KINESITHERAPEUTIC INFLUENCE ON PHYSICAL TOLERANCE AFTER TRANSCATHETER AORTIC VALVE IMPLANTATION

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ABSTRACT

Cardiac rehabilitation is a customized in-hospital and outpatient program of therapeutic exercises and education, designed to improve the recovery of patients with a various heart diseases, cardiac surgery or implantation.

The aim of the present study is to evaluate the effect of three months of kinesitherapy on the functional mobility in patients post transcatheter aortic valve implantation (TAVI). 31 patients were referred for in-hospital and home based kinesitherapy for three months after TAVI. The subjects underwent four assessments in-hospital and after discharge to evaluate their functional abilities, muscle strength and muscle endurance with the following tests – six minutes walking test (6MWT), five times sit-to-stand test (FTSTS), Borg scale and dynamometry of the upper limbs.

All patients had significant improvement in their physical tolerance. The time for performing the FTSTS test decreased with 3 sec on the 3rd month, which indicates improvement in their functional lower limb muscle strength. Positive changes in muscle strength of the upper limbs were also noted.

The kinesitherapeutic program benefits all the patients after TAVI in regards to their walking performance and their upper and lower limbs muscle strength.

Key words: exercise therapy, cardiology, geriatric

INTRODUCTION

Transcatheter aortic valve implantation (TAVI) is an alternative intervention mainly for elderly patients with contraindications to surgical aortic valve replacement. Cardiac rehabilitation (CR) is a well-established therapeutic approach for people with cardiac disease. Regular physical activity is an essential part of treatment in geriatric patients. It demonstrates preventative and therapeutic effects on many chronic conditions (Fauchere, et al., 2014).

Patients after TAVI, are candidates for referral to exercise-based patient-centered kinesitherapy (KT) to reduce prolonged limitation in functional abilities and to increase independency for daily life activities and participation in socio-cultural life (Ribeiro, et al., 2017). To ensure better treatment plan and positive results, many components should be taken into consideration in the assessment of patients, as comorbidities, physical condition, motivation etc.

The aim of the present study is to evaluate the effect of three months of KT on the functional mobility in patients after TAVI.

METHODS

31 patients (15 male, 16 female; mean age $78,4 \pm 3,1$; NYHA III-IV before TAVI) referred for KT underwent 4 assessments in-hospital and after discharge to evaluate the muscle strength and muscle endurance with the following tests – five times sit-to-stand test (FTSTS), Borg scale and dynamometry of the upper limbs. The assessments were performed before TAVI procedure, on the day of hospital discharge, on the 1st and 3rd month after TAVI procedure.

The Borg Scale assesses the intensity of breathlessness during the physical exertion. It is a 10-point scale (0-10 points) for subjectively determining the level of exertion. The higher the number of points, the greater is the feeling of shortness of breath (Borg, 1982). The timing of FTSTS test performance is important for the patient's ability to perform functional activities and for the functional strength of their lower limbs. Normative values are 11,4 sec (60-69 years), 12,6 sec (70-79 years) and 14,8 sec (80-89 years) (Bohannon, 2006). The grip strength was measured with a conventional electronic hand dynamometer EH101, with the patient in a standing position with their arm extended straight down on the side of the body.

Three attempts are made for each hand and the best result is taken into consideration in the results. In our study the right hand was the dominant for all subjects. The patients enrolled in the current study, were chosen based on the following inclusion criteria (TAVI patients above the age of 70; male or female; signed informed consent) and

exclusion criteria (unstable clinical condition - according to treating physician; handicap before the procedure; recent stroke; decompensate diabetes mellitus type II; severe cognitive decline). Patients' sociodemographic and concomitant diseases' characteristics were collected at the beginning of the study [Table 1].

