SHORT REPORT

A pilot study on the effects of pre-event manipulation on jump height and running velocity

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Purpose: To compare changes in jump height and running velocity with and without pre-event high-velocity, low-amplitude manipulation (HVLA).

Methods: A crossover study design with elite healthy athletes was used. After a 15 min warm-up, the subjects were tested for countermovement jump height (CMJ) and flying 40 m sprint time (SPRINT). A sport chiropractor then evaluated each subject. Subjects were randomised to either HVLA (applied to joints based on examination) or placebo (simulated performance-enhancement stickers). They then rested for 60 min, performed another 15 min warm-up, and were retested. The protocol was repeated 48 h later with the alternative intervention. The mean of two sprints and three jumps were analysed, as well as peak performances. The sample size was based on prior results from the effects of stretching.

Results: 19 subjects involved in sprint sports were enrolled; two were too sore to participate on day 2, and one could only participate in the jump (all had HVLA on day 1). Of the 17 participants analysed, seven were female, age range was 19–35, and 17 were national or world-class athletes. The ranges for baseline measures were: SPRINT 4.1–5.5 s; CMJ 47.4–92.7 cm. Overall, the greater than expected variability in this pilot study led to the study being underpowered. Subjects tended to perform better after HVLA for both CMJ and SPRINT (both mean and peak results), but none of the results were statistically significant ($p = 0.30–0.61$).

Conclusion: Although the larger than expected variability in the pilot study means that the observed clinically relevant differences were not statistically significant, the direction and magnitude of the changes associated with HVLA suggest that it may be beneficial. That said, the increased soreness after HVLA suggests that it may be detrimental. HVLA warrants further study.

Elite level athletes constantly seek methods to enhance performance. One common but unevaluated method is pre-competition manipulation. This treatment often uses high-velocity, low-amplitude thrusts (HVLA) of the spinal or extremity joint depending on the assessment. Basic science studies suggest that HVLA may improve performance because it facilitates motor neurone pool excitability for 20–60 s,[1] produces a significant increase in surface electromyographically measured erector spinae isometric maximum voluntary contraction muscle output when performed on the joints of the lumbar spine,[2] and is effective in producing short-term pain relief.[3] Alternatively, HVLA may impair performance through short-term inhibitory effects on the human motor system[4] or because it introduces an acute stretch to the soft tissue.[5] Therefore, the objective of this pilot study was to compare the changes in countermovement jump height (CMJ) and 40 m flying sprint time (SPRINT) that occur with typical pre-competition HVLA with a placebo intervention (CON), in elite athletes accustomed to HVLA.

METHODS

Participants

Inclusion criteria were: varsity or national team athlete in a sprint-type sport (eg bobsleigh); had previously received HVLA; able to understand English. Exclusion criteria were any current musculoskeletal injury or illness likely to affect performance. Each subject signed an informed consent form, and the study was approved by the University of Calgary Cojoint Health Research Ethics Board.

Design

We used a randomised crossover design with 48 ± 1.5 h rest between testing sessions. Subjects were block-randomised in groups of two or four to receive HVLA on either day 1 or day 2 and to receive CON on the other day.

Procedures

Subjects presented to the laboratory dressed in their typical warm-up gear for both sessions. They were instructed to maintain their normal training, diet and sleep patterns on the day before testing sessions. After providing informed consent, they completed a short questionnaire.

We tested subjects for baseline CMJ and SPRINT after a 15 min warm-up of their own choosing. After baseline testing, a sport chiropractor with extensive training and experience in pre-event HVLA (over 60 international events) assessed each patient for inter-articular movement and restrictions for each motion segment from the thoracolumbar region to the mid-tarsal region. On day 1, subjects were then randomised as noted above to receive either the HVLA or CON intervention. They then rested for 1 h, performed another 15 min warm-up, and were retested. The entire protocol was repeated after 48 h of rest with the alternative intervention.

HVLA intervention

We attempted to mimic the complex intervention of standard pre-event HVLA. If a joint had restricted range of motion, altered joint end-play or end-feel, or was symptomatic on provocative testing (ie joint dysfunction), the sport chiropractor performed diversified methods (the most common form of chiropractic manipulation) of lumbar, thoracolumbar and lower extremity HVLA.[6] The chiropractic examination was repeated to ensure that the adjustment(s) had corrected the joint dysfunction, and further correction was applied if necessary. The examination and intervention lasted ~10 min.

