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THE EFFECT OF BALL COMPRESSION ON THE MATCH-PLAY CHARACTERISTICS OF ELITE JUNIOR TENNIS PLAYERS

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ABSTRACT

The purpose of this article was to examine the effect of equipment scaling, through the modification of tennis ball compression, on elite junior tennis players (aged 10 years) within a match-play context. The two types of ball compressions that were compared were the standard compression (the normal ball) and 75% compression (termed the modified ball). Ten boys and 10 girls participated in the study. Participants were stratified into pairs based on their Australian Age Ranking and gender. Each pair played two two-set matches: one match with standard compression balls and one match with modified balls. The characteristics of each match were analyzed and compared. The results showed that the use of the modified ball increased rally speed, allowed players to strike the ball at a lower (more comfortable) height on their groundstroke's and increased the number of balls played at the net. Ball compression had no effect on the relative number of winners, forehands, backhands, first serves in and doubles faults. The results are discussed in relation to skill acquisition for skilled junior tennis players.

In 2012, the International Tennis Federation (ITF) made only the fifth change to the game's rule book in over a century (ITF, 2012). The rule change mandated that low-compression balls be used in authorized 10-and-under competitions held by the ITF's member associations. In practice, the most commonly used low-compression ball is colored green and reportedly characterized by 75% the compression of a standard tennis ball (ITF, 2013).

KEYWORDS

skill acquisition, tennis, child, modified equipment, talent development

Introduction

The intent of this article was therefore to compare the effect of two types of ball compression, standard compression (the normal ball) and 75% compression (termed the modified ball) on the performance characteristics of match play as undertaken by 10-and-under players who would be affected by the ITF's rule change. It was predicted that matches played with the 75% compression ball would be characterized by an increase in rally duration and the number of balls played per rally, an increase in rally speed, players impacting the ball at lower (more comfortable) heights on their groundstroke's, an increase in the number of balls played at the net and an increase in the number of volleys. Ball compression was not predicted to influence the number of forehands and backhands, or serve performance, but was considered to reduce the relative number of unforced errors, forced errors and winners produced in match play.

Methodology

Participants

A total of 10 male (age, mean = 10.2 years, s = 0.6 years; height, mean = 139.1 cm, s = 4.8 cm) and 10 female (age, mean = 10.2 years, s = 0.6 years; height, mean = 142.3 cm, s = 5.1 cm) tennis players aged 10 years and under voluntarily participated in this study after ethics approval was granted by the University and parental consent obtained. All players were ranked among the top players in their state and regularly participated in national tournaments.

Procedure

Children were stratified into pairs based on their age ranking and gender. Each pair played two two-set matches: one match with standard Wilson "yellow" (normal) balls and one match with low-compression Wilson "green" (modified) balls ("10/under ball", 75% of standard ball compression, ITF, 2013ITF. (2013). ITF approved tennis balls, classified surfaces & recognized courts: A guide to products and test methods. London: The International Tennis Federation, ITF Ltd. Both sets of balls were new. As assessed by a ball rebound test from a drop height of 2.54 m on a plexicushion surface, the ball rebound heights of the standard ball and the modified ball were consistent with the ITF's recommendations (ITF, 2013ITF. (2013). ITF approved tennis balls, classified surfaces & recognized courts: A guide to products and test methods. London: The International Tennis Federation, ITF Ltd. The order in which the two types of balls were used was counterbalanced and a 60-min rest period was provided between matches. All matches were played on a plexicushion surface on full-size tennis courts (23.77 m × 10.97 m). All players used their own tennis racquets and were accustomed to playing competitive matches with both balls.

Six digital video cameras (one at either end mounted on the fence to provide aerial view and four placed on tripods, with wide-angle lenses, at 90 degrees to the baseline at each end and side of the court) were set up around the court to allow for analysis of the matches via video replay. The cameras were synchronized at the beginning of each match. The video footage was analyzed using customized software (Fairplay) by a trained analyst. A high reliability was found amongst multiple analysts when coding tennis match-play data. Each match was analyzed in its entirety.

Data analysis

Descriptive data on the characteristics of match play that form the basis of most commercially available notational analysis approaches in tennis – number of points, shots, forehands and backhands, winners, unforced errors, forced errors, first serves in and double faults – were examined using paired t-tests. Further analyses examined the effect of ball compression on the dependent variables proposed to change with ball compression. These variables and their definitions are:

Rally speed

Rally speed was calculated as the number of shots per rally divided by the length of time per rally. The length of time per rally began when the ball was served and ended when an error was made (e.g. the moment the ball landed out) or a winner was hit (i.e. once the ball bounced twice on the opponent's side of the court).

