SIMULATED WEIGHT BEARING SQUAT MOVEMENT – PATELLOFEMORAL MEASUREMENTS ON CADAVERIC SPECIMENS

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Abstract

Cadaveric knees were mounted in the Ghent knee rig to simulate a weight bearing squat[1]. During this flexion-extension movement, the patellofemoral contact area's and pressures were continuously monitored. The results seem to indicate that the contact area and pressure are not only determined by the knee angle and quadriceps force but also by the movement phase (flexion or extension).

Keyword: biomechanics

1 Materials and Methods

Embalmed knees were tested in the knee rig after they were scanned to check for morphological abnormalities. A Tekscan pressure sensitive sensor was inserted in the patellofemoral joint through a lateral release. The tests were performed with a linear motor speed of 2mm/s and a knee angle range from 20° to 60° flexion. During the squat simulation, the knees were loaded with a weight of 30 kg which equalizes a normal weight on 1 leg during bipedal stance (mass above hip height/2).

2 Results and discussion

The mean patellofemoral contact area measured in this study ranged from 68.8 (± 8) mm^2 at 20° to 336.5 (± 64.7) mm^2 at 60° knee flexion. The mean contact pressure ranged from 0.7 (±0.15) MPa at 20° flexion to 5.5 (± 1) MPa at 60°.

Statistical analysis of the contact area and pressure was done for knee flexion angles of 20°, 30°, 40°, 50° and 60° and for the flexion and extension phase separately. Out of the 5 x 2 conditions, 3 conditions did not have a normal distribution, so a Wilcoxon Signed Ranks Test was performed; a significant difference between the 2 movement phases for the contact area ($p < 0.001$, $z = -4.341$) as well as for the contact pressure ($p < 0.001$, $z = -4.627$) was found, with higher values for the extension phase. Obviously, during extension the linear motor systematically produces a higher force than during flexion, but this is not the only determining factor.

To reveal the predicting variables of the contact area and pressure, a linear regression was performed with the knee angle, flexion-extension phase and quadriceps force as independent variables. For the contact area as well as the contact pressure, the multiple regression models with these 3 independent variables show a better correlation with the data, with respectively $R^2 = 0.88$ and $R^2 = 0.85$ than the regression models for each single or 2 independent variables. However, care should be taken in the interpretation of these results since the quadriceps force is highly correlating with the knee angle ($p < 0.001$) as well as the movement phase (flexion - extension) ($p < 0.001$). This collinearity affects the reliability of the individual predictors, not the reliability of the model as a whole.

3 Conclusion

The present results revealed a difference in contact area and pressure between extension and flexion.

These results suggest that all contributing factors; the knee angle, the applied quadriceps force and the movement phase should always be taken into account when investigating the contact areas and pressures.

References

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