Abbreviations: CMJ, countermovement jump height; HVLA, high-velocity, low-amplitude manipulation; SPRINT, flying 40 m sprint time

Table 1 Baseline characteristics of subjects

	Males (n = 10)	Females (n = 7)
Continuous variables		
Age (years)	26.6 (3.9)	25.4 (4.1)
Height (cm)	182.6 (4.6)	167.7 (5.4)
Performance measures*		
40 m sprint time (s)	4.49 (0.22)	5.00 (0.42)
Jump height (cm)	71.5 (11.7)	55.0 (6.1)
Categorical variables		
Number adjusted day 1	50% (5)	29% (2)
Competitive level		
National team/world-class	90% (9)	86% (6)
Varsity/provincial	10% (1)	14% (1)
Experience with pre-event HVLA†		
Usually	40% (4)	57% (4)
Never/seldom	60% (6)	43% (3)
Sport		
Bobsleigh/skeleton	70% (7)	43% (3)
Other‡	30% (3)	57% (4)
Pre-study beliefs		
HVLA superior	60% (6)	43% (3)
Control superior/no difference	40% (4)	57% (4)

Continuous variables are expressed as mean (SD), and categorical variables as percentage with the number in parentheses.
*Values reflect performances on day 1 before any intervention. One male subject could not complete the run on the second day and his result is omitted for this result only (n = 9).
†All subjects were experienced with HVLA but not always pre-event HVLA.
‡Other includes road racing, duathlon, decathlon, track, and triple jump.
HVLA, High-velocity, low-amplitude thrust manipulation.

Control intervention

To minimise the placebo effect, we took advantage of a performance-enhancement product currently being marketed.[7] Round-cut pieces of traditional electromyographic electrode stickers were applied to the left mid anterior thigh and the right palmar mid-forearm, and the sport chiropractor explained that the stickers were designed to act through traditional Chinese principles to (1) increase energy and (2) facilitate ATP transfer between muscle fibres and mitochondria.

Countermovement jump height

We used CMJ with arm swing to measure vertical jump height.[23] Measurements were taken using the Vertec Jump System (Sports Imports, Columbus, Ohio, USA). Reach height was subtracted to obtain CMJ. For each testing session (before and after the intervention on each day), we recorded three trials. Subjects were allowed 1 min of rest between attempts to recover.

Sprint times

Measurement of SPRINT was performed using photocell and reflector units (Brower Timing Systems, Draper, Utah, USA) appropriately positioned. Subjects began from a standing start, and time was measured from 20 m to 60 m. On the first day, we recorded three maximal sprint trials with 5 min rest between sprints. However, several subjects complained of soreness that night. To minimise the risk of injury but maintain consistency throughout the experiment, subjects performed three trials before the intervention on day 2 and only two trials after the intervention. We used the mean of the first two trials for both day 1 and day 2 as the SPRINT time.

Analysis

We report baseline measurements as mean (SD) for continuous variables and percentage for categorical variables. For CMJ, we calculated both the mean of the three trials and the peak performance (best of three jumps) before and after

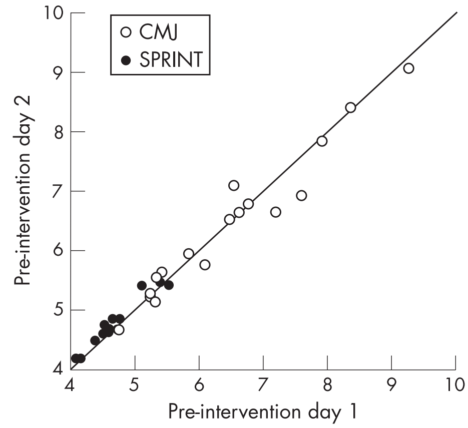

Figure 1 Results for each subject on day 1 and day 2 for jump height (CMJ) (in decimetres so that the results of both tests can be seen on the same scale) and flying 40 m sprint time (SPRINT) (s) are shown in the scatter plot. The line of identity is also plotted. Sprint times were slower on day 2 for all but two subjects. Jump heights were not different on the two days.

the intervention for both interventions. For SPRINT, we analysed the mean and peak performance of the first two trials for reasons noted above.

We used a mixed modelling analysis to adjust for the order that interventions were received, and we report the difference between the change scores (post − pre) under the two conditions (HVLA minus CON; positive means HVLA superior for CMJ and inferior for SPRINT) with 95% confidence intervals in parentheses.

Because there are no clinical data on HVLA, we based sample size on the results of pre-event stretching studies (ΔCMJ effect size = 3, ΔSPRINT effect size = 1[8]). Given the nature of HVLA, we expected a larger variability in our study. Using an effect size of 0.8, α = 0.05 and power = 0.8, the required sample size is 15 subjects.

RESULTS

Table 1 shows the baseline characteristics of the subjects. Two male subjects did not return for the second session because of excessive soreness (both received HVLA), and a third male subject was too sore to perform the SPRINT on the second day (also received HVLA): n = 17 for CMJ and n = 16 for SPRINT.

