

Focus on IFA's work

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Biomechanical stress analysis of squatting and kneeling postures

Problem

In the scientific justification for recognition of knee osteoarthritis as an occupational disease (BK No. 2112), the cause is stated to be increased compressive force upon the joint cartilage during occupational activity performed in a kneeling or squatting posture. No convincing biomechanical studies of this subject are as yet available, however. The increase in loading upon the joint during bending of the knee in a standing position cannot be extrapolated to the loading during squatting and kneeling.

The accident insurance institutions have the task of preventing hazardous stresses during occupational activity, as well as making compensation payments. Sound background knowledge is however required in order for suitable prevention recommendations to be made. A considerable need therefore exists for validated data on the loading on the knee joint during tasks performed in squatting and kneeling postures.

Activities

In co-operation with the BG BAU, the German Social Accident Insurance Institution for the building trade, a project was launched for the analysis of kneeling and squatting postures. Besides the analysis of static postures such as kneeling, squatting and kneeling on the heels, sample measurements were also to be taken during tasks typically performed by tilers and heating system fitters.



Fitter during installation of a radiator in the laboratory

Altogether, ten skilled personnel – five tilers and five heating system fitters – were involved in the tests.

Firstly, however, a special biomechanical analysis model had to be developed in order to permit analysis of loading upon the knee joint at least under laboratory conditions.

Results and Application

The knee (tibio-femoral) joint forces measured in squatting and kneeling postures attained uniform values of around 50% BW (body weight). The contact force of the knee-cap was between 80% and 100% BW. Comparable stress values were measured during tile-laying and radiator fitting; these were reduced still further when the hands were used for additional support.

By contrast, joint forces of 250% to over 300% BW – around 400% BW on the knee-cap – were obtained during kneeling down and standing up. For the purpose of comparison, maximum knee-joint forces of between 170% and 250% BW may be anticipated on the leg under load during standing and walking.

The latest results from the study do not therefore bear out the assertion made in the scientific justification for the occupational disease that very high compressive forces on the joint cartilage must be anticipated in squatting and kneeling postures. Greater attention should however be paid to kneeling down and standing up, and to changes to and from squatting and kneeling postures, since high contact forces must certainly be anticipated in these cases. The key data should be considered during the definition of suitable prevention measures.

Area of Application

Prevention services of the accident insurance institutions, occupational disease case workers; areas of the economy in which activities involving constrained kneeling postures arise

Additional Information

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- Glitsch, U.; Lundershausen, N.; Knieps, D.; Johannknecht, A.; Ellegast, R.: Biomechanische Analyse der Kniegelenkbelastung bei Tätigkeiten im Hocken und Knien. 49th annual conference of the Deutsche Gesellschaft für Arbeitsmedizin und Umweltmedizin e.V., 11-14 March 2009, Aachen. CD-ROM, pp. 391-394. DGAUM, Aachen 2009
- Ditchen, D.; Ellegast, R.; Rehme, G.: GonKatast – Ein Messwertkataster zu beruflichen Kniebelastungen (IFA-Report 1/2010). Ed.: Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (IFA), Sankt Augustin 2010

Expert Assistance

IFA, Division 4: Ergonomics – Physical environmental factors

Literature Requests

IFA, Central Division