

A comparison of knee pad designs on knee pressure during kneeling

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Introduction

Kneeling poses a risk to the development of medial tibiofemoral osteoarthritis and infrapatellar bursitis (Jensen, 1996). Therefore future knee pad designs should focus on reducing the pressure to the bursa areas along the patellar tendon and tibial tubercle (Reid, 2010). This study aims to identify the optimum spring characteristic for a new knee pad design and to compare the peak pressures developed on the knee during kneeling with commercially available knee pads.

Methods

Following ethical approval, 5 male and 3 female volunteers were recruited. All self-diagnosed themselves to be free of current knee problems.

Participants performed a double knee descend twice on the floor and the pressure profile across their knee was recorded using a pressure mat (3100, Tekscan Inc., Boston, US) placed between the knee pad and knee. Participants randomly wore six versions of a prototype knee pad (VHinnovation Ltd) utilising combinations of 22mm and 25mm springs each with 6, 8 and 14 N/mm stiffness. Subsequently, participants randomly wore one of six commercial knee pads (Nailers, TommyCo, Snickers, Redbacks, Impacto Red, Impacto Rubber) together with a no knee pad condition.

Peak pressures were normalised by the peak pressure developed during kneeling without a knee pad. ANOVA was used to analyse whether normalised peak pressure varied between knee pads and between genders.

Results

Peak pressure without a knee pad significantly correlated with body mass ($r=0.49$ $p < 0.001$), but normalised peak pressure did not, giving confidence to the normalization assumption catering for both kinematic and inertial differences between participants. For the new designs, a gender difference existed whereby, on average across all designs, females reduced their peak pressure by $77\pm 4\%$ using knee pads, whilst men experienced a $60\pm 3\%$ reduction ($p <$

0.01). Statistically, there was no difference between the VH designs. However, since the 22 mm 8 N/mm spring had the lowest normalised peak pressure on average, reducing pressure by $76.6 \pm 6\%$, this design was compared against the other market competitors.

Significant differences were found between different pad designs with regards to peak pressures ($p < 0.001$). Post hoc t-tests demonstrated the average normalised peak pressure reduction achieved with the new design was significantly better than all other competitor brands with the nearest competitor achieving a 60.7% reduction in peak force. Females reduced their peak pressure by $58.3 \pm 2.9\%$ whilst men obtained a $49.3 \pm 2.6\%$ reduction ($p < 0.05$) across all designs.

Discussion

The VHinnovation Ltd. design adopting 22mm, 8N/mm springs achieved significantly greater reductions in peak pressures during kneeling compared to market competitors. If peak pressures translate into knee injury, then this new design may have the potential to reduce such pathologies. Interestingly there was a gender difference whereby females seemed to benefit more than males in using a knee pad. Whilst many potential reasons exist, one might be that they altered their kneeling style whilst using the pads. They could have been unused to wearing such pads or possibly being protective of the pad itself. Due to the low participant numbers, however, more data is required to confirm this result and to elucidate the possible reasons for the increased benefits for women identified here.

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References

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