Evaluation of Change-of-Direction Movements in Young Rugby Players

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The evaluation of change-of-direction (COD) performance is strongly focused on the time spent to perform the test trials, while much less is known about the technical execution adopted during the COD movements. Thus, the purposes of this study were to evaluate (1) the relationship between straight- and COD-sprint tests and (2) the technical execution of COD movements in relation to different age categories of young rugby players. Young rugby players (N = 157, age range 8–19 y) completed a test battery composed of a 15-m straight-sprint test (15SS) and a 15-m sprint test performed with 2 changes of direction (15COD). Significant differences were detected between age categories for both tests. Significant correlations were found between 15SS and 15COD. The analysis of the technical execution of the 15COD test showed differences between age categories, with a prevalence of rounded turns up to the U15 category. These findings confirmed the relationship between straight and COD abilities in young male rugby players. Moreover, the new approach introduced by this study, based on the analysis of COD technical execution, revealed that this performance could be conditioned by the age and mastery level of the players.

Keywords: team sports, field tests, technical execution, youth performance

In many field and court sports, agility represents a critical component of athletic performance. Based on the deterministic model of agility developed by Young et al., which includes both cognitive (perceptual and decision-making) and change-of-direction (COD) speed factors, a more comprehensive definition considers agility “a rapid whole-body movement with change of velocity or direction in response to a stimulus.” Running technique, anthropometrical features, leg-muscle qualities, and straight-sprinting speeds are further aspects influencing COD ability.

In team sports such as rugby players need great ability to accelerate, decelerate, and change direction in a short distance and in a variety of directions more than to attain maximal speed. Consequently, higher agility skills allow a player to perform a play in a fast, efficient, and repeatable manner. To obtain these advantages, the running technique plays a key role. Accordingly, rugby players are used to running with a lower center of gravity, a more forward-leaning upper body, less knee flexion during leg recovery, less knee lift, and a shorter stride length. These running adjustments allow greater body control, as well as the ability to perform rapid changes of direction. Thus, in training, coaches should address increasing acceleration and deceleration in short distances, foot speed, dynamic balance, and pelvic-stability exercises.

In a multiyear youth training plan designed to develop agility, Vescovi proposed a drills progression that evolves from general to specific tasks, from slower to faster, and from rounded to sharp COD executions, advancing from the first (5–8 y) to the last (>17 y) period of age-group play. In particular, Vescovi introduced 2 different technical executions to perform a change of direction: rounded and sharp. The former should be prevalent up to the age of around 13 years, for reasons of safety and injury prevention, as well as because a certain level of movement mastery has not yet been achieved. On the other hand, the latter should be emphasized after age 14, when movement mastery, body control, and physical capacities have significantly improved.

The relationship between COD speed and straight-sprinting speed has been widely investigated to understand how much these abilities have in common. Contrasting results have been found in relation to different team sports. Young et al., in Australian football players, found low correlations between 20-m straight sprint and COD sprint performed with 90° ($r = .27$) and 120° ($r = .19$) angles of directional change. Buttifant et al. reported a low correlation ($r = .33$) between 20-m straight-sprint and 20-m zigzag tests in male soccer players. Similar low correlations in male soccer players were also found by Little et al. when comparing 10-m straight-sprint,
flying 20-m, and 100° zigzag tests \( r = .35 \) and \( r = .46 \), respectively. In addition, poor correlations were evident in male basketball players between T-test and 5-m \( r = –.22 \), 10-m \( r = .07 \), and 30-m \( r = .23 \) straight sprints.\(^\text{11}\) Conversely, Gabbett et al\(^\text{12}\) found significant correlations \( r = .52–.73 \) between straight-sprint (5-m, 10-m, 20-m) and COD-sprint tests (L-run test, 505 test, modified 505 test) in male rugby players. In young basketball players (12–14 y), Jakovljevic et al\(^\text{13}\) reported statistically significant correlations, from low to moderate \( r = .37–.62 \), between straight-sprint (20-m, 30-m, 50-m) and COD-sprint tests (T-test, zigzag agility, agility run 4 × 15-m).

In the literature, the COD performance of rugby players (both adult and young) has frequently been assessed by means of field tests such as the L run, 505, modified 505, and Illinois Agility run,\(^\text{12,14–16}\) all of which consist of COD with a 90° or 180° angle. Nevertheless, none of these studies considered the analysis of the technical execution during a change of direction task, since they investigated only the time required to perform the tests.

Thus, this study had a double purpose: to evaluate the relationship between straight- and COD-sprint tests and the technical execution of the COD task in relation to the different age categories of rugby players.

**Methods**

**Experimental Design**

The current study used a cross-sectional experimental design to evaluate straight- and COD-sprint performances of young team-sport athletes. We asked whether the relationship between them could be confirmed in young rugby players as previously demonstrated in adult rugby\(^\text{12}\) and young basketball\(^\text{13}\) players.

In the current study, a COD test with two 60° changes of direction was run along a path of 15 m. The reason we chose an angle of 60° reflects the characteristics of rugby performance, since