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TABLE 1 Demographics and Outcomes of Minimal Approach to Left Atrial Appendage Occlusion

	PWH, April 2014 to September 2015 (n = 17)	CCB + NH, October 2016 to September 2017 (n = 14)
Demographics		
Male	12 (70.6)	8 (57.1)
Age (yrs)	69 ± 6.8	79 ± 7.0
CHA_2DS_2-VASc score	3.9 ± 1.3	4.6 ± 1.5
HAS-BLED score	2.8 ± 0.9	4.5 ± 0.8
Procedural outcomes		
Procedural time (min)	89.1 ± 22.6*	36.1 ± 18.0†
Fluoroscopy time (min)	12.5 ± 4.3	7.6 ± 8.8
Length of stay (days)	2.3 ± 1.0	2.1 ± 0.3
Device success	17 (100.0)	14 (100.0)
Periprocedural complications	0	0
Follow-up TEE		
Peridevice leak		
Significant (>5 mm)	0	0
3–5 mm	1	2
<3 mm	7	1
Device-related thrombus	0	0
Clinical outcomes		
Median follow-up duration (months)	39.3 (4–45)	9 (3–14)
Ischemic stroke	0	0
ICH	1 (5.9)	0
CV death	2 (11.8)	0
Non-CV death	2 (11.8)	0
Major bleeding events	0	0

Values are n (%), mean ± SD, or median (range). *Procedural time defined as total catheterization laboratory on-table time. †Procedural time defined as wound puncture to closure time.

CCB = Cardioangiologisches Centrum Bethanien; CV = cardiovascular; ICH = intracranial hemorrhage; NH = Neubrandenburg Hospital; PWH = Prince of Wales Hospital; TEE = transesophageal echocardiography.

ICE in the coronary sinus, right ventricular outflow tract, left pulmonary artery, or left atrium may improve image quality, but not without risk.

To the best of our knowledge, this is the first reported case series of MALAAO using LAmbre, which appeared feasible and safe. This approach might be adopted as the initial approach to LAAO or an alternative for those at risk for TEE (e.g., esophageal varices) or who wish to avoid repeat TEE. However, evaluation in larger number of patients from different populations and institutions is needed before wide-ranging adoption of this approach.

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RESEARCH CORRESPONDENCE

Early Introduction of Pulmonary Endarterectomy or Balloon Pulmonary Angioplasty Contributes to Better Health-Related Quality of Life in Patients With Chronic Thromboembolic Pulmonary Hypertension

Pulmonary endarterectomy (PEA) and balloon pulmonary angioplasty (BPA) have showed beneficial effects on hemodynamics and exercise tolerance in patients with chronic thromboembolic pulmonary hypertension (CTEPH) (1,2). Although several publications have demonstrated improvement in health-related quality of life (HRQOL) after treatment with PEA or BPA, as measured by Medical Outcome

Study 36-Item Short Health Survey (SF-36), residual impairment in HRQOL frequently remains (3,4). The factors that cause impaired HRQOL following invasive therapies are not well delineated. We sought to identify factors significantly affecting HRQOL after invasive therapies for CTEPH.

Between January 2014 and December 2016, 48 patients were diagnosed as CTEPH in Kobe University Hospital. The diagnostic procedures and the indications for invasive therapies have been described previously (2). Of the 48 patients, 39 patients were treated invasively (PEA in 15 and BPA in 24) with completed follow-up including HRQOL questionnaires. In addition to clinical parameters, we assessed time from symptom onset to invasive therapy (time to treatment [TT]). This study was approved by the ethic committee of Kobe University Graduate School of Medicine (approval no. 160171). We used SF-36 version 2 as the HRQOL measurement. Eight subscales (physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, and mental health) were calculated from questionnaires. Subscales normalized to the general population and scaled to a national average of 50 and a standard deviation of 10, and 2 summary scores (physical component summary and mental component summary) were then obtained.

