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Inter-relation between Variables of Physical Disability in Postoperative Patients with Adult Hip Disorders: A Statistical Approach

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The inter-relation between variables of physical disability in patients with hip disorders is unclear. Two hundred and twenty-three postoperative hip patients (female: 187, male: 36, a mean age at follow up: 61.6 years, a mean follow up period: 8.2 years, bilateral involvement: 121, hip replacement: 152 hips, osteotomies: 49 hips) were evaluated with the Japanese Orthopaedic Association (JOA) hip score. A mean of total JOA hip score was 74.4. Eleven variables of activities of daily living (walk, sit on chair, stand to work, squat, stairs, public transport, sit on floor in Japanese style, bow while sit on floor in Japanese style, put on socks, cut toenails, and unipedal stand, each categorized as unable, difficult, and easy) were analyzed to describe the inter-relation between the variables in a two-dimensional space graphically by correspondence analysis. Spearman correlation and correspondence analysis found that sit on chair and stand to work are independent variables. Identification of a large group of variables consisting of walk, stairs, public transport, and squat may suggest that they all are inter-related each other and dependent on some dynamic hip function.

Key Words: Hip joint, Disability, Outcome evaluation, Multivariate analysis.

Introduction

Almost all adult hip diseases are slowly progressive and result in joint impairment. Patients with these diseases experience functional deterioration and difficulty in physical activities of daily living (ADL) such as long-distance walking, stair climbing, and standing up from floor because of impaired joint function. Conservative treatment often fails in the long run and surgical treatment is then required in their clinical course. Surgeries such as osteotomy or total hip replacement do not always provide recovery to normal functional. Some patients have some degree of long-term or permanent

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impairment and disability that could increase with time postoperatively[1,2].

Identification of existing impairment and disability is an integral component of treatment planning in physical therapy. Relationship between joint impairment and disability has been reported in the elderly and patients with hip and knee osteoarthritis[3-5]. However, disability in hip disorders has not been studied extensively in terms of its inter-relation and dimensionality, description of which will help understand hip function in normal and abnormal conditions and plan rehabilitation programs for symptomatic hip patients.

In this study we attempted to evaluate variables of ADL in postoperative patients with adult hip disorders by using hip score and then examine the correlation between these inter-related variables. We further tried to describe the inter-relation between the variables graphically in a low-dimensional space by using corresponding analysis.

Materials and Methods

Demographic and characteristics of patients are shown in Table 1. Two hundreds and twenty-three patients who underwent surgical procedures of the hip joint(s) were evaluated in an outpatient clinic of the Kobe University Hospital between May 2000 and June 2001. One hundred and eighty-seven (84%) were female and 36 (16%) were male and 121 (54%) had bilateral involvement. A mean age at follow up was 61.6±13.7 years and a mean of postoperative period was 8.2 ± 6.1 years. A mean of the total Japanese Orthopaedic Association (JOA) hip score at follow up was 74.4 ± 13.8. Forty-nine (22%) underwent pelvic or femoral osteotomy as the latest operation and 152 (68%) did primary total hip replacement, femoral head replacement or revision total hip replacement. Ten percent underwent other operations such as cup arthroplasty, shelf operation, etc.

Table 1. Demographic and characteristics of hip patients.
fu = follow up, ope = operation, involv = involvement, JOA = the Japanese Orthopaedic Association, THR = total hip replacement, FHR = femoral head replacement.

total	223
women	187(84%)
mean age at fu	61.6±13.7
mean age at ope	53.4±15.5
mean fu period	8.2±6.1
bilateral involv	121(54%)
mean JOA score	74.4±13.8
surgeries	
joint replacement	
THR	100
FHR	30
revision	22
osteotomy	
pelvic	16
femoral	33
others	22

An ADL part of JOA hip score was used to evaluate physical disability by face-to-face interview. It contains 11 variables: walking ability, sitting on chair, standing to work, squatting or standing up from floor, stair climbing, public transportation, sitting on floor in Japanese style (so called seiza), bowing while sitting on floor in Japanese style, putting on socks, cutting toenails, and unipedal standing. Each variable was scored in 3 grades (0: unable, 1:

difficult, 2: easy) with respect to disability levels except for walking, which was scored in 6 grades. The walking grades were 0: unable to walk at all, 1: walking indoor only, 2: possible 10-15 min or 500m without cane and, if more, requires cane, 3: possible 30 min or 2km without cane, almost no limitation outdoor, 4: possible long distance but mild limping, 5: normal gait. Six grades of walking were then lowered to 3 grades so as to meet other variables, where a walking grade 0 was categorized as unable, grades 1-3 were as difficult and grades 4 and 5 were as easy for the following statistical analysis that requires an equal number of categories to be prepared in all variables. This procedure of lowering the walking grades would be reasonable to consider their definition. These data were handled as qualitative thereafter.

