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Original article

Esophageal positions relative to the left atrium; data from 293 patients before catheter ablation of atrial fibrillation

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ABSTRACT

Aims: Three-dimensional rotational angiography (3DRA) of the left atrium (LA) and the esophagus is a simple and safe method for analyzing the relationship between the esophagus and the LA during catheter ablation of atrial fibrillation. The purpose of this study is to describe the location of the esophagus relative to the LA and mobility of the esophagus during ablation procedure.
Methods: From 3/2011 to 9/2015, 3DRA of the LA and esophagus was performed in 326 patients before catheter ablation of atrial fibrillation. 3DRAwas performed with visualization of the esophagus via peroral administration of a contrast agent. The positions of the esophagus were determined at the beginning of the procedure, for part of patients also at the end of procedure with contrast esophagography.
Results: The most frequent position is behind the center of the LA (91 pts., 31.9%) The least frequent position is behind the right pulmonary veins (27 pts., 9.4%). The average shift of the esophagus position was 3.36 ± 2.15 mm, 3.59 ± 2.37 mm and 3.67 ± 3.23 mm for superior, middle and inferior segment resp.
Conclusions: The position of the esophagus to the LA is highly variable. The most common position of the esophagus relative to the LA is behind the middle and left part of the posterior wall of the LA. The least frequently observed position is behind the right pulmonary veins. No significant position change of esophagus motion from before to after the ablation procedure in the majority (≥95%) of the patients was observed.

1. Introduction

A catheter ablation of complex atrial arrhythmias, especially a catheter ablation for atrial fibrillation, has become the most common ablation.[1] Ablation procedures are performed in the complex anatomy of the left atrium[2] with the support of 3D electroanatomical mapping systems that create virtual 3D non-fluoroscopic maps of the left atrium[3] (CARTO, Biosense Webster, and EnSite Velocity, St. Jude Medical). Support of catheter ablations with a 3D X-ray model of the left atrium, mainly from CT, is currently often.[4] 3D rotational angiography (3DRA) of the left atrium represents a new alternative to CT cardiac imaging. This method is used mainly for left atrium imaging, but imaging of other cardiac and extracardiac structures is possible (cardiac ventricles,[5] esophagus).[6,7] Images created by rotational angiography of the heart are fully comparable with CT Images[6,8–10]. The final models of the left atrium are used to guide the creation of non-fluoroscopic 3D electroanatomical maps, direct fusion/integration with the 3D electroanatomical mapping system[4,9], and/or direct fusion/integration of a 3D model with live fluoroscopy.[4,10]

The esophagus is an important noncardiac structure that can be imaged with 3DRA.[6,7,11,12] During ablation on the posterior wall, which is in close anatomical relation with the esophagus,[13] an atrioesophageal fistula develops in 0.04% of cases.[2] An atrioesophageal fistula is the cause of almost 16% of all deaths related to catheter ablation of atrial fibrillation,[14] and it is fatal in 70 to 80% of cases.[14] A 3D model of the esophagus can be useful in preventing damage to this vulnerable structure during left atrial ablation.

The position of the esophagus from the CT of the heart have been described in a lot of works since 2004.[15–18] Some authors also proved longterm mobility of the esophagus comparing preprocedural CT of the left atrium and esophagus and 3DRA of the left

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atrium with esophagus imaging or contrast esophagogram during ablation procedure.[6,12,19,20] Two works with small group of patients assessed position of the esophagus from the 3DRA of the left atrium and esophagus[6,12] and data about mobility of the esophagus during ablation procedure are ambiguous.[21,22]

The objective of this study is to describe the location of the esophagus relative to the left atrium and mobility of the esophagus during ablation procedure from large group of patients who underwent 3DRA of the left atrium with esophageal imaging.

2. Methods

2.1. Patient population

This retrospective study enrolled 326 consecutive patients who were referred for catheter ablation of atrial fibrillation and who underwent 3D rotational angiography of the left atrium with esophageal imaging in the period from March 2011 to September 2015. Thirty-three patients participated in prospective study dealing with periprocedural mobility of the esophagus – comparison of the position of the esophagus at the beginning and at the end of the procedure. The institutional review board approved the study protocol for this study, and written informed consent was obtained from these patients. Patients with a history of iodine allergy or with impaired renal function (glomerular filtration rate estimated using Modification of Diet in Renal Disease (MDRD) formula less than 45 ml/s/1.73 m^2) were excluded from the study.

