ISB 2013 BRAZIL
XXIV CONGRESS OF THE INTERNATIONAL SOCIETY OF BIOMECHANICS
XV BRAZILIAN CONGRESS OF BIOMECHANICS

POSTURAL BEHAVIOR IN PATIENTS WITH SEVERE KNEE OSTEOARTHRITIS DURING A QUIET STANDING TASK

Katia Turcot, Yoshimasa Sagawa Júnior, Pierre Hoffmeyer, Domizio Suva, Stéphane Armand.
Geneva University Hospitals and Geneva University, Switzerland; email: kturcot@gmail.com

SUMMARY
The objective of this study was to investigate the postural behavior during a quiet standing task in a group of patients with severe knee osteoarthritis (OA). The full-body kinematics, the ratio of the vertical ground reaction forces (GRF) and the center of pressure (COP) data were calculated. Data obtained for the group of patients with knee OA were compared to healthy elderly participants (control group). Results show that patients with symptomatic and severe knee OA adopt a more flexed posture at all joint levels compared to the control group. A significant difference in the vertical GRF ratio was also found between groups, showing asymmetric weight distribution in the group of patients. Finally, a significant decrease in the COP range in the anterior-posterior (AP) direction was also observed in the group of patients with knee OA compared to the control group. No significant correlation between the clinical outcomes (pain and function) and the postural data (joint kinematics, GRF ratio and COP data) was revealed in this study.

INTRODUCTION
Individuals with knee OA experience a progressive loss of functional capacity in activities of daily living such as walking, transfer from a sitting to a standing position and climbing stairs. The capacity to preserve postural stability under static and dynamic activities contributes to maintain the functional capacity in the elderly. As individuals with knee OA exhibit muscle weakness, malalignment, loss of proprioception and knee joint instability [1]; their postural stability may be compromised [2].

Therefore, the aim of this study was to investigate the postural behavior in a group of patients with severe knee OA.

METHODS
Participants
Eighty eight patients with knee OA and planned for a unilateral total knee arthroplasty (TKA) participated in this study. Patients were included if they had a symptomatic end-stage knee OA. The exclusion criteria were joint prosthesis and a recent history of orthopedic or neurological disorders that could affect their balance. The mean and standard deviation (SD) of age and body mass index (BMI) were 69 (7) years old and 31 (6) kg.m-2, respectively.

Twenty five healthy elderly were recruited as the control group. The mean and SD of age and BMI were 68 (6) years old and 25 (4) kg.m-2, respectively.

Clinical assessment
The pain level and functional capacity were evaluated using the reduced version of the Western Ontario and McMaster Universities Arthritis Index (WOMAC) [3]. The pain and function scores range between 0 and 100 (lower numbers indicate a worse score and higher numbers indicate a better score). Therefore, if a patient did not experience any pain or any functional limitation, the score would be 100. In contrast, a 0 score indicated extreme pain or extreme functional limitation.

Postural assessment
A motion analysis system (VICON Peak, Oxford, UK) was used to capture the three-dimensional (3D) full-body kinematics during a quiet standing task. Reflective markers were positioned on the pelvis and lower limbs landmarks according to the Davis protocol [4] and on the trunk according to Gutierrez-Farewik et al. [5]. Two force plates (AMTI, Watertown, USA) were used to measure the GRF under each leg and the COP. The motion and force plate data were synchronized and sampled at 100 and 1000 Hz, respectively. Force plate data were normalized to body mass. The joint kinematics were generated using the dynamic Vicon Plug-in-Gait model.

To realize the quiet standing task, the participants were asked to rise from a chair at their self-selected speed and were instructed to stand as still as possible with the arms on each side for a period of 10 seconds. The first three well-executed trials were kept for data analysis.

The mean position of the trunk and the pelvis as well as the mean position of the hip, the knee and the ankle for the affected side (i.e., knee OA joint) were calculated in the sagittal and frontal planes. For the affected side, the range of the COP in AP and medial lateral (ML) directions and the average speed of the COP in AP and ML directions were calculated. Moreover, the mean ratio of the vertical GRF was calculated using the affected side divided by the non-affected side. For the control group, the ratio was calculated in a randomized way (right or left).

Statistical analysis

Comparison between both groups was performed using an analysis of variance (ANOVA) and Tukey *post hoc* tests. A significant difference was set at $P < 0.05$. Correlations between postural assessment parameters and clinical outcomes were also performed using Pearson coefficients of correlation.