Shot contact height

The point of ball contact was defined as a comfortable shot height, a high shot height or a low shot height. Comfortable shot height was recorded as the impact made between the hip joint and the shoulder joint (on the hitting side), low contact height was below the hip joint and high contact height was above the shoulder joint. The number of shots played at a comfortable, high and low height, respectively, has been represented as a relative figure to the total number of shots played.

Points played at the net

This was defined as any point where a shot was played in front of the service line at some stage during the rally. This figure was relative to the total number of points played.

Number of volleys

A shot was considered to be a volley if the ball was hit on the full in front of the service line. This figure was relative to the total number of shots played.

Preliminary analysis indicated that none of the dependent variables had an interaction with gender, and so males and females were analyzed together as one group. Analysis of shot contact height was conducted using a 2 (ball type) × 2 (contact height) repeated-measures

ANOVA. A significant ball type × contact height interaction was further analyzed using paired t-tests, with the Bonferroni method adjusting P-values ($P \leq 0.016$). To compare the effect of ball type on all other variables, paired t-tests were conducted. To account for the multiple comparisons made and alleviate the risk of subsequent type I error, Bonferroni correction adjusted the P-value to 0.004 for these tests. Combining effect size estimates in meta-analysis with repeated measures and independent-groups designs, Threshold (<0.2, trivial; 0.2–0.5, small; 0.5–0.8, moderate; >0.8, large). The 95% confidence intervals were reported for the raw mean difference and the standardized mean difference between the two ball types for each dependent variable that was hypothesized to be affected by the ball type used.

Results

Match-play variables

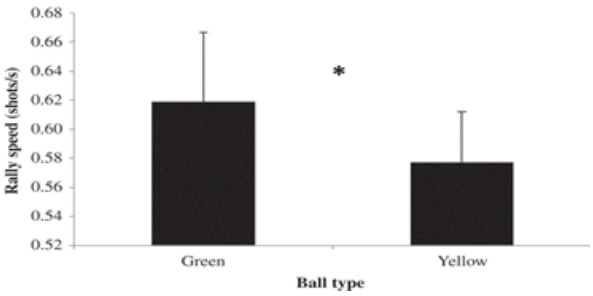
Table I summarizes the descriptive statistics and paired t-test results for the characteristics of tennis match play. As predicted, ball compression had no effect on these variables.

Table I. Descriptive characteristics of tennis match play and the paired t-tests results.

Rally speed

No significant differences were found in the number of shots per rally between the two ball types ([t (9) = −0.43, P = 0.68, one-tailed], modified ball, mean = 5.24, s = 0.52; normal ball, mean = 5.35, s = 0.97), with a mean difference of 0.10 shots (95% CI [−0.64, 0.43], which was considered a trivial effect size (d = 0.16, 95% CI [0.70, 1.00]). Similarly, there was no significant difference between the two ball types in the length of time per rally ([t (9) = −1.72, P = 0.12, one-tailed], modified ball, mean = 8.52, s = 1.02; normal ball, mean = 9.34, s = 2.09), although the effect size was moderate (d = 0.72, 95% CI [0.20, 1.70]) with a mean difference of 0.82 s per rally (95% CI [0.30, 1.90]). Subsequently, analysis revealed that rally speed was faster with the modified ball (mean = 0.62 shots/s, s = 0.05) than the normal ball (mean = 0.58 shots/s, s = 0.04) [t (9) = 5.18,P = 0.001, one-tailed]), with a mean difference of 0.04 shots/s (95% CI [0.02, 0.06]) and a large effect size (d = 1.80, 95% CI [1.0, 2.7]) (see Figure 1).

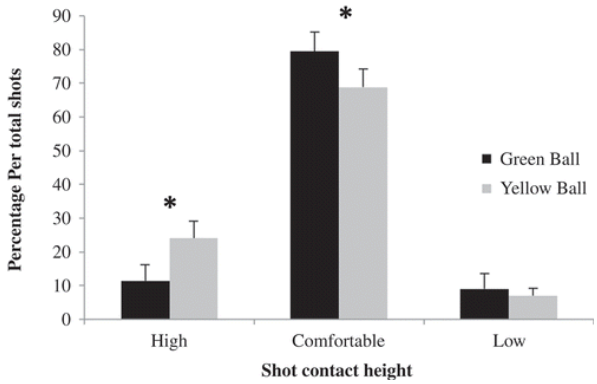
Figure 1. The rally speed when children played with the green and yellow balls, respectively. *Represents a significant difference between the two ball types. Error bars represent the standard deviation.