2.2. Rotational angiography imaging

All 3DRA of the left atrium and esophagus were carried out with the Allura Xper FD 10 X-ray system (Philips Medical Systems Inc., Best, Netherlands). The basic principle of 3DRA is application of the contrast agent (Ultravist 370, Bayer Pharma AG, Berlin, Germany) to the atrium to acquire the rotational image. After opacification of the left atrium and pulmonary veins with the applied contrast agent, the C-arm is isocentrically rotated over 240° (from 120° right anterior oblique to 120° left anterior oblique) over 4.1 s with an X-ray acquisition speed of 30 frames per second. The patients are in a supine position during rotational imaging with the natural position of the arms along the body and normal breathing. Isocentering of the left atrium was achieved from the anteroposterior and left lateral X- ray projections with a maximally raised flat panel.

In total, we used three acquisition protocols: two right atrial protocols with different delays and one left atrial protocol.

Right atrial protocol. The contrast agent was injected using a pigtail catheter into the right atrium and after a certain delay (the time required for passage of the contrast agent through the pulmonary circulation into the left atrium), rotation of the C-arm commenced. The delay of the second protocol was individually adjusted by the system operator when the LA was filled with the contrast agent; an optimized second protocol has a fixed delay of 9 s.

Left atrial protocol. A pigtail catheter was introduced transseptally into the left atrium. A stimulation quadrupolar catheter was inserted into the right ventricle with a pacing threshold ≤5 mA/1.0 ms. After reducing the cardiac output with rapid stimulation of the ventricles (frequency of 230/min) with a drop in blood pressure that was verified by the disappearance of the pulse waveform from the saturation sensor at the distal finger phalanx of the right upper extremity (Philips IntelliVue MP-20, Philips, Eindhoven, The Netherlands), application of the contrast agent was initiated; with a delay of 2 s, we commenced the rotation of the C-arm.[8]

Opacification of the esophagus was achieved via oral administration of 20–30 ml of barium sulphate contrast agent (Micropaque, Guerbet, Roissy, France).[6,9] Swallowing of the contrast agent was initiated in both protocols 1 s. before starting the C-arm rotation. The time remaining until the start of rotation is visible on the angiogram. For protocol details, see Table 1.

At the end of the rotational angiography, the data were automatically transported to the workstation EP Navigator (EP Navigator 3.2, Philips Healthcare, Best, Netherlands). The 3DRA model of the left atrium was automatically reconstructed using the standard algorithms of the EP Navigator Workstation. The 3D model of the esophagus was manually segmented at the same workstation. See Fig. 1.

2.3. Current imaging of the position of the esophagus

To verify the position of the esophagus at the end of the procedure, contrast esophagography was performed. The esophagus was opacified using the oral administration of 20–30 ml of barium sulphate contrast agent, and the current localization of the esophagus was recorded on an X-ray screen with fused 3D model of the LA and the esophagus.

2.4. Qualitative image analysis

For a qualitative evaluation of the resulting models we classified two options: an optimal model', defined as a clearly segmented course of the esophagus with identifiable edges in most areas behind the left atrium, and a suboptimal model', where the course of the esophagus could not be reliably visualized. To determine the position of the esophagus to the atrium, we used a modified method according to Kottkamp et al.[13] For an assessment of the esophageal position, Kottkamp et al. used the grid structure on the CT model of the left atrium. We modified this method and divided the posterior wall of the left atrium and the adjacent pulmonary veins into five vertical columns, A–E, from left to right. Columns A and E were laterally behind the ostia of the pulmonary veins, column C was in the middle of the left atrial posterior wall and columns B and D were in intermediate positions. The course and

Table 1
Overview of the protocols.

	Right atrial protocol 1	Right atrial protocol 2	Left atrial protocol
Injected cavity	RA	RA	LA
Displayed cavity	LA	LA	LA
Amount of contrast agent [ml]	60	60	60
Velocity of injection [ml/s]	15	15	15
Delay [s]	Variable from 8937 s to 11.546 s(Ø 10.67 s)	Fixed 9	Fixed 2
Simulation of RV 220–240 [bpm]	no	no	yes
Succes rate with esophagus imaging	81.81% (9/11)	88.89% (112/126)	97.87% (184/189)