Continuous variables are expressed as mean ± SD. Differences between 2 groups were determined using the Mann-Whitney *U* test. Changes before and after invasive therapies were determined using the Wilcoxon signed rank test. Differences in frequencies were analyzed using the chi-square test. The Spearman correlation coefficient value was computed to measure a linear relationship between clinical parameters and HRQOL scores. A p value <0.05 was considered statistically significant.

Invasive therapies showed beneficial effects on hemodynamic parameters: mean pulmonary arterial pressure (37.6 ± 10.7 mm Hg to 22.9 ± 7.6 mm Hg), pulmonary vascular resistance (PVR) (10.3 ± 5.2 Wood units to 4.3 ± 2.1 Wood units), oxygen saturation (90.5 ± 4.1% to 94.3 ± 3.4%), and brain natriuretic peptide (285 ± 324 pg/ml to 90 ± 123 pg/ml). The 6-min walk distance (6MWD) improved (336 ± 123 m to 375 ± 115 m). Except for bodily pain, all HRQOL scores significantly improved after invasive therapies: physical functioning (21.8 ± 18.3 to 35.9 ± 14.9), role physical (28.3 ± 17.3 to 38.6 ± 13.7), bodily pain (48.1 ± 13.2 to 47.3 ± 10.4), general health (37.5 ± 10.8 to 45.5 ± 9.4), vitality (43.5 ± 12.4 to 50.0 ± 8.9), social functioning (35.7 ± 14.9 to 43.8 ± 12.9), role emotional (36.4 ± 17.2 to 42.6 ± 16.2), mental health (46.0 ± 11.1 to 52.0 ± 8.5), physical component summary (23.2 ± 16.8 to 34.0 ± 14.6), and mental component summary (50.9 ± 9.0 to 54.4 ± 7.4). However, most of the HRQOL scores were under a national average of 50. We analyzed the correlation between HRQOL scores and clinical parameters. Four of 8 subscales showed significant correlations with clinical parameters; physical functioning with TT ($r = -0.42$; $p = 0008$), mixed venous oxygen saturation (Svo_2) ($r = 0.35$; $p = 0.043$), and 6MWD ($r = 0.48$; $p = 0.003$); role physical with age ($r = -0.36$; $p = 0.024$), TT ($r = -0.34$; $p = 0.024$), PVR ($r = -0.37$; $p = 0.021$), Svo_2 ($r = 0.49$; $p = 0.003$), and 6MWD ($r = 0.44$; $p = 0.008$); social functioning with

TABLE 1 Parameters After Invasive Therapies Stratified by Time From Symptom Onset to Invasive Therapy

