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DO PATIENTS WITH KNEE OSTEOARTHRITIS USE DIFFERENT STRATEGIES DURING SIT-TO-STAND TASK?

[1]Yoshimasa Sagawa Júnior, [1]Stéphane Armand, [1]Anne Lubbeke, [1]Pierre Hoffmeyer, [1]Domizio Suva, [1]Katia Turcot
[1] Geneva University Hospitals and Geneva University, Switzerland; email: sagawajunior@yahoo.com.br

INTRODUCTION

Patients with knee osteoarthritis (OA) usually experience difficulty to realize the sit-to-stand (STS) task [1]. Recent studies pointed out that they have altered and persisted movement pattern during the STS when compared with healthy elderly before and after a total knee arthroplasty (TKA) [2-3]. However, based on literature, no study was designed to identify if patients with knee OA have different strategies to realize the STS and which clinical parameters could be best associated with these strategies. The identification of STS strategies and the main clinical associations with this task could help to better understand knee OA function. Therefore, this study aimed to determine if patients with knee OA use different strategies to realize the STS and to identify the main clinical associations among these strategies.

METHODS

One hundred and one patients with knee OA and scheduled for a unilateral TKA were enrolled in this study. They were included if they had end-stage knee OA and complained of knee pain. The exclusion criteria were joint prosthesis and a recent history of disorders other than the knee OA that could affect their balance or gait. The mean and standard deviation (SD) of age, weight, height, and body mass index (BMI) were 68 (7) years old, 84.6 (16.2) kg, 1.65 (0.1) m, and 31 (5) kg.m^{-2}, respectively. Twenty seven healthy elderly were recruited as the control group. The mean and SD of age, weight, height, and BMI were 66 (7) years old, 67.3 (10.3) kg, 1.68 (0.1) m, and 23 (2.5) kg.m^{-2}, respectively.

The evaluation of the STS was performed using a 12-camera motion analysis system (Vicon, UK) and 2 force plates (AMTI, USA). The STS task was standardized as follow: all individuals sat on a backless and armless chair with both knee angles at 90° of flexion. The individuals were asked to rise from the chair without the use of the arms and at their self-selected pace. Three trials were used for analysis. Six biomechanical discrete parameters were obtained by averaging values across the trials for each individual [1]: *STS time (s), STS suspension time (s), Thorax flexion max (°), Thorax obliquity max on the non affected side (°), Knee flexion moment max (N.m.kg^{-1})* and *Knee adduction moment max (N.m.kg^{-1}).*

The pain and function were assessed using the WOMAC Index [4] and the quality of life was assessed (physical and mental components) by the SF-12 questionnaire [5].

All parameters were coded by using triangular fuzzy membership functions related to three modalities — *Low*, *Average* and *High*. The membership values were determined based on the data distribution of the parameters of the knee OA group. *Low* and *High* boundaries correspond to the 5th and 95th percentiles, respectively and the *Average* boundary corresponds to the median. Afterward, a Multiple Correspondence Analysis (MCA) was used to extract relevant information. The MCA is an exploratory multivariate analysis used to produce a simplified representation of the information from a large dataset. The MCA converts a matrix of data into a particular type of graphical display known as factor planes [6]. In the present study, the columns of the matrix correspond to the chosen biomechanical parameters and the rows of the matrix correspond to the patients. Clinical parameters were used to express, according to different colour intensities, the level of a clinical parameter for each patient in the factor plane. Finally, groups with different STS strategies were compared with each other and with the control group using analysis of variance and Tukey *post hoc* tests or their non-parametric equivalents.

RESULTS AND DISCUSSION

The MCA revealed that the *STS time*, the *STS suspension time*, the *Thorax flexion max* (axis 1) and the *Thorax obliquity max on the non affected side* (axis 2) best contributed to create the first factor plane. Figure 1 shows the representation of the modalities of these parameters and the position of the patients on the factor plane. Moreover, the *mental score* of the SF-12 for each patient was represented by colour intensity; light colours represent a *bad* score whereas dark colours represent a *good* score.

According to the organisation between the modalities of the biomechanical parameters and the patients in the factor plane, three main groups characterized by different STS strategies were observed. The first group (n=59) was positioned on the bottom of the plane (B group), the second group was positioned on the left top of the plane (LT group, n=24) and the third group on the right top of the plane (RT group, n=18).

