Multilevel venous obstruction in patients with cardiac implantable electronic devices

Supplementary materials

Table S1 presents the relationship between the rate of different MLVSO severity (maximal narrowing) in groups with different narrowing/occlusion extent expressed as a few significantly (3-5th degree) involved veins. The rate of different narrowing/occlusion extent in compared groups with different degrees of maximal MLVSO is also presented. The lower part of the Table 3 presents mirror analysis of different narrowing / occlusion length rate in compared groups with different degree of maximal MLVSO (another calculation of percentages). The results seem to confirm a relationship between single maximal narrowing appearance and a number of significantly problematic veins (extent of narrowing).

Table S1 The rate of different degree of maximal VSO in compared groups with different length of narrowing / occlusion (A) and the rate of different length of narrowing / occlusion in compared groups with different degree of maximal VSO (B).

A. Rate of different degree of maximal VSO in compared groups with different length of narrowing / occlusion	**Lack of significant narrowing (only 1,2 degree)**	**One vein involved with significant narrowing (3,4,5 degree)**	**Two veins involved with significant narrowing (3,4,5 degree)**	**Three, four or five veins involved with significant narrowing (3,4,5 degree)**	**All examined patients**
Number of patients number of the group	**1108**	**1152**	**665**	**77**	**3002**
Presented values	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
Lack of narrowing (1 degree)	510 (46,03)	0 (0,00)	0 (0,00)	0 (0,00)	510 (16,99)
Small/ mild narrowing (2 degree)	598 (53,97)	0 (0,00)	0 (0,00)	0 (0,00)	598 (19,92)
Moderate narrowing (3 degree)	0	543 (47,13)	76 (11,43)	2 (2,597)	621 (20,69)
Severe narrowing (4 degree)	0	407 (35,33)	185 (27,82)	6 (7,792)	598 (19,990
Total occlusion (5 degree)	0	202 (17,53)	404 (60,75)	69 (89,61)	675 (22,49)
All examined patients	1108 (100,0)	1152 (100,0)	665 (100,0)	77 (100,0)	3002 (100,0)
B. Rate of different length of narrowing / occlusion in compared groups with different degree of maximal VSO	**Lack of significant narrowing (only 1,2 degree)**	**One vein involved with significant narrowing (3,4,5 degree)**	**Two veins involved with significant narrowing (3,4,5 degree)**	**Three, four or five veins involved with significant narrowing (3,4,5 degree)**	**All examined patients**
Number of patients number of the group	**1108**	**1152**	**665**	**77**	**3002**
Presented values	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
Lack of narrowing (1 degree)	510 (100,0)	0 (0,00)	0 (0,00)	0 (0,00)	510 (100,0)
Small narrowing (2 degree)	598 (100,0)	0 (0,00)	0 (0,00)	0 (0,00)	598 (100,0)
Moderate narrowing (3 degree)	0 (0,00)	543 (87,44)	76 (12,24)	2 (0,322)	621 (100,0)
Severe narrowing (4 degree)	0 (0,00)	407 (68,06)	185 (30,94)	6 (1,003)	598 (100,0)
Total occlusion (5 degree)	0 (0,00)	202 (29,93)	404 (59,85)	69 (10,22)	675 (100,0)
All examined patients	1108 (36,91)	1152 (38,37)	665 (22,15)	77 (2,565)	3002 (100,0)

A comparative analysis of the difficulty of lead extraction depending on MLVSO showed that time of the procedure, the necessity of non-functional lead abandonment, the necessity of non-functional superfluous lead extraction, the appearance of any technical problem during TLE (such as a block in lead venous entry, lead to lead strong scar connection, Byrd dilator collapse/torsion / "fracture", extracted lead collapse/rupture during extraction) and the number of technical problem were significantly more frequent, especially in groups of patients with two or more problematic veins with significant stenosis/occlusion. There were positive correlations between number of levels of MLVSO and number of big technical problems (Spearman r coefficient = 0,069; p<0,001) and procedure duration time (Spearman r coefficient = 0,108; p<0,001). Similarly, the need for additional tools utility, such as mechanically driven sheaths, metal sheath, lasso catheter/snare or basket catheter, was much more frequent in this group of patients (Table S2)