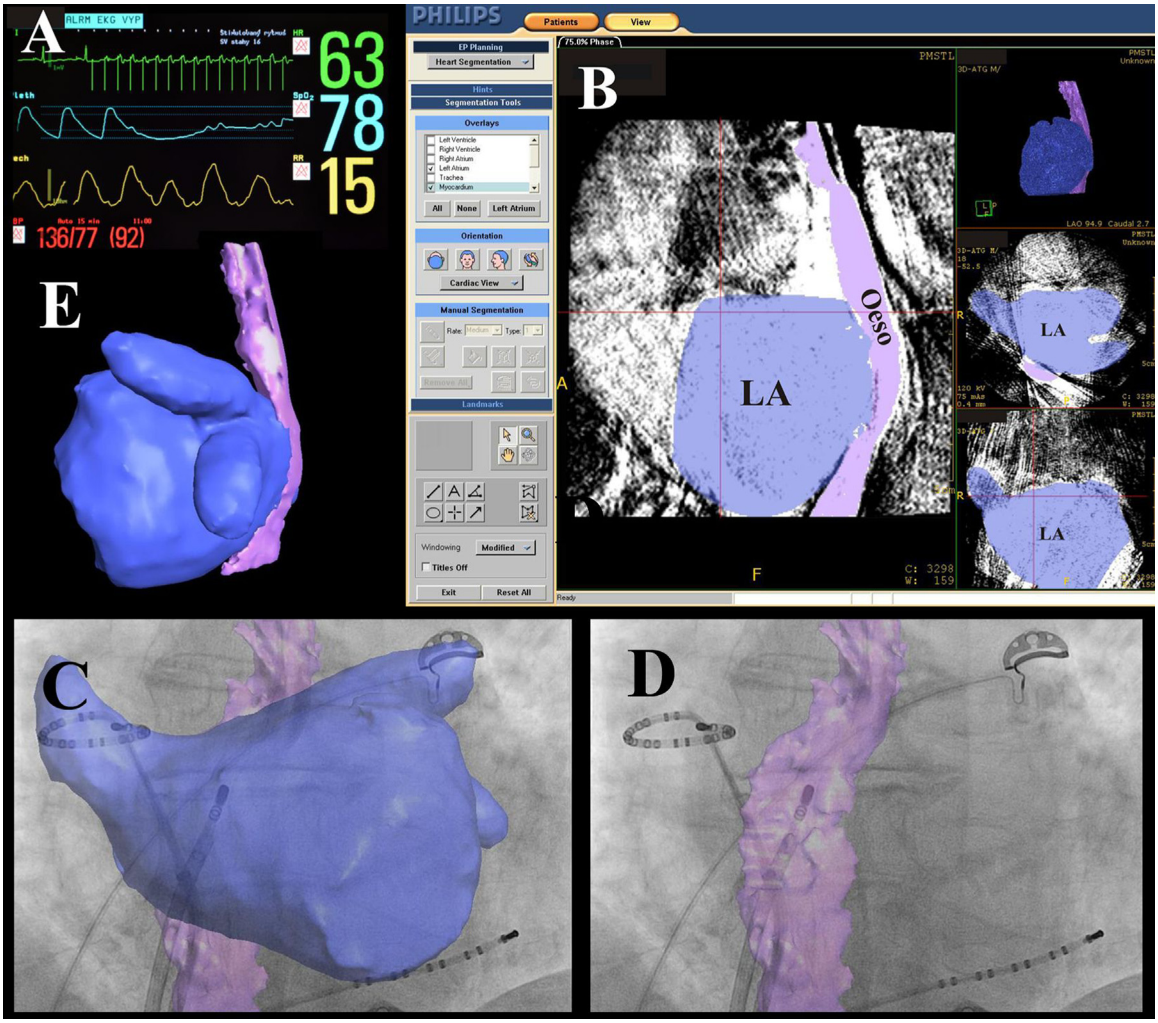

Fig. 1. Acquisition of the 3DRA data and the segmentation of the 3D model of the left atrium and esophagus. A – a reduction in the cardiac output with rapid stimulation of the ventricles (right ventricular pacing at 220/min.) documented by a decrease in saturation and the record from the bedside monitor. B – raw data from the 3D rotational angiography of the left atrium with segmentation of the 3D model. The picture shows a section of raw data in three mutually perpendicular planes and a preview of the resulting 3D model in the left lateral view. The blue color shows the automatic evaluation of the left atrial cavity; the purple color shows the manually segmented esophagus. C and D – examples of an application of the 3D model of the left atrium with visualized esophagus during the isolation of the pulmonary veins (anteroposterior view). The twenty pole circular catheter is introduced into the RSPV, and the tip of the ablation catheter is in sight of the resulting line on the posterior wall of the left atrium. The tip of the ablation catheter is inside the esophagus model. D – for greater clarity, the model of the left atrium is hidden. E – the final model of the left atrium and esophagus in the left lateral view. We can see the left-sided pulmonary veins, base of the auricle and the esophagus (in purple) adjoined to the posterior wall of the left atrium. LA – left atrium, oeso – esophagus, RSVP – right superior pulmonary vein.

