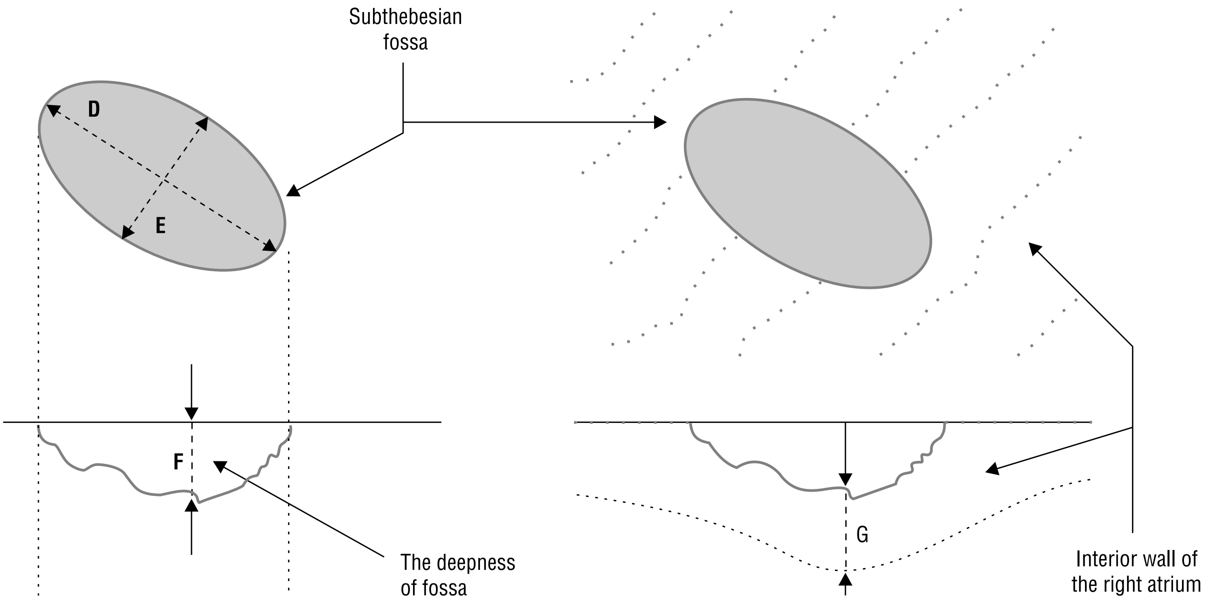

**Figure 2.** The measured sizes of the subthebesian fossa (drafting scheme).

(100%). The shapes and sizes of this structure were variable in the examined group of hearts.

Diameter A was from to 2 to 7 mm (avg. 4.9 ± ± 1.4 mm), diameter B from 2 to 8 mm (avg. 4.0 ± ± 1.6 mm) and diameter C from 5 to 9 mm (avg. 7.0 ± 1.5 mm). The exact data are presented in Table 1.

The topographical relations of anatomical structures to each other (coronary sinus orifice, vena cava inferior orifice, subthebesian fossa, tricuspid annulus) were constant in hearts with a well-developed subthebesian concavity.

During examination of the shape of subthebesian fossa we observed that it was elliptical in the inlet plate in the majority of cases. Therefore, we decided to measure two perpendicular sizes in the inlet plane of the fossa: sizes D and E mentioned earlier. The longest size (diameter D) was from 12 to 18 mm (avg. 14.1 ± 1.7 mm) and the shortest size (diameter E) was from 7 to 14 mm (avg. 9.0 ± 1.7 mm). The depth of the fossa (diameter F) was from 2 to 7 mm (avg. 4.8 ± 1.2 mm). The above-mentioned diameters are presented in Table 2.