The scores of these 11 variables were calculated to obtain Spearman correlation coefficients (SPSS Base 10.0 J, Tokyo, Japan) and then submitted to correspondence analysis (SPSS Categories 10.0 J, Tokyo, Japan) with a personal computer.

Results

Table 2 shows correlation matrix of the 11 ADL variables. Forty-six out of total fifty-five Spearman correlation coefficients were statistically significant but only five were higher than 0.50. Among the 11 variables, sitting on chair correlated very poorly with every other variable, indicating that it is an independent variable. Standing to work also has small coefficients with other variables. In contrast to these, strong correlation ($r > 0.7$) was found between public transport and stair climbing ($r = 0.78$), sitting in Japanese style and bowing while sitting in Japanese style ($r = 0.76$), and cutting toenails and putting on socks ($r = 0.87$).

Table 2. Matrix of Spearman correlation coefficients of the ADL variables.
Numbers in italic style in the cells mean statistically significant ($p<0.01$).
pub = public transport, japsit = sitting on floor in Japanese style, bowsit = bowing while sitting in Japanese style, toe = cutting toenails, upst = unipedal standing (see text).

Spearman Correlation Coefficient											
walk	1.00										
sit	0.15	1.00									
stand	*0.40*	0.22	1.00								
squat	*0.54*	0.11	*0.27*	1.00							
stair	*0.63*	0.13	*0.29*	*0.61*	1.00						
pub	*0.58*	0.12	*0.29*	*0.61*	*0.78*	1.00					
jasit	*0.32*	0.18	*0.34*	*0.32*	*0.31*	*0.29*	1.00				
bowsit	*0.39*	0.15	*0.28*	*0.42*	*0.38*	*0.38*	*0.76*	1.00			
socks	*0.44*	*0.19*	*0.29*	*0.35*	*0.36*	*0.28*	*0.28*	*0.42*	1.00		
toe	*0.45*	0.16	*0.30*	*0.34*	*0.37*	*0.31*	*0.30*	*0.43*	*0.87*	1.00	
upst	*0.50*	0.14	*0.36*	*0.41*	*0.43*	*0.46*	*0.35*	*0.36*	*0.30*	*0.37*	1.00
	walk	sit	stand	squat	stair	pub	jasit	bowsit	socks	toe	upst

The numbers and percentage of the patients corresponding between the ADL variables and their disability levels were shown in Table 3. Among the all variables, the patients showed a unique frequency pattern to sitting on chair and standing to work, where none or very small numbers are scaled as unable or difficult. Although some similarity of walking to these two variables, with only 0.4% scaled as unable, was detected, as much as 75% were scaled as difficult in walking. This indicated that long-distance walking is much more difficult than sitting on chair and standing to work. Other two groups could be recognized with possible exclusion of bowing while sitting on floor. One consisted of squatting, stair climbing, public transport and cutting toenails and was characterized by 50-70% difficult and 30-40% easy, which was similar to walking to some extent. The other consisted of sitting on floor in Japanese style and unipedal standing with about 10% unable, 20% difficult, and 70% easy.

The data of correspondence table were further processed to correspondence analysis to describe graphically the inter-relation between the ADL variables in terms of disability levels. It revealed two dimensions to represent the underlying relationship between the ADL variables. The first dimension explained 84% and the second dimension did 16% of the total inertia. Figure 1 displays a scatterplot of the all variables against the two dimensions. A large group consisting of walking, stair climbing, putting on socks, public transport, and squatting could be identified. Another group was unipedal standing and sitting on floor in Japanese style, and possibly bowing while sitting on floor. Sitting on chair was located farthest from the origin (a mean of the variables) and was near standing to work. This strongly suggested that these two are very different variables from others.