location of the esophagus behind the left atrium was evaluated and described by one of the columns. In the case of an oblique course of the esophagus intersecting multiple columns, we determined the position of the esophagus according to the column where the largest part of the esophagus lies. In all patients with successful segmentation, the esophageal positions in relation to the left atrium were evaluated. See Fig. 2.

2.5. Quantitative imaging analysis

For purpose of our study, we set the shift of analyzed structure lesser than 5 mm as negligible. According to our experiences, shift lesser than 5 mm is non significant for the operator during atrial fibrillation ablation. Two experienced investigators measured the positions of the esophagus and LA. Each measurement was repeated three times to reduce the intra-individual variability, and the result was the average of these three measurements. Average of the two results measured by the two investigators was used for statistical analysis. Intraindividual and interindividual variability was calculated.

At the beginning of the procedure position of the 3D model of the esophagus fused with live fluoroscopy was measured. At the end of the procedure position of the contrast esophagogram was measured. The positions of both the 3D model of the esophagus and the contrast esophagogram were measured in the anteroposterior projection in the superior, middle and inferior segments of the esophagus, with the spine serving as a stationary reference structure. The superior segment of the esophagus corresponded to the highest level of the 3D model of the LA, the inferior segment corresponded to the bottom level of the LA 3D model, and the middle segment corresponded to the level between the upper and lower segments. For details see Fig. 3.

Measurements were performed using GIMP (a free program that enables measurements on JPG images, version 2.8.14, http://

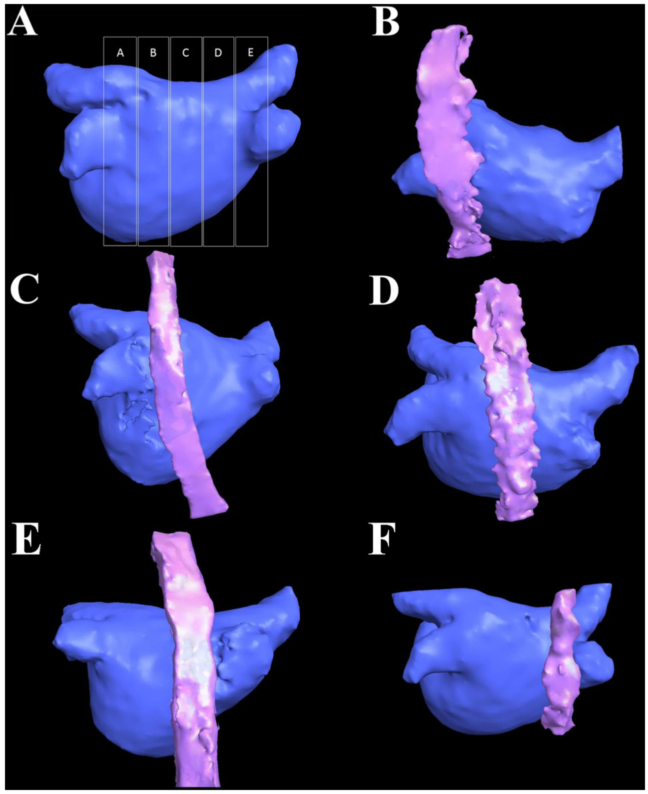

Fig. 2. A – methodology of the assessment of the esophageal position, B to F – examples of different positions of the esophagus in posteroanterior view, B – extremely left lateral position (A), C – left lateral position (B), D – middle position (C), E – right lateral position (D), F – extreme right lateral position (E).