We plotted pre-intervention performance results from day 2 against day 1 to assess recovery and/or learning effect (fig 1). There was no difference for CMJ (0.60 cm (−0.87 to 2.07)), but SPRINT was slower on day 2 (−0.08 s (−0.13 to −0.03)).

CMJ decreased after both HVLA and CON interventions, with qualitatively less decrease after HVLA (fig 2), but the results were not significant. SPRINT decreased (improved) with HVLA and increased (worsened) with CON but the results were not significant.

Finally, subjects who believed HVLA would be more beneficial before the study did not have consistently different results from the others (ΔCMJ_{mean}, 0.3 cm (−2.3 to 2.9); $\Delta SPRINT_{mean}$, −0.04 s (−0.15 to 0.07)).

DISCUSSION

Although the results from our pilot study found more than expected variability among subjects, the direction and magnitude of the changes were consistent with a clinically relevant performance enhancement despite the lack of statistical significance. However, all three subjects who were excluded from the analysis because they were too sore to

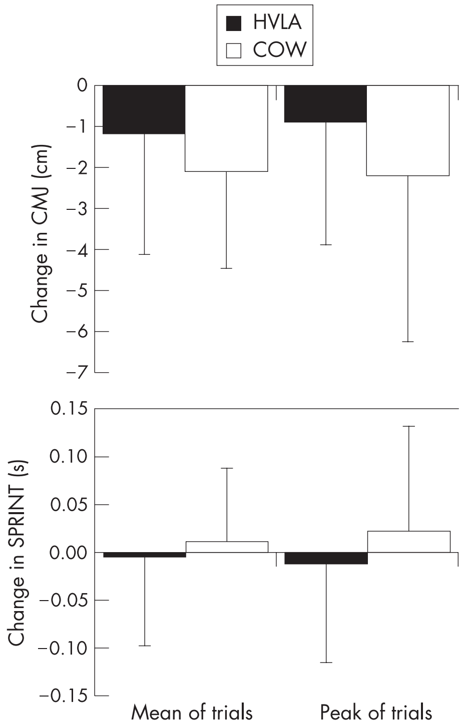

Figure 2 Changes, with standard deviation, in jump height (CMJ) and flying 40 m sprint time (SPRINT) with high-velocity, low-amplitude manipulation (HVLA) and with placebo stickers. For CMJ, the difference in means is 0.9 (−0.9 to 2.8), p = 0.32, and the difference in peaks is 1.3 (−1.2 to 3.8), p = 0.30. For SPRINT, the difference in means is −0.02 (−0.07 to 0.05), p = 0.61, and the difference in peaks is −0.03 (−0.11 to 0.04), p = 0.37.

participate on the second day had received HVLA on the first day.

We had to make difficult choices for this pilot study. We measured subjects 15 min after the intervention (similar to competition); shorter or longer intervals may produce different results. We used a 15 min warm-up of the subjects' own choosing; a standardised warm-up would mean a different routine from usual for all athletes and would not reflect clinical reality (note that some athletes felt 15 min was insufficient). We used only one very experienced sport chiropractor to assess and administer treatments. Results are expected to vary depending on the experience and technique of the person performing HVLA. We did not pre-screen the subjects, and HVLA might only be effective in certain subgroups—for example, those with joint dysfunction/ restriction. Finally, our subgroup analysis suggests that we were modestly successful in minimising the placebo.

Many subjects complained of soreness after day 1. Three were too sore to participate in SPRINT even 48 h later, and SPRINT was slower on the second day for those that participated. This increased the variability and reduced the power of the study. Further, all three subjects who could not participate on day 2 had received HVLA on day 1 (note that all subjects were able to participate on day 1 after HVLA without problems). With such small numbers, this may have occurred by chance, or HVLA may increase the risk of injury (similar to what has been proposed with pre-competition stretching[9]).

In conclusion, the variability in CMJ/SPRINT with HVLA was greater than expected in this pilot study, and this may be why the observed clinically relevant performance enhancement with HVLA was not significant. These results and the fact that three subjects who received HVLA on day 1 were unable to participate on day 2 because of soreness suggest that both the potential positive and negative effects of HVLA warrant further study.

What is already known on this topic

- Many clinicians use pre-event manipulation to enhance performance because they believe in it, but there are no clinical studies.
- Theoretically, pre-event manipulation could improve or impair performance through neurological mechanisms.

What this study adds

- This is the first clinical study on this topic.
- Although the results of this pilot study are inconclusive, the data can be used for sample size calculations in future studies.
- The study describes feasibility issues particular to studies of pre-event manipulation that must be addressed in any future studies.

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