Table S2

Table S2 TLE procedure complexity in patients divided into groups according to the number of lead related significantly stenosed / occluded vein

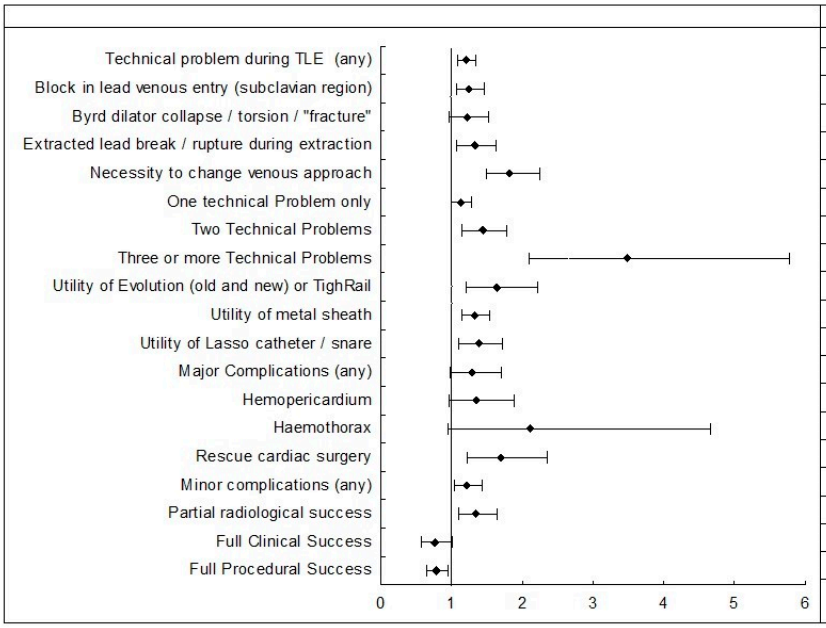
	Lack of significant narrowing (only 1,2 degree)	**One vein involved with significant narrowing (3,4,5 degree)**	**Two veins involved with significant narrowing (3,4,5 degree)**	**Three, four or five veins involved with significant narrowing (3,4,5 degree)**	**Kruskal-Wallis ANOVA Test**	**"U" Mann-Whitney / Chi² Tests**	**All examined patients**
Number of patients (number of the group)	**1108 (1)**	**1152 (2)**	**665 (3)**	**77 (4)**			**3002**
Presented values	Mean ± sd N (%)	Mean ± sd N (%)	Mean ± sd N (%)	Mean ± sd N (%)	**P 1,2,3,4**	**P 1 *vs* (2,3,4) 1 *vs* (3,4) 1 *vs* 4**	Mean ± sd N (%)
TLE procedure complicity							
Procedure duration (skin to skin) [minutes]	58,26 ±24,17	58,18 ± 20,94	62,87± 31,57	81,30 ± 50,28	<0,001	0,100 <0,001 <0,001	59,84 ± 26,15
Procedure duration (sheath to sheath) [minutes]	12,81 ± 20,34	12,89 ± 17,26	18,59 ± 29,04	38,81 ± 53,57	<0,001	<0,001 <0,001 <0,001	14,78 ± 23,39
Average time of single lead extraction. (sheath-to sheath / number of extracted leads) [minutes]	8,259 ± 13,23	8,055 ± 10,23	9,464 ± 13,91	16,23 ± 18,15	<0,001	0,264 <0,001 <0,001	8,649 ± 12,55
All leads were extracted	860 (77,61)	855 (74,22)	500 (75,19)	61 (79,21)	0,229		2276 (75,82)
Functional lead was left for continuous use	241 (21,75)	291 (25,26)	162 (24,36)	13 (16,88)	0,087	0,074 0,298 0,251	707 (23,55)
Non-functional lead was left	4 (0,361)	2 (0,174)	2 (0,301)	4 (5,195)	0,093	0,961 0,332 <0,001	12 (0,400)
Non-functional, superfluous lead was extracted	81 (7,310)	87 (7,552)	99 (14,89)	22 (28,71)	<0,001	<0,001 <0,001 <0,001	289 (9,627)
Technical problem during TLE (any)	204 (18,41)	213 (18,49)	162 (24,36)	29 (37,66)	<0,001	0,087 <0,001	608 (20,25)