Each group took a different time to complete the STS (LT: 2.4s, B: 3.4s, RT: 6.0s; p=0.001). This parameter was also associated with the suspension time of the STS showing the same trend (LT: 1.8s, B: 2.5s, RT: 4.5s; p=0.001). However, when we compared all knee OA groups with the control one, we observed that the LT group realized the STS (2.4s) and its suspension phase (1.8s) in a time similar to the control group (control: 2.7s and 1.9s; p=0.999). This result contrast with a recent study which found a significant difference for the time to realize the STS when compared patients with knee OA to a control group (mean [SD]: knee OA: 3.2 [1.2]s vs. control: 2.6[0.4]s) [1].

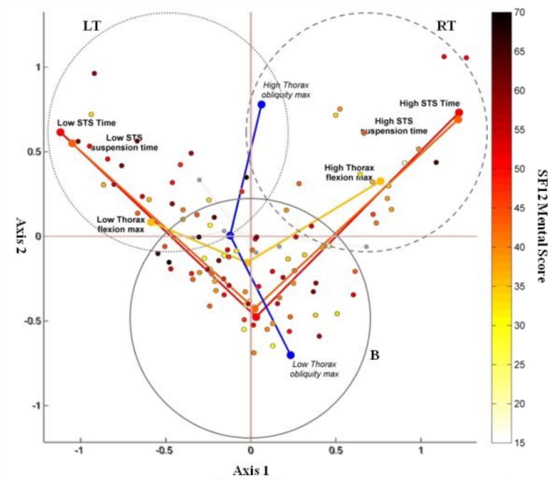

Figure 1: The first factor plane. Association of the modalities of the main biomechanical parameters used to characterise the STS. The parameters illustrated by red, orange and yellow lines represent those with the largest contribution to the first axis. The parameter illustrated by the blue line represents those with the largest contribution to the second axis. The points correspond to the patients' position on the plane. The colour intensity of each point represents the level of the mental score of the SF-12.

Although one of the knee OA group realized the STS at the same time as the control group, all of the knee OA groups had different strategies concerning the thorax movement. One of these thorax strategies was the level of flexion during the STS which was more important than the control group (LT: 47.1°, B: 47.7°, RT: 59.2°, control: 38.3°, $p < 0.01$). This strategy probably permits patients to shift their center of mass close to their knee joint in order to decrease the amount of knee joint moments [7]. This possibility is supported by other studies which found an inverse correlation between the thorax flexion and the knee extensors strength [8] and by a higher contribution of hip flexion moment following a TKA compared to control group [2].

The second thorax strategy was the level of thorax obliquity on the non-affected side. The MCA pointed out a non linear association between the time to execute the STS and the thorax obliquity. The group (B) who realized the STS with an average value of 3.4s leaned the thorax significantly less (B: 1.6°) than those who realized the STS quickly (LT: 2.4s, 4.6°) or slowly (RT: 6s, 4.1°). For the groups which employed this thorax strategy, as the thorax represent about 49% of the body mass [9], its lateral displacement probably decrease loads on the affected side during the STS. This strategy was previously observed [1, 3], but has never been associated with other parameters.

Regarding the 5 clinical parameters, no difference was found among the knee OA groups (p>0.1). However, comparing the knee OA groups with the control one, significant differences were found for all parameters (p<0.001); with the exception of the mental score of the SF-12 between the LT group (48.1 points) and the control one (53.9 points; p=0.171). This score is composed of items about the vitality, the social functioning, the role-emotional and the mental health of the individuals [5]. A previous study has already demonstrated that psychological factors were significant and independent predictors of the performance of different functional tests as the STS [10].

CONCLUSION

From our study, three main STS strategies in individuals with severe knee OA were identified. These strategies involved mainly the STS time and the thorax flexion in a linear relationship as well as the STS time and the thorax obliquity in a non linear relationship. Using the thorax flexion and thorax obliquity, one of the knee OA groups compensated well the STS, realizing the task in the same time as the control group. Moreover, it was the only group without a difference in the mental score of the SF-12 relative to the control group. The second group used only the thorax flexion showing an inadequate STS compensation. To finish, the last group, spent a long time to execute the STS as well as important thorax flexion and obliquity, which probably experienced more difficulty to realize the STS.

Follow these patients with different STS strategies after a TKA could permit to evaluate which group had the best (or the worst) evolution. This could improve strategies to prevent and to treat patients with knee OA.

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