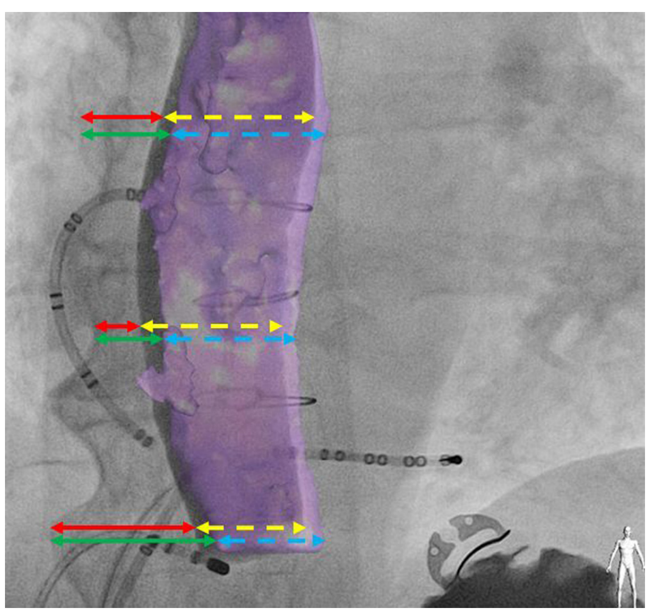

Fig. 3. Methodology of the esophageal shift measurement. Measurement of the position of the esophagogram and 3D model of the esophagus. Green arrows show the measurement of the position of the esophagus at the beginning of procedure (3D model of the esophagus) relative to the nearest vertebra. Red arrows show the measurement of the position of the esophagus at the end of procedure (contrast esophagogram) relative to the nearest vertebra. Blue arrows show the measurement of the width of the esophagus at the beginning of the procedure (3D model of the esophagus), yellow arrows show the measurement of the width of the esophagus at the end of the procedure (esophagogram). Picture shows the small shift of the esophagus by 0.8 mm at the top position, by 2.6 mm at the central position and by 2.1 mm at the lower position.

www.gimp.org/). We measured the distances from the vertebrae to the lateral wall of the esophagus and the width of the esophagus in all segments, which allowed us to calculate the position of the center of the esophagus in every segment.

We evaluated the position of the esophagus before and after the ablation – the shift of the position of the esophagus at the end of procedure (contrast esofagogram) in the left-right direction toward the input position (3D model of the esophagus acquired at the beginning of the procedure) (Fig. 4).

2.6. Image integration

The resulting 3DRA model of the left atrium was automatically integrated with live fluoroscopy. No registration for a 3D image overlay is necessary if the original X-ray table and the object's position that was imaged during 3DRA are maintained; the overlay takes place automatically within a few seconds. In the case of reregistration after patient movement or in the case of CT models, we use a standard carina-based registration procedure.[10] This technique uses the alignment of a reconstructed overlay and a live fluoroscopic image of the trachea and mainstem of the bronchi.

Ablation procedures were performed in a standard manner, and 3D models of the left atrium were used as support for the creation of 3D electroanatomical maps of the left atrium or for direct fusion with the 3D electroanatomical mapping system. All patients were ablated using an irrigated tip catheter guided by the 3D electro-anatomical mapping system EnSite Velocity (St. Jude Medical, St. Paul, MN, USA).

2.7. Statistical analysis

At first, the positions of the esophagus were statistically analyzed by using the Kolmogorov-Smirnov test. The null hypothesis H0 ($\alpha = 0.05$) assumed that the distribution of the esophageal positions were drawn from the normal distribution. Consequently, the position of the esophagus in each group was analyzed by the Mann-Whitney *U* test. The null hypothesis H0 ($\alpha = 0.05$) assumed that there is no statistically significant difference between the esophageal position incidence in individual segments (real distribution of esophageal position in each segment vs. homogeneous distribution of esophageal position throughout all segments). Furthermore, an analysis was carried out in the second case where locations of the esophagus were divided into categories of left or right-sided incidences. The null hypothesis assumed a consistent incidence of the esophageal position in both groups.

The average distances of the esophagus from the spine were measured in three levels. Statistical analysis compares these distances in two time intervals (at the start and at the end of the procedure). The measured data was tested on normality by Kolmogorov k Smirnov test and subsequently they were evaluated by Wilcoxon Matched Pairs test. The null hypothesis H_0 ($\alpha = 0.05$) of this test assumed that there is no statistically significant difference in the mean shift in each level at various time intervals. Furthermore, the general average shift was computed in the three levels (depending on the time). These data were analyzed by *t*-test (against the reference constant). The null hypothesis H_0 ($\alpha = 0.05$) assumed that there is no statistically significant difference between the general average shift and the reference constant in milimetres.