Discussion

It is indispensable to evaluate joint impairment and disability for rehabilitation practices of hip patients preoperatively and postoperatively. In order to report treatment outcome, nearly 20 hip scores have been described in Western literature. Previous studies have raised problems that these hip scores have different measures of joint impairment and physical disability and use different weight ratios to sum up, thereby creating different results if applied to the same patients[6-9]. The Japanese Orthopaedic Association published a standard hip score for Japanese patients in 1970 and revised it more recently. In this study we employed 11 variables of ADL included in these old and new hip scores. Four of the 11 variables are not included in any of Western hip scores: squat, sit on floor in Japanese style, bow while sitting on floor in Japanese style, and unipedal stand. Although the latter three were deleted in the new hip score, sit in Japanese style still seems an important activity because there are a considerable number of patients who

prefer to do in such a way and have no other choice. Squat is also an important activity for those who live in a traditional Japanese style. Thus, the 11 variables, at least, are thought necessary to study limitation of physical daily activities in Japanese hip patients.

The aim of the present study was to describe the inter-relation between different physical disabilities in a low-dimensional space, which was not previously reported. Although factor analysis is a standard technique to describe the relation between the variables, the categorization into three grades in this study are not quantitative but qualitative and, therefore, not indicated for factor analysis. For this reason, we used correspondence analysis, which is useful to analyze the relation between variables measured in a qualitative way[10]. The analysis was performed on the basis of a correspondence table (Table 3) showing different frequency patterns of the 223 patients to the 11 variables in terms of the proportion of the categories: unable, difficult, and easy. As depicted in Figure 1, sit on chair and stand to work are located relatively close each other but much far from others. This finding strongly suggests that both have little relation to others and are independent variables. This is substantiated by the low column scores of their Spearman correlation coefficients. Another finding in Figure 1 is that there are two other groups detected: a large group consisting of walk, stair, public transport, socks, and squat and a small group: sit on floor in Japanese style and unipedal stand. In relation to this finding, a trial application of factor analysis to the present data revealed that walk, squat, stair, and public transport are inter-related with some restriction on interpretation of the result as discussed above (data not shown). In consistent to our observation, Bryant et al. also found a core factor to form a large assembly of ADL variables including walk, stairs, and public transport by using factor analysis[8]. An assembly of walk, stair,

Table 3. Correspondence of the patients between the variables and categories.
The cells contain frequency counts of the patients corresponding to the variable and its categories. Numbers in parentheses are percentage of the patients.

	unable	difficult	easy
walk	1 (0.4)	167 (74.9)	55 (24.7)
sit	0 (0.0)	2 (0.9)	221 (99.1)
stand	2 (0.9)	32 (14.3)	189 (84.8)
squat	17 (7.6)	121 (54.3)	85 (38.1)
stair	6 (2.7)	150 (67.3)	67 (30.0)
pub	10 (4.5)	139 (62.3)	74 (33.2)
japsit	25 (11.2)	42 (18.8)	156 (70.0)
bowsit	34 (15.2)	79 (35.4)	110 (49.3)
socks	9 (4.0)	135 (60.5)	79 (35.4)
toe	28 (12.6)	124 (55.6)	71 (31.8)
upst	29 (13.0)	45 (20.2)	149 (66.8)

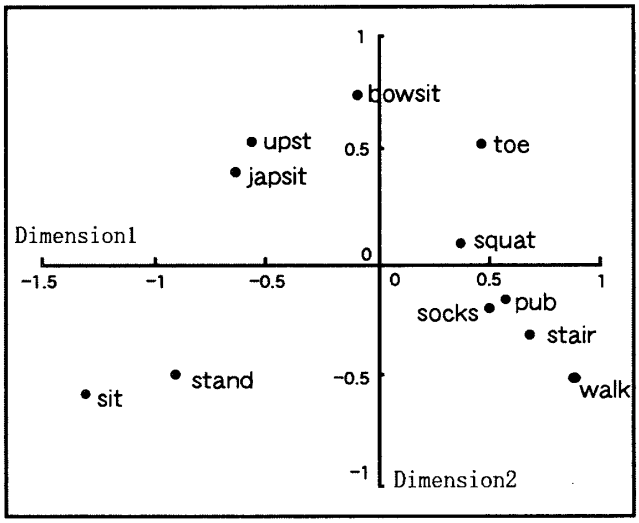

Figure 1. Correspondence analysis plot showing the inter-relation between the variables. The ADL variables are plotted against scores of the first two dimensions calculated by corresponding analysis to show the inter-relation (see text).

public transport, and squat detected in the present study is apparently important in daily living. It is, however, noteworthy that these activities were impaired in a majority of the patients. Interestingly, they appears to require hip function to support the body in a dynamic sense, disability of which could be closely linked to impairment such as muscle weakness, restricted range of motion, and joint pain. Further study is required to test a hypothesis that improvement of these impairments will lead to a reduction of the physical disability of walk, stairs, public transport, and squat.

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