						<0,001	
Block in lead venous entry (subclavian region)	79 (7,130)	80 (6,944)	70 (10,53)	12 (15,58)	<0,001	0,128 0,002 0,004	241 (8,028)
Lead to lead strong connection with scar	62 (5,596)	74 (6,424)	60 (9,023)	16 (20,78)	<0,001	0,017 0,765 0,138	212 (7,062)
Byrd dilator collapse / torsion / "fracture"	35 (3,159)	32 (2,778)	29 (4,361)	7 (9,091)	0,038	0,663 0,100 0,025	103 (3,341)
Extracted lead break / rupture during extraction	47 (4,242)	64 (5,556)	39 (5,865)	12 (15,58)	<0,001	0,022 0,182 <0,001	162 (5,396)
Necessity to change venous approach	25 (2,256)	34 (2,951)	26 (3,910)	16 (20,78)	<0,001	0,011 <0,001 <0,001	101 (3,364)
Functional lead dislodgement	14 (1,264)	13 (1,128)	3 (0,451)	0 (0,00)	0,298		30 (0,999)
Loss of free lead fragment	4 (0,361)	2 (0,174)	3 (0,451)	2 (2,597)	0,007	0,961 0,332 0,006	11 (0,366)
Number of big technical problems	1,321 ±0,668	1,357 ± 0,668	1,379 ± 0,632	1,731 ± 1,151	<0,001	0,091 <0,001 <0,001	1,368 ± 0,696
One technical problem only	126 (11,37)	123 (10,68)	95 (14,29)	15 (19,48)	<0,001	0,648 0,055 0,035	359 (11,96)
Two technical problems	30 (2,708)	33 (2,865)	31 (4,662)	6 (7,792)	<0,001	0,103 0,026 <0,001	100 (3,331)
Three or more technical problems	9 (0,812)	12 (1,042)	9 (1,353)	5 (6,494)	<0,001		35 (1,155)
Utility of additional tools							
Evolution (old and new) or TighRail	12 (1,063)	13 (1,128)	15 (2,259)	6 (7,792)	<0,001	0,198 0,005 <0,001	46 (1,533)
Metal sheath	72 (6,498)	80 (6,944)	67 (10,09)	12 (15,58)	<0,001	0,043 <0,001 <0,001	231 (7,697)
Lasso catheter / snare	29 (2,617)	40 (3,472)	24 (3,614)	8 (10,39)	<0,001	0,103 0,029 <0,001	101 (3,366)
Basket catheter	13 (1,173)	5 (0,434)	7 (1,054)	2 (2,597)	0,047	0,121 0,877 0,259	27 (0,900)

sd – standard deviation, N – number, TLE – transvenous lead extraction

TLE procedure is much more time-consuming, difficult and skill-demanding in patients with two or more veins involved with significant narrowing. The OR of influence of the number of levels of MLVSO and above mentioned complications is also presented in Figure S1.

Figure S1



	Univariable regression results		
	OR	95%CI	P
Technical problem during TLE (any)	1.250	1.125-1.389	<0.001
Block in lead venous entry (subclavian region)	1.296	1.118-1.503	<0.001
Byrd dilator collapse / torsion / "fracture"	1.248	1.000-1.558	0.050
Extracted lead break / rupture during extraction	1.354	1.102-1.664	0.004
Necessity to change venous approach	1.857	1.513-2.279	<0.001
One technical Problem only	1.154	1.016-1.310	0.027
Two Technical Problems	1.460	1.174-1.814	<0.001
Three or more Technical Problems	3.503	2.119-5.791	<0.001
Utility of Evolution (old and new) or TighRail	1.667	1.239-2.244	<0.001
Utility of metal sheath	1.341	1.154-1.558	<0.001
Utility of Lasso catheter / snare	1.389	1.115-1.731	0.003
Major Complications (any)	1.309	0.996-1.720	0.053
Hemopericardium	1.362	0.977-1.899	0.068
Haemothorax	2.115	0.955-4.683	0.065
Rescue cardiac surgery	1.706	1.230-2.367	<0.001
Minor complications (any)	1.221	1.045-1.428	0.012
Partial radiological success	1.342	1.098-1.641	0.004
Full Clinical Success	0.759	0.574-1.003	0.052
Full Procedural Success	0.787	0.650-0.935	0.014