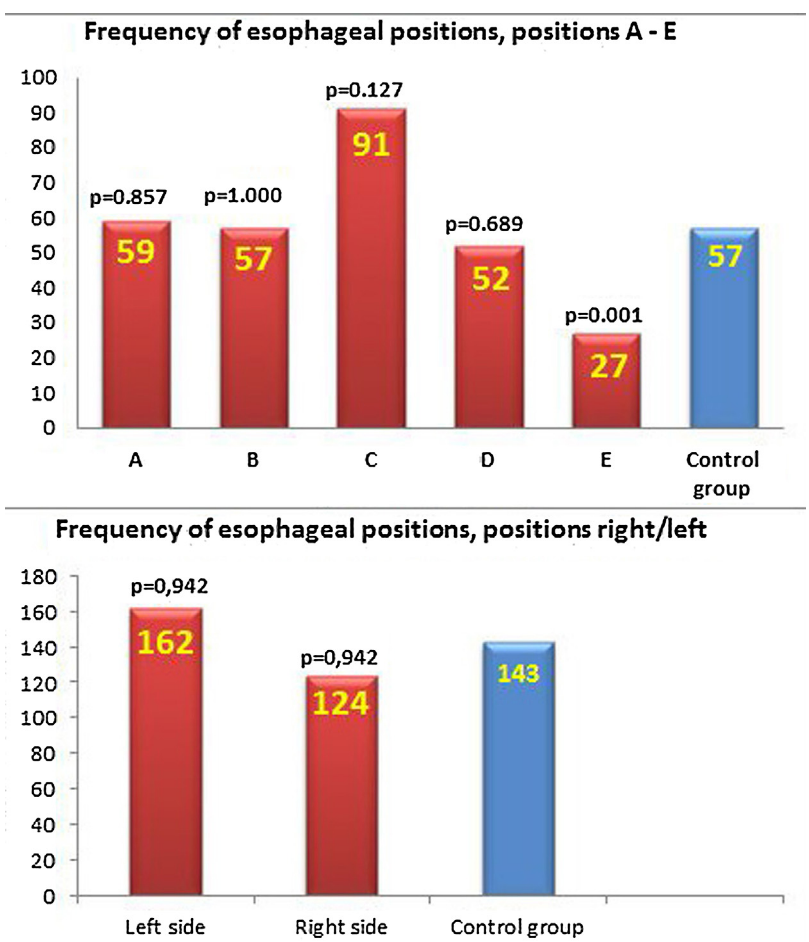

Fig. 4. Graphs of esophageal position frequency.

3. Results

In the period from March 2011 to September 2015, a total of 580 of 3DRA of left atrium in patients prior to catheter ablation of atrial fibrillation were performed. Three hundred twenty-six patients had 3DRA of the left atrium performed together with contrast 3D imaging of the esophagus. Last 33 patients (ablated from March 2015 to September 2015) participated in prospective study analyzing periprocedural mobility of the esophagus. The acquisition of data occurred without major complications. Direct left atrial injection of the contrast agent had no complications. No patients experienced aspiration of the oral contrast agents or other complications associated with the use of contrast agents dosed orally.

3.1. Patient characteristics

Characteristics of the patients including patients from study regarding periprocedural mobility of the esophagus are summarized in Table 2. Most patients were males with a mean age of 60 years and had no structural heart disease, with normal left ventricle function and slightly enlarged LA. The population of patients was highly homogeneous.

3.2. Rotational angiography image acquisition and qualitative image assessment

Only eleven patients underwent the first right atrial protocol (starting protocol with unsatisfactory success). After development of an optimized second right atrial protocol and after realizing a better success rate, we exclusively used this second protocol. From the beginning, we only used one left atrial protocol with a good success rate. Because both protocols have advantages and disadvantages, we used them simultaneously at the discretion of the electrophysiologist. The esophagus was successfully imaged in 87,7% of patients. The failure rate of imaging the esophagus was most often caused by delayed swallowing of the contrast agent or rapid passage through the esophagus.

In 286 patients with a successfully displayed esophagus and LA, we evaluated the position of the esophagus relative to the left atrium. The esophagus was positioned most frequently in the central part of the left atrium (column C, 91 pts., 31.9%), equivalently in the left part of the left atrium (column A, 59 pts., 20.6% and column B, 57 pts., 19.9% resp.) and least often in the right middle and especially in the right lateral part (column D, 52 pts., 18.2%, column E, 27 pts., 9.4% resp.). The significantly least frequent position of the esophagus occurred on the right side behind the right-pulmonary veins (27 pts., 9.4%, $p = 0.001$). The most often observed position of the esophagus that was seen in the middle of the posterior wall of the left atrium did not reach statistical significance (91 pts., 31.9%, $p = 0.127$). If we divide the position of the esophagus to the left atrium only at the position behind the left and right side of the left atrium (like in the study of Cury et al. [14]), then there is a trend towards a more frequent position of the esophagus behind the left vs. right-side of the left atrium (162 pts., 56.6%, $p = 0.942$ vs. 124 pts., 43.4%, $p = 0.942$ resp.). For details see Fig. 3. In our group, we observed the esophagi reaching a maximum of two adjacent segments. For example, see Fig. 2B and 2C, where models of the esophagus reach two adjoining segments.