Table 1. Baseline characteristics of the patients before implantation

Parameters	TAVI n=31
Age (years) mean±SD	78,4±3,1
Male – n	15
Female – n	16
BMI male (kg/m ²)	23,9±0,8
BMI female (kg/m ²)	24,8±1,2
NYHA class	3,2±0,2
Cumulative Illness Rating Scale	10,9±3,9
COMORBIDITIES N	
CHD	31
Peripheral vascular disease	8
Arterial hypertension	28
Pulmonary diseases	7
Renal diseases	12
Diabetes mellitus	8
Gastrointestinal diseases	14
Anaemia	10
Osteoarthritis	10
PREVIOUS DISEASES N	
Prev MI	2
Prev PCI	2
Prev CABG	7
Stroke/TIA	4
SMOKING STATUS N	
Current smoker	7
Smoking history	17
Never smoked	7

SD-standard deviation; BMI-Body Mass Index; NYHA-New York Heart Association; CHD-chronic ischaemic heart disease; MI-myocardial infarction; PCI-percutaneous coronary intervention; CABG-coronary artery bypass graft; TIA- Transient Ischemic Attack

Exercise protocol for in-hospital kinesitherapy

Exercise protocol for in-hospital KT was performed twice daily, with low intensity (40-50% HR max), duration from 10-15 min to 30-45 min, on average for 10 days. KT was individually tailored, in connection with the patient's goals for everyday life activities. The protocol included educating the patients on proper mobility and performance of daily life activities, mobilization to sitting, standing and slow walking at least six minutes daily; rhythmic exercises for the distal parts of the limbs, exercises for gradually strengthening the upper and the lower limbs, diaphragmatic and chest breathing, breathing with

a device (Coach2 Incentive Spirometer) for inspiratory training, isometric exercises in circular mode. The feedback breathing device for inspiratory training was applied to all patients with the instruction to make 5 repetitions with 1 to 3 min rests between them, at least 4-5 times a day, every day of the week during hospital stay (Grigorova-Petrova, 2018). The exercises were performed in supine position with a raised upper part of the body, in sitting or in standing position. Blood pressure, heart and breathing rate, saturation and electrocardiography were monitored. The terminating criteria for performing the exercises were in accordance the evidence-based

recommendations for effective and safe diagnostic assessment and intervention strategies for the KT treatment of patients in intensive care units (Somers, et al., 2015).

Exercise protocol for home-based exercise program

Home-based KT was performed twice daily, every day, for 3 months. All the patients were given a device for inspiratory training and a booklet with instructions for exercising at home with a description of all therapeutic exercises and how to increase gradually the walking distance, stairs climbing, daily activities, etc. The patients were instructed how to measure their heart rate during the exercises at home. The indications for discontinuing the exercising are arrhythmia, tachycardia, precordial pain or chest discomfort, a change in the breathing pattern with inclusion of additional respiratory muscles, severe fatigue or dyspnea, muscle weakness, patient's desire to discontinue.

Statistical analysis

All statistical analyses were performed using SPSS for Windows, Version 19.0. The level of significance was set at p less than 0.05. All data subsets were assessed for the presence of a normal distribution (Shapiro-Wilk test $p > 0.05$) and for homogeneity with Levene's test for equality of variance before using parametric analysis. Differences between data in Six minutes walking test, Borg Scale and FTSTS were assessed by repeated measures analysis of variance with post hoc multiple comparisons by t-test with Bonferroni corrections.

RESULTS

The patients were observed over the study period of 3 months (Table 2). We compared the effect of KT in patients after TAVI on breathlessness, and functional strength of the lower and upper limbs in 4 time points.

Table 2. *Changes in physical activity and dyspnea (mean value and standard deviation) in the patients over the study period*

TEST	mean values $\pm$ SD			
	before TAVI	on hospital discharge	1 st month	3 ^d month
Borg scale (points)	6,6 $\pm$ 2,6	4,2 $\pm$ 2,4	2,8 $\pm$ 1,6	1,9 $\pm$ 1,4
p-value	0,001^a			
FTSTS (sec)	21,9 $\pm$ 0,8	20,8 $\pm$ 0,2	19,0 $\pm$ 0,2	17,1 $\pm$ 0,2
p-value	0,009^a			

TAVI-transcatheter aortic valve implantation; FTSTS-5 times sit-to-stand; ^a-RM ANOVA; SD-standard deviation

The patients had decreased the levels of dyspnoea with 4,7 points in the mean values after 3 months of KT. Their score in mean values decreased from 6,6 points (very strong dyspnea) to 1,9 points (weak dyspnea). Improvement in the functional lower limbs muscle strength was observed because the

time for performing the FTSTS test decreased with 4,8 sec on the 3rd month compared to the condition before TAVI in mean values. Both men and women improved their left and right hand grip strength in mean values. (Figure 1, 2).