Shot height

There was no main effect for ball type [F (1, 19) = 0.3, P = 0.58], but there was a main effect for contact height [F (2, 38) = 1045.6, P < 0.001]. Pairwise comparisons showed that there were significantly more shots played at a comfortable height compared to "high" and "low", and there were more shots played at a "high" height than a "low" height (see Figure 2). A significant interaction was found between ball type and contact height [F (2, 38) = 75.5, P < 0.001]. Paired t-tests found that more shots were played at a comfortable height when using the modified ball (mean = 79%, s = 6%) compared to the normal ball (mean = 69%, s = 5%) [t (19) = 8.22 P < 0.001, one-tailed], with a mean difference of 11% (95% CI [8%, 13%]). A large effect size was also found (d = 1.9, 95% CI [1.0, 2.8]). Conversely, when playing with the normal ball, more shots were played at a "high" height ([t (19) = −12.77, P < 0.001, one-tailed], modified ball, mean = 0.12, s = 0.05;normal ball, mean = 0.24, s = 0.05). The effect size also indicated that the difference was large (d = 2.9, 95% CI [1.5, 4.2], with 13% more shots played at a "high" height when using the normal ball (95% CI [10%, 15%]). A similar number of shots were played at a low height with the modified (mean = 0.09, s = 0.05) and normal ball (mean = 0.07,s = 0.02) [t (19) = 1.95 P = 0.07, one-tailed]. The mean difference was 2% (95% CI [−1%, 4%]), which was considered a small effect size (d = 0.41, 95% CI [−0.03, 0.85].

Figure 2. The percentage of shots played at a high, comfortable and low height when children played with the green and yellow balls, respectively. *Represents a significant difference between the two ball types. Error bars represent the standard deviation.



Balls played at the net

Ball compression also influenced children's willingness to play balls at the net. Pairedt-tests showed that children played more balls at the net with the modified ball (mean = 0.14, s = 0.07) compared to the normal ball (mean = 0.09, s = 0.06) [t (19) = 4.64,P < 0.001, one-tailed]. The effect size also indicated a large difference (d = 1.1, 95% CI [−0.1, 2.3]), with children playing 4% more shots at the net when using the modified ball compared to when using the normal ball (95% CI [2%, 6%]). However, there was no significant difference in the number of volleys played ([t (19) = −0.49, P = 0.68, one-tailed], modified ball, mean = 0.04, s = 0.06; normal ball, mean = 0.05, s = 0.13), with only a 1% difference in volleys played between the two ball types (95% CI [−5%, 3%]). The effect size was considered trivial (d = 0.16, 95% CI [0.57, 0.89]).

Discussion

This article examined the effect of equipment scaling, through the modification of tennis ball compression, on elite junior tennis players within a match-play context. Scaling sports equipment serves a number of purposes; namely to expedite skill acquisition through age or maturation appropriate constraints, but also to preserve the characteristics of the "adult" or professional game. To this end, the findings of this article add further support for the use of scaled equipment for children and are timely given the ITF's recent rule change that has mandated the use of low-compression balls in all 10-and-under competitions held by its member associations (ITF, 2012ITF. (2012). The use of the modified ball increased rally speed, allowed players to strike the ball at a lower (more comfortable) height on their groundstroke's and increased the number of balls played at the net.

Interestingly, although match play was characterized by an increase in rally speed, this did not materialize in the fashion expected. That is, the use of the modified ball failed to result in rallies of longer durations or more shots played. This finding differs from previous research that has reported lower compression balls to increase rally length and therefore provide more hitting opportunities for children. The effect of equipment scaling on the skill acquisition of beginning tennis players is possible that the elite players played with greater control when using modified balls compared to the beginners in previous studies. This may have led to the elite players attempting to hit more winners, resulting in shorter and faster rallies. Indeed, the variables of shots per point and point duration combined to create a significant difference in rally speed. When playing with the modified ball, rally speed was 0.62 shots/s compared to 0.58 shots when using the normal ball.

Conclusion

The results of this study outline the benefits of the modified ball during match play (competition) and appear to support modifying equipment to accelerate the learning process. For coaches aspiring to develop children with all-round tennis games, the use of modified balls appears desirable. Further research is required to probe the efficacy and transition of scaled equipment at different stages of skill development and maturation, both in training and in competition, to help to contextualize the scaling discussion in sport.

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