	Early Group (n = 20)	Late Group (n = 19)	p Value
Age, yrs	61.8 ± 13.8	64.6 ± 11.6	0.647
Female	16 (80)	14 (73.7)	0.465*
Time from symptom onset to invasive therapy, months	12.3 ± 4.4	72.1 ± 42.6	<0.001
Time from invasive therapy to follow-up, months	12.6 ± 8.7	10.1 ± 8.7	0.127
Invasive therapy, PEA/BPA	5/15	10/9	0.076*
WHO-FC, I/II/III/IV	4/5/11/0	2/2/15/0	0.214
BNP, pg/ml	63.3 ± 116.3	119.2 ± 127.0	0.119
mPAP, mm Hg	20.9 ± 5.9	25.1 ± 8.7	0.224
Fick CI, l/min/m^2	2.41 ± 0.42	2.28 ± 0.63	0.428
TD CI, l/min/m^2	2.72 ± 0.37	2.72 ± 0.95	0.633
PVR, Wood units †	3.75 ± 1.50	4.88 ± 2.55	0.095
Sao_2, %	94.4 ± 3.8	94.2 ± 3.0	0.584
Svo_2, %	69.4 ± 5.3	65.3 ± 5.6	0.043
6MWD, m	400 ± 118	344 ± 102	0.227
Peak Vo_2, ml/min/kg	16.8 ± 3.2	16.0 ± 6.4	0.418
VE/VCo_2 slope	32.4 ± 3.9	35.1 ± 10.8	0.448
HRQOL scores, normalized score (raw score)			
Physical functioning	42.1 ± 13.7 (76.5 ± 19.4)	29.4 ± 13.6 (58.4 ± 19.3)	0.006
Role physical	42.6 ± 13.3 (75.0 ± 24.3)	34.3 ± 13.2 (59.9 ± 24.1)	0.044
Bodily pain	47.9 ± 11.1 (69.3 ± 25.1)	46.7 ± 9.9 (66.6 ± 22.4)	0.749
General health	48.6 ± 9.6 (61.4 ± 17.8)	42.2 ± 8.2 (49.7 ± 15.2)	0.054
Vitality	52.7 ± 8.4 (67.5 ± 17.2)	47.2 ± 8.8 (56.3 ± 17.8)	0.044
Social functioning	44.3 ± 15.6 (75.6 ± 29.7)	43.3 ± 9.8 (73.7 ± 18.6)	0.411
Role emotional	46.8 ± 15.7 (80.8 ± 30.8)	38.2 ± 15.9 (64.0 ± 31.2)	0.079
Mental health	55.1 ± 7.6 (81.3 ± 14.2)	48.7 ± 8.4 (69.2 ± 15.7)	0.016
Physical component summary	38.8 ± 13.9	28.9 ± 14.0	0.015
Mental component summary	55.6 ± 6.1	53.1 ± 8.5	0.247

Values are mean ± SD, n (%), or n. p Values were from the Mann-Whitney *U* test or *chi-square test. †PVR was calculated by using the value of Fick CI.

6MWD = 6-min walk distance; BNP = brain natriuretic peptide; BPA = balloon pulmonary angioplasty; CI = cardiac index; HRQOL = health-related quality of life; mPAP = mean pulmonary arterial pressure; PEA = pulmonary endarterectomy; PVR = pulmonary vascular resistance; Sao_2 = arterial oxygen saturation; Svo_2 = mixed venous oxygen saturation; TD = thermodilution; VE/VCo_2 = minute ventilation/carbon dioxide production; Vo_2 = oxygen uptake; WHO-FC = World Health Organization functional class.

PVR (r = −0.37; p = 0.022); role emotional with Svo_2 (r = 0.46; p = 0.006) and 6MWD (r = 0.44; p = 0.008). Physical component summary significantly correlated with TT (r = −0.36; p = 0.024), PVR (r = −0.38; p = 0.019), Svo_2 (r = 0.53; p = 0.001), and 6MWD (r = 0.52; p = 0.001). From these results, we stratified the patients by TT (Table 1). Patients whose TT were less than median were defined as the early group, and the others were defined as the late group. There were no significant differences in most of the clinical parameters except for Svo_2 between 2 groups. However, the late group showed significantly lower HRQOL scores (physical functioning, role physical, vitality, mental health, and physical component summary) than the early group.

In the present study, we found that PVR, Svo_2, 6MWD, and TT correlated with HRQOL after invasive therapies. Although most hemodynamic parameters and exercise tolerance were not significantly different between the 2 groups, the HRQOL parameters in the late group were significantly lower than those in the early group in 4 of 8 subscales and in the physical component summary, suggesting that early introduction of invasive therapy in CTEPH can result in better HRQOL.

This study had several limitations. Firstly, it was a retrospective, single-center, and small-sized study. Second, SF-36 is not a CTEPH-specific HRQOL measurement tool, but rather a comprehensive measurement of HRQOL. It might be better to use a disease-specific tool for assessing the effects of invasive therapies in this population. To the best of our knowledge, this is the first study to investigate the factors affecting HRQOL after invasive therapies. In addition to normalization of hemodynamics and exercise tolerance, early use of invasive therapies in appropriately selected CTEPH patients can result in better quality of life.

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