3.3. Quantitative imaging analysis

Subgroup of 33 patients was subjected to analysis of the periprocedural change in esophagus position. Not in all patients were performed all measurements. Unfortunately, not all dimensions were measurable (unclear outline of the vertebra, esophagus model non- segmented up to the level of the vertebra, overlap of the esophagus model and vertebra). There are 7% of unmeasurable values during measurement (7 unmeasurable values from 99 values measured in the superior, middle and inferior segments of the esophagus). This data was excluded from calculation. Overwiev of esophageal shifts in an individual patients see Table 3.

Interobserver variability was 1.8 ± 1.5 mm. Intraobserver variability was 1.5 ± 1.3 mm.

The average duration of catheter ablation was 112 ± 43 min (time from sheat placement to catheter removal). The total execution time of the 3DRA of the LA and the esophagus including the manual segmentation of the esophagus was 9.92 min. The average radiation dose for all 3D rotational angiography was 11302.4 mGy/cm2, for 33 patients participated in periprocedural mobility substudy was 11204.3 mGy/cm2The average width of the esophagus was 18.8 ± 5.8 mm in the superior position, 19.5 ± 6.1 mm in the medium position and 16.9 ± 4.6 mm at the inferior position.

The average shift of the position of the esophagus during catheter ablation was 3.36 ± 2.15 mm, 3.59 ± 2.37 mm and 3.67 ± 3.23 mm for superior, middle and inferior segment resp. The shift of the esophagus during the procedure was significantly lower than 5 mm for all segments ($p < 0.001$, $p = 0.002$, $p = 0.04$, respectively)

The maximum shift of the esophagus was 11.9 mm, and the minimum shift was 0.1 mm. A shift of the esophagus $\geq$3 mm was present in 44.8% of the patients, and a shift of the esophagus $\geq$8 mm was present in 5% of the patients.

4. Discussion

Our results confirmed the findings of smaller studies based on CT data from a large sample of patients who underwent a different imaging modality. In the study of Kottkamp et al.,[12] the most common position of the esophagus was in the central part of the left atrium, with the next most common position being behind the left pulmonary veins and only a small portion observed on the right side. Additionally, Cury et al., [15] Lemola et al. 16 and several other studies examined in detail the relationship between the left atrium

Table 2
Patient characteristics.

Patient characteristics	3DRA of left atrium with imaging of esophagus	Right atrial protocol	Lef atrial protocol
Number of patients	326	137	189
Age	60.68 ± 9.44	59.7 ± 10.74	60.3 ± 10.78
Male	243 (74.54%)	96 (70.07%)	147 (77.77%)
Ejection fraction of left ventricle	57.01 ± 8.47	57.24 ± 8.38	57.18 ± 8.12
Size of left atrium	43.72 ± 5.72	44.72 ± 5.72	44.12 ± 5.89
Body mass index	28.95 ± 8.53	29.42 ± 5.55	29.02 ± 5.42
Structural heart disease	56 (17.18%)	30 (21.89%)	26 (13.75%)
Hypertension	170 (52.15%)	74 (54.01%)	96 (50.79%)

Table 3
Measurement of esophageal shifts in an individual patients.