**Table 1.** Data representing the results of A, B, C diameters in studied group of normal hearts

| No. | Examined hearts (n = 45) Diameter [mm] | | |
|---|---|---|---|
| | A | B | C |
| 1 | 4.2 | 3.2 | 6.2 |
| 2 | 5.0 | 3.0 | 7.2 |
| 3 | 3.6 | 3.2 | 6.8 |
| 4 | 5.6 | 5.0 | 6.0 |
| 5 | 4.4 | 8.0 | 5.2 |
| 6 | 7.0 | 4.6 | 8.8 |
| 7 | 5.4 | 6.0 | 7.8 |
| 8 | 2.8 | 2.0 | 5.2 |
| 9 | 6.0 | 8.0 | 5.0 |
| 10 | 6.2 | 2.0 | 5.2 |
| 11 | 4.8 | 2.6 | 5.0 |
| 12 | 6.4 | 4.0 | 6.0 |
| 13 | 6.0 | 2.8 | 5.4 |
| 14 | 6.8 | 3.0 | 7.0 |
| 15 | 4.0 | 3.2 | 5.8 |
| 16 | 4.6 | 3.0 | 9.0 |
| 17 | 6.0 | 2.8 | 8.8 |
| 18 | 3.4 | 4.0 | 8.4 |
| 19 | 2.2 | 2.4 | 5.2 |
| 20 | 5.2 | 3.8 | 7.8 |
| 21 | 4.4 | 4.2 | 9.0 |
| 22 | 2.6 | 6.0 | 5.6 |
| 23 | 2.0 | 7.2 | 5.4 |
| 24 | 2.6 | 3.0 | 8.6 |
| 25 | 6.8 | 7.2 | 5.8 |
| 26 | 5.8 | 2.4 | 8.4 |
| 27 | 6.0 | 3.0 | 9.0 |
| 28 | 5.0 | 4.4 | 8.8 |
| 29 | 3.8 | 2.0 | 9.0 |
| 30 | 7.0 | 3.0 | 5.2 |
| 31 | 3.2 | 4.0 | 5.6 |
| 32 | 6.6 | 5.6 | 9.0 |
| 33 | 5.8 | 4.0 | 7.6 |
| 34 | 6.0 | 3.4 | 9.0 |
| 35 | 6.8 | 3.0 | 5.2 |
| 36 | 5.0 | 2.2 | 5.0 |
| 37 | 3.4 | 3.2 | 8.0 |
| 38 | 4.8 | 7.4 | 9.0 |
| 39 | 6.6 | 3.2 | 8.6 |
| 40 | 6.0 | 5.4 | 5.6 |
| 41 | 4.4 | 5.0 | 6.6 |
| 42 | 6.2 | 3.2 | 7.0 |
| 43 | 4.0 | 3.8 | 8.4 |
| 44 | 3.0 | 3.8 | 7.4 |
| 45 | 6.8 | 6.4 | 7.2 |
| AVG | 4.98 | 4.00 | 7.01 |
| SD | ±1.44 | ±1.63 | ±1.52 |

**Table 2**. Data representing the results of D (longest size), E (shortest size), F (deepest place) diameters in studied group of normal hearts

