Effect of force plate coverings on vertical ground reaction forces

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BACKGROUND AND AIM:

To increase ecological validity when researching the kinetics of sporting movements a covering that replicates surfaces used in sporting competition, may be placed on top of a force plate. Standardised in vitro testing procedures that quantify the effect of a surface on impact force exist, but do not always translate to force measurements during human movement (Dixon et al, 2000).

It has been demonstrated that when dropping an object onto a covered force plate, changing the object's mass, drop height or area of contact will alter the relative effect on force platform recordings (Nigg, 1990). Therefore to determine the effect of using a covering during human movement, replicating ground reaction force (GRF) data close to that expected in the movement of interest is appropriate. The aim of this study was to investigate the association between surface type and vertical force characteristics during a standardised drop test using conditions that replicate GRF data concomitant with sporting activities.

METHODS:

Vertical GRF was measured by dropping a 2kg medicine ball onto on a 600 x 400mm Kistler 9286AA force platform (Kistler, Winterthur, Switzerland; 5000Hz) from two known heights (low: 61cm; high: 139cm). Four surface conditions were used; bare plate, no covering (Ba), vinyl floor covering (Vi), Mondotrack athletics track surface (Sp) (Mondo, Rugby, UK) and a multi-sport astroturf covering (As) (As Good As Grass, Preston, UK). Sixty trials were repeated for each height and surface. Peak GRF and rate of force development (RFD; slope of GRF from onset to peak force), were calculated. A 4 (surface) by 2 (height) repeated measure ANOVA was used to analyse the data.

RESULTS:

With regards to GRF, there was a significant effect for surface and height (both $p < 0.01$) and a significant interaction effect ($p < 0.01$). At the high condition, GRF for Sp (2894.8 N) was greater than the three other surfaces ($p < 0.01$). A similar result was found for the lower height, with both Sp (1916.1 N) and As (1935.7 N) greater than Ba and Vi ($p < 0.01$). Sp and As recorded the highest GRF at the high and low condition, respectively.

A significant effect for surface and height (both $p < 0.01$) and a significant interaction effect ($p < 0.01$) were also evident for RFD. At both higher (809615.0 $N \cdot s^{-1}$) and lower (556281.7 $N \cdot s^{-1}$) height Sp recorded a greater RFD compared to the other three surfaces ($p < 0.01$), a greater difference to the other surfaces observed for the high condition. Vi recorded the lowest RFD for low condition and Ba for the high condition.

CONCLUSIONS:

The type of covering of a force plate significantly affects the magnitude of vertical GRF and RFD recorded. The Sp surface yielding the greatest GRF and RFD values. This needs to be taken into account when comparing results from studies carried out in laboratories with different plate coverings. Future investigations could examine the effect of plate coverings on horizontal components of GRF and RFD.