Figure. 1 *Changes in the strength of the upper limbs in the mean values of the women*

Figure 2. *Changes in the strength of the upper limbs in the mean values of the men*

The mean difference of the grip strength for the non-dominant left hand in women before TAVI and 1 month after was 0,7 kg and increased to nearly 8 kg on the 3rd month. The mean difference for the dominant right hand before TAVI and 1 month after was 1,9 kg and increased to 8,4 kg on the 3rd month. The mean difference of the grip strength for the non-dominant left hand in men before TAVI and 1 month after was 2,5 kg and increased to 5,5 kg on the 3rd month. The mean difference of the hand grip strength for the dominant hand before TAVI and 1 month after was 6 kg and increased to 8,2 kg on the 3rd month.

DISCUSSION

The role of the KT as a part of the clinical management of patients after TAVI is to maintain independency in daily life activities and participation in socio-cultural life (Russo, 2014).

The hand grip strength is a simple measure for screening and predicting important treatment outcomes such as length of in-hospital stay, complications after surgery, survival for elderly patients (Bohannon, 2008). Dominant hand grip strength is a marker that reflects frailty associated with incremental risks for late mortality. The prognostic value and optimal threshold of grip strength are not fully validated in elderly patients who undergo TAVI (Kagase, et al., 2018). There are different scales for average values depending on gender, age, dominant hand or body mass index. According to the hand grip strength average tables the mean value for men between 70-99 years old is 21,3-35,1 kg and for women between 70-99 years old is 14,7-24,5

kg (<https://www.prohealthcareproducts.com/blog/hand-grip-strength-norms/>). In another study the grip strength was assessed as the average of 3 trials of maximal isometric grip measured in kilograms using a Jamar dynamometer (Sammons Preston, Chicago, IL). Grip strength was considered weak if it was <17,3 kg for women with BMI between 23,1–26 and <30 kg for men with BMI between 24,1–28 (Fried, et al., 2001). A study conducted in Sweden reported the mean average values for healthy men 75-79 years of age for the dominant hand to be 36,8 kg and for the non-dominant hand to be 36,6 kg. The average mean values for healthy women 75-79 years of age are 25,0 kg for the dominant hand and 23,7 kg for the non-dominant hand (Werle, et al., 2009). The grip strength is considered to be a reflection of overall muscle mass and fitness in adults, and it is an indicator of muscle strength in aging people. Many authors recommend the importance of grip strength assessment before and after TAVI (Kagase, et al., 2018; Shimura, et al., 2017). The results of the current study demonstrated that peak grip strength was a useful marker for predicting all-cause mortality following TAVI, particularly the non-cardiac related deaths (Shimura, et al., 2017). In a recent large study with 281 men and 646 women after TAVI the grip strength was measured with a conventional dynamometer before TAVI, with the patient in a standing position with an arm extended straight down to the side. The mean peak grip strength was $17,9 \pm 6,9$ kg in the overall cohort, $24,5 \pm 7,0$ kg in men, and $15,0 \pm 4,3$ kg in women (Kagase, et al., 2018). The grip strength of our patients is above the average values for gender, age, dominant and non-dominant hand and body mass

index.

The FTSTS test is a simple measure to assess the lower limb muscle strength and the risk of falls. Average values are 11,4 sec (60-69 years), 12,6 sec (70-79 years) and 14,8 sec (80-89 years) (Bohannon, 2006). Patients with results over 15 sec are considered to have an increased risk of falling. A change of 2.3 sec is significant (Bohannon, 2006). Our patients' results decreased significantly from $21,9 \pm 0,8$ sec to $17,1 \pm 0,2$ sec in mean values but the risk of falling still remained.

CONCLUSION

The applied three-month KT program benefits all participating patients' upper and lower limbs muscle strength compared with their baseline results and decreased dyspnea.

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