Figure S1 Univariate regression analysis of the influence of multilevel venous obstruction/stenosis on the difficulty of lead extraction

The log-rank analysis of the Kaplan Meier survival curves showed no effect of the multi-level nature of venous stenosis/occlusion on long-term survival (log rank p = 0.437, Figure S2).

Figure S2

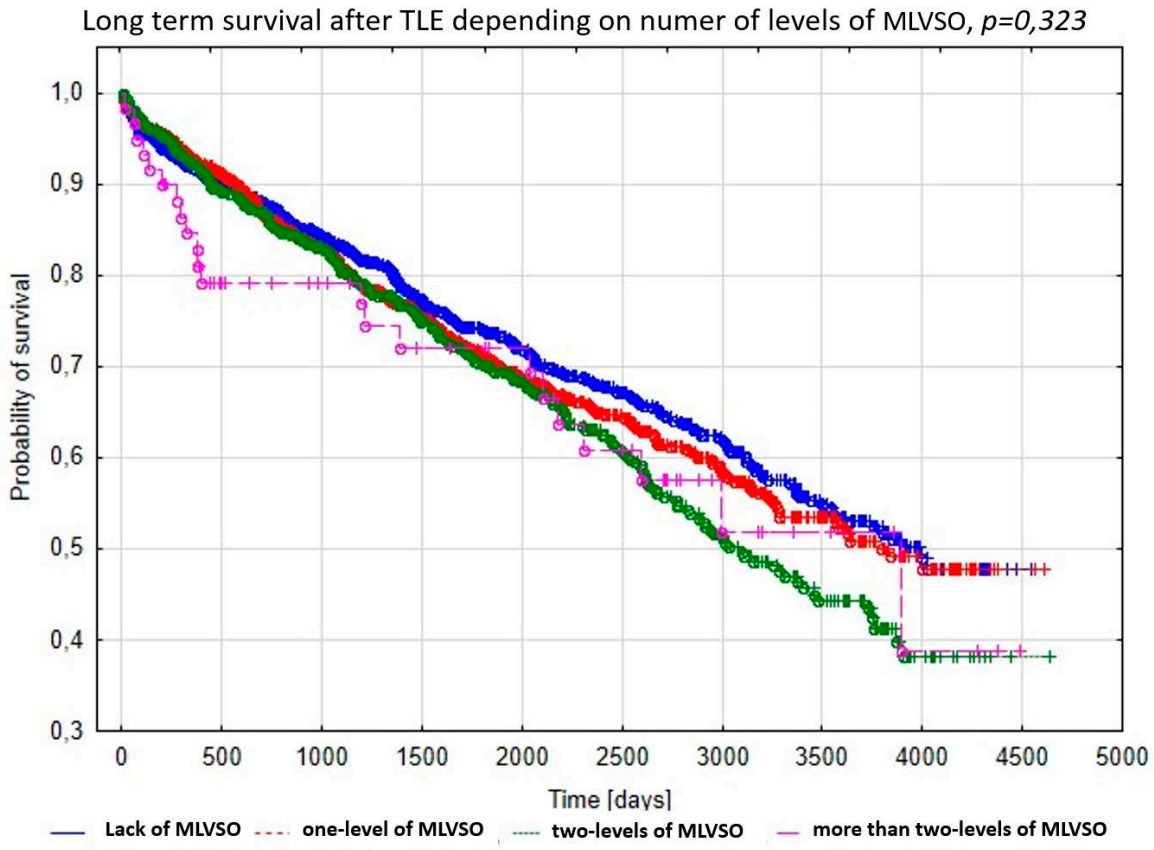


Figure S2 Kaplan Meier survival curves of patients with MLVSO undergoing TLE