Patients/measurement	sup	med	inf
1	2,3	2,7	2,7
2	2,2	2,3	1,2
3	7,3	7,9	7,1
4	1,9	3,9	1,8
5	3,2	3,1	6,2
6	7,7	5,5	3
7	1,4	4,5	2,6
8	3	4,6	8,2
9	1,2	2,7	1,4
10	2,1	4,4	7,7
11	2,5	1	1
12	N/A	1	2,2
13	N/A	0,9	N/A
14	1,3	1,8	0,3
15	0,9	1,6	3,4
16	3,5	2	N/A
17	4,5	1,8	11,6
18	0,4	3,4	2,9
19	6	4,9	1,4
20	3,8	4,6	11,9
21	3,9	4,1	1,8
22	1,8	5,9	4,3
23	2,7	0,2	1,9
24	1	2,9	1
25	2,3	5,7	N/A
26	6,8	1,5	1,6
27	3,4	2,9	1,3
28	5,5	N/A	N/A
29	1,1	2,8	2,1
30	7,7	8,9	8,5
31	1,8	1,1	5,3
32	5,3	4,1	1,3
33	5,9	10,5	1,1

and the esophagus [17–18] and reached similar conclusions. Previous works determined the position of the esophagus using different methods with similar results; the most frequent position of the esophagus is behind the left part of the left atrium.

It is well known that the position of the esophagus to the left atrium is not stable but may change over time. Longterm mobility of the esophagus has been proven in several works comparing periprocedural 3DRA with a preprocedural CT of the heart.[19,20] Interesting result of our work is that the position of the esophagus before and after procedure is a relatively stable within a few hours of the ablation procedure. No significant position change of esophagus motion from before to after the ablation procedure in the majority (≥95%) of the patients was observed. Our findings confirm the results of Sherzer et al.,[21] who reported the stable position of the esophagus in a group of 27 patients undergoing 33 ablations for atrial fibrillation ablated under general anaesthesia. Our results suggest that the position of the esophagus behaves similarly in patients ablated under light sedation. Current study did not confirm results of Daoud et al. or Good et al.,[19,22] which described significant mobility of the esophagus position during these procedures. The cause of this inconsistency is not clear, as both works compared two contrasting esophagograms acquired during catheter ablation for atrial fibrillation conducted under light sedation.

5. Limitations

Comparison of the esophagus position at the beginning and at the end of procedure is limited by the fact that we measured the lumen of the esophagus, not the complete width of the organ (i.e. lumen and wall), during esophagography. According to our data of the long-term mobility of the esophagus,[20] there were no significant differences between the width of the esophagus from 3DRA (esophagography, imaging of the lumen of the esophagus) and CT imaging of the whole esophagus (average widths of 17.13 ± 4.3 mm and 15.89 ± 4.03 mm, respectively).[20] In this paper we compared the preprocedural CT of the heart and esophagus (static imaging of the whole esophagus including lumen and wall) and the periprocedural 3DRA of the LA and the esophagus (dynamic imaging of the esophagus lumen during esophagography). This width was in the range of the widths of the esophagus reported in studies dealing with the detailed anatomy of the esophagus and the left atrium using CT data (from 11 to 24 mm).[15,16] Swallowing the contrast agent in 3DRA appears to compensate for the thickness of the esophageal muscle (which is usually <5 mm[16]), and the resulting esophagogram approximates the actual esophagus displayed by CT.

In the study, we determined the esophagus position relative to the spine. Hence the esophagus does not change position before and after the ablation procedure with respect to the spine, but not with respect to the left atrium.

Only a two time point measurement of the esophagus was performed which may in turn fail to observe esophagus motion during the ablation.

There is limited number of measurable values. Despite the 7% of unmeasurable values, the results are statistically significant.

Two-dimensional measurements were done in anteroposterior projection and no conclusions about mobility of the esophagus in saggital plane were done.

One of the limitations of the technique is that most of the ablation procedures nowadays are performed under general anaesthesia and oral contrast can not be given to sedated patient.

There exists a concern that swallowing the barium contrast agent could stimulate the motility of the esophagus and increase its mobility. However, this effect has not been demonstrated during the routine investigations of esophageal mobility.[23] Swallowing the barium contrast agent could cause also transient position or volume changes. Also free breathing during imaging of the esophagus can cause artifacts and the esophagus does move with respiration, even though it is only a couple millimeter.

There is a question, if data regarding esophagus mobility are transferable to the general public due to the limited number of esophagus mobility measurements.

6. Conclusion

Imaging of the esophagus in 3D rotational angiography of the left atrium is a simple and safe method that can reliably locate the actual position of the esophagus relative to the left atrium. The most frequently observed position of the esophagus is the middle position behind the middle part of the left atrial posterior wall, and the least frequent position of the esophagus is the right lateral position behind the right pulmonary veins. The most frequently observed position of the esophagus is behind the left part of the left atrium. There was no significant change in the position of the esophagus before and after the procedure during the ablation procedure lasting in average almost two hours with patients in light sedation.

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Declaration of conflicting interests

The authors declare that they have no conflicts of interest.

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