Knee joint loading in alpine skiing: a comparison between carved and skidded turns

Klous Miriam, Mueller Erich, Schwameder Hermann
(University of Salzburg, Austria)

In recreational skiing, injuries at the lower extremities account for 40 – 64% of all injuries and 31% of the total injuries involve the knee (Klous, 2007). These high percentages afford systematic research to determine joint loading on the lower extremities in skiing. So far, only rough estimations of joint loading in skiing are reported (Quinn & Mote, 1992; Read & Herzog, 1992) and none in full 3D and with sufficient accuracy. The present study is part of a larger project in which 3D joint loading on the lower extremities in carved and skidded ski and snowboard turns were determined using inverse dynamics. The purpose of the present study is to compare knee joint loading in carved and skidded ski turns. It is presumed that loading at the knee joint is larger in carved turns than in skidded turns.

Four subjects participated in the study. Kinetic data were collected with mobile force plates (KISTLER), placed between riser and binding (200 Hz). Two force plates were mounted under each binding, one at the front and one at the rear part. Kinematic data of both legs, pelvis, and trunk were collected with five synchronized analogue panning, tilting and zooming cameras (50Hz). 3D marker positions were digitized and calculated with Simi Motion. Further analyses of kinetic and kinematic data and the inverse dynamics were carried out with specifically developed Matlab software. To calculate segment inertial parameters, an extended version of Yeadon (1990) was developed. To eliminate influence of ski vibrations and chattering, data was filtered with a 12 Hz 2nd order low pass Butterworth filter (Klous et al., 2005). One representative carved and skidded turn of one subject are presented comparatively.

Average vertical knee forces for the inside and outside leg of a carved turn were 0.50 and 0.76 times body weight, respectively. These forces were clearly higher than the average vertical forces working at the inside and outside leg in skidding (0.41 and 0.48, respectively). In anterior-posterior and medial-lateral direction, knee forces in the outside leg were higher for carving, whereas for the inside leg knee forces were larger for skidding. Regarding the moments, higher average and peak moments were found for skidding, except for the average and peak flexion-extension moments at the inside leg in carving.

Results show higher knee forces in the outside leg in a carved turn compared to a skidded turn. It seems that higher forces have to be produced to keep the ski on the edges in carving turns. However, knee moments were higher for skidding than for carving, except for the flexion-extension moment at the inside leg in carving. Therefore, it can not be concluded that knee joint loading is higher in carved than in skidded turns.