RESULTS AND DISCUSSION

A significant group effect was obtained (P=0.003). Results show that patients with knee OA adopt a more flexed posture in all joints compared with the control group (Figure 1). Significant differences were obtained in the sagittal plane for the trunk (OA: 1.4° ± 6.3°; Control: -1.5° ± 4.7°; P=0.034), the pelvic (OA: 9.0° ± 6.9°; Control: 5.2° ± 4.0°; P=0.011), the hip (OA: 5.2° ± 8.7°; Control: -3.5° ± 5.6°; P<0.001), the knee (OA: 4.6° ± 6.3°; Control: -2.4° ± 4.8°; P<0.001) and the ankle (OA: 7.8° ± 4.0°; Control: 5.4° ± 3.4°; P=0.008). No significant difference between groups for the mean joint position in the frontal plane was found. A significant difference in the vertical GRF ratio was obtained between groups (OA: 0.92 ± 0.18; Control: 1.03 ± 0.09; P=0.009). Significant decreased in the AP COP range was also observed in the OA group compared to the control group (OA: 29.4mm ± 9.9mm; Control: 34.8mm ± 11.1mm; P=0.021) (Figure 1). Finally, no significant correlation between clinical outcomes (pain and function) and the postural data (joint kinematics, GRF ratio and COP data) was revealed in this study.

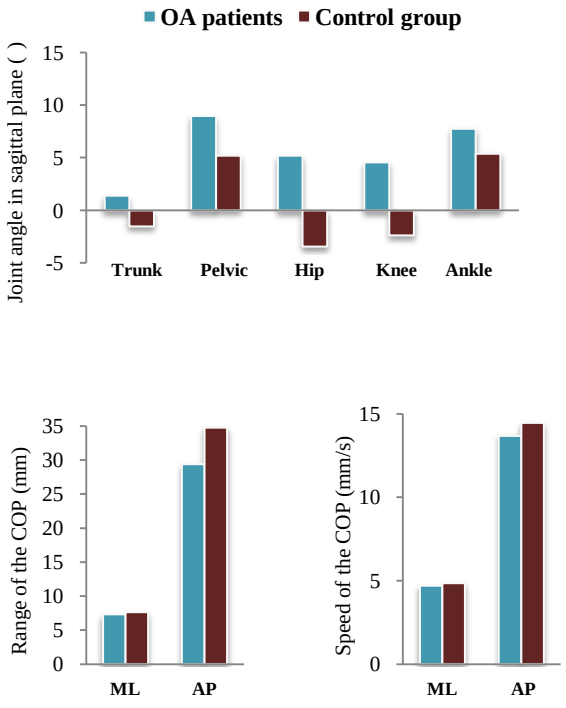

Figure 1: Top figure show the joint position (°) for the trunk, the pelvic, the hip, the knee and the ankle in the sagittal plane for both groups. Bottom left figure show the range of the COP (mm) while bottom right figure show the speed of the COP (mm/s) for both groups.

These results demonstrated that patients with end-stage and symptomatic knee OA have to adapt their postural strategy to achieve a stable upright posture. We observed a significant increase of the mean forward segmental position at each joint level (i.e., trunk and lower body segments) in the sagittal plane for this group. These results suggest that patients attempt to move forward their center of mass (CoM) to locate the load on a less painful knee joint area. Moreover, the vertical GRF ratio demonstrated that patients overload approximately 10% of their body weight on the contralateral side compared to the equal distribution of weight observed in the control group. A higher range of the AP COP displacement as well as joints positioned in hyperextension (i.e., stiffening all joints) were observed in the control group. Unlike, patients with knee OA seem to use a multi-joints coordination which possibly leads to a decrease of the AP COP displacement [6]. However, since both lower limbs and back muscles were involved in this strategy; further studies are needed to observe if patients would adopt the same behavior if they had to maintain this posture for a longer period of time. If so, we assume that we should observe an increase of muscles activities with this postural strategy and therefore an increase of fatigue over time.

We also hypothesized that the level of pain and functional deficit in the groups of patient should be associated with postural parameters. However, it was not confirmed by our results.

CONCLUSION

This study brings new insights regarding the postural behavior in terms of full-body position, vertical GRF ratio and COP parameters in a group of patients with severe knee OA during a quiet standing task. The results confirm the asymmetric posture adopt by patients with knee OA. Moreover, we observed a postural strategy (i.e., lower limbs in flexion) that could be very challenging in terms of muscles capacity but that might help to protect the affected joint.

Because improvement of balance may be a desired outcomes following TKA, special attention should be given in the rehabilitation program after surgery to evaluate if patients continue to protect their knee by fear or due to functional limitations.

ACKNOWLEDGEMENTS

This work was supported by the Clinical Research Center of the Hospital and Faculty of Medicine Geneva and the Louis-Jeantet Foundation and by the “Fonds de la Recherche en Santé du Québec”.

REFERENCES

[1] L. Sharma, Curr Opin Rheumatol,(13);441-6;2001.

[2] D. C. Sanchez-Ramirez, et al., J Rehabil Med,(45);192-7;2013.

[3] S. L. Whitehouse, et al., J Bone Joint Surg Br,(85);706-11;2003.

[4] R. B. Davis III, et al., Human Movement Science,(10);575-587;1991.

[5] E. M. Gutierrez-Farewik, et al., Hum Mov Sci,(25);238-56;2006.

[6] W. L. Hsu, et al., J Neurophysiol,(97);3024-35;2007.