| No. | Examined hearts (n = 45) Diameter [mm] | | |
|---|---|---|---|
| | D | E | F |
| 1 | 4.2 | 3.2 | 6.2 |
| 1 | 14.5 | 8.0 | 5.8 |
| 2 | 13.0 | 8.0 | 2.8 |
| 3 | 12.5 | 9.2 | 2.0 |
| 4 | 14.0 | 8.2 | 6.8 |
| 5 | 13.0 | 8.6 | 7.0 |
| 6 | 15.6 | 8.4 | 3.2 |
| 7 | 15.2 | 7.2 | 5.8 |
| 8 | 12.2 | 10.0 | 5.6 |
| 9 | 12.4 | 7.8 | 3.4 |
| 10 | 15.8 | 8.0 | 4.6 |
| 11 | 14.8 | 7.0 | 4.0 |
| 12 | 17.2 | 12.0 | 3.8 |
| 13 | 18.0 | 11.0 | 4.2 |
| 14 | 12.0 | 9.6 | 6.6 |
| 15 | 14.8 | 7.8 | 5.6 |
| 16 | 13.2 | 7.2 | 5.2 |
| 17 | 12.2 | 9.4 | 6.8 |
| 18 | 12.0 | 9.8 | 6.0 |
| 19 | 14.0 | 10.2 | 6.0 |
| 20 | 13.2 | 8.8 | 5.6 |
| 21 | 16.6 | 10.0 | 3.6 |
| 22 | 15.8 | 8.2 | 5.0 |
| 23 | 13.0 | 7.8 | 6.0 |
| 24 | 14.0 | 8.4 | 4.8 |
| 25 | 16.0 | 8.2 | 5.4 |
| 26 | 12.7 | 8.0 | 4.0 |
| 27 | 14.6 | 8.0 | 5.8 |
| 28 | 13.8 | 7.2 | 3.0 |
| 29 | 12.0 | 7.4 | 2.8 |
| 30 | 14.0 | 14.0 | 4.0 |
| 31 | 13.2 | 9.6 | 5.6 |
| 32 | 16.6 | 7.8 | 5.8 |
| 33 | 15.8 | 7.2 | 6.2 |
| 34 | 13.0 | 10.2 | 4.4 |
| 35 | 14.0 | 9.6 | 3.4 |
| 36 | 12.2 | 8.2 | 4.0 |
| 37 | 12.4 | 11.2 | 4.8 |
| 38 | 15.8 | 12.8 | 5.8 |
| 39 | 14.8 | 10.2 | 6.0 |
| 40 | 17.2 | 10.2 | 4.8 |
| 41 | 18.0 | 14.0 | 4.6 |
| 42 | 12.0 | 7.0 | 4.2 |
| 43 | 14.8 | 9.4 | 3.8 |
| 44 | 13.2 | 7.8 | 2.6 |
| 45 | 12.2 | 9.8 | 5.2 |
| AVG | 14.16 | 9.07 | 4.80 |
| SD | ±1.74 | ±1.73 | ±1.25 |

The thickness of the inferior wall of the right atrium in the region of the subthebesian concavity (diameter G) was from 1 to 4 mm (avg. 2.8 ± 1.1 mm) (Table 3). Very thin muscle tissue in some places in the area of subthebesian fossa was even pellucid (1.0 mm) (Fig. 3). It was observed in 6 hearts (13.3%) with a well-developed subthebesian area (n = 45). We could not find any connection between the examined diameters (A, B, C) or the sizes of the fossa (D, E, F) and age or sex of hearts.

We did not find also any correlation between age or sex of examined material with the thickness of the atrial wall in the subthebesian area in the examined group of hearts.

**Table 3.** Data representing the results of G thickness diameter in studied group of normal hearts

| No. | Examined hearts (n = 45) Diameter [mm] |
|---|---|
| | G |
| 1 | 2.2 |
| 2 | 2.6 |
| 3 | 1.0 |
| 4 | 3.6 |
| 5 | 4.0 |
| 6 | 2.8 |
| 7 | 4.6 |
| 8 | 3.2 |
| 9 | 3.8 |
| 10 | 4.0 |
| 11 | 3.8 |
| 12 | 1.6 |
| 13 | 1.4 |
| 14 | 1.0 |
| 15 | 2.8 |
| 16 | 2.8 |
| 17 | 4.0 |
| 18 | 3.0 |
| 19 | 1.0 |
| 20 | 4.0 |
| 21 | 2.2 |
| 22 | 4.8 |
| 23 | 3.8 |
| 24 | 3.6 |
| 25 | 4.0 |
| 26 | 1.2 |
| 27 | 1.4 |
| 28 | 1.0 |
| 29 | 3.8 |
| 30 | 4.0 |
| 31 | 2.6 |
| 32 | 1.0 |
| 33 | 1.6 |
| 34 | 1.4 |
| 35 | 2.8 |
| 36 | 4.0 |
| 37 | 3.2 |
| 38 | 3.8 |
| 39 | 4.0 |
| 40 | 2.6 |
| 41 | 2.6 |
| 42 | 2.8 |
| 43 | 2.8 |
| 44 | 3.0 |
| 45 | 1.0 |
| AVG | 2.80 |
| SD | ±1.13 |

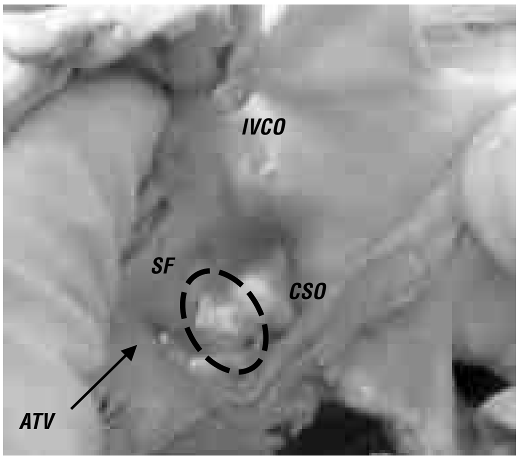

**Figure 3.** The thin and pellucid muscle tissue in the subthebesian area; 6 normal hearts (13.3%); IVCO — inferior vena cava orifice, CSO — coronary sinus orifice, ATV — attachment of the tricuspid valve, SF — subthebesian fossa.

## DISCUSSION

Radiofrequency ablation procedures are currently the most popular method of treatment of supraventricular cardiac arrhythmias, being very effective and less invasive than surgery [15]. Electrophysiologists have to imagine the cardiac anatomy from weak references, such as the heart shadow and certain catheters strategically positioned within the heart (e.g. in the coronary sinus, right atrial appendage etc.). They must still accept the limitations of their abstractions about the roentgenoscopic heart anatomy [1]. The detailed knowledge about the topography of the subthebesian fossa, a structure placed in the inferior wall of the right atrium, could be helpful and even mandatory for electrophysiologists during the procedures mentioned above.

There are a few publications dealing with the subthebesian area, but rather one can find research concerning the neighbouring structures. There are reports that the topography of the coronary sinus orifice region is variable in relation to other structures of the right atrium [8]. Our data show the differences in distances between the subthebesian fossa and the edge of the coronary sinus. This distance (diameter A) is inconstant, which could influence the exact orientation of the catheter electrodes during procedure. When the subthebesian concavity is next to the coronary sinus orifice and tricuspid annulus, the ablation of typical atrial flutters might be easier to perform and the time will probably be shorter, because it is near to the critical area (cavotricuspid isthmus). In the case when the concavity is far from regions mentioned earlier (a few hearts), the fixation of the ablative electrode could require more time.

The problem is much more complex, because it seems that foetal development of the heart influences the topography of the subthebesian region [7]. Another problem can arise in hearts with thin muscle tissue in the region of the examined concavity. It seems that these places are more prone to injury and even puncture. In literature there are reports of such complications during ablation procedures [15]. Regarding the distances between the subthebesian fossa and the inferior vena cava orifice it sems that in some anatomical conditions this area could be damage too. Sometimes the femoral approach (vena cava inferior orifice) to the right atrium during ablation procedure is reasonable and in other cases the subclavian approach (vena cava superior orifice) is better [1]. Cardiologists have to imagine another possibility of difficulties in the fixation of the electrode. There are a few cases in which the thebesian and eustachian valves are very well developed [7, 8].

The subthebesian area is a very interesting region from the cardiological point of view. Near to this concavity the slowing of the conduction can occur [11]. It could be responsible for the arising and even the perpetuation of some supraventricular dysrhythmias. This hypothesis requires more morphological and clinical research.

Our data suggest that differences in diameters between the subthebesian fossa and neighbouring structures may have clinical importance during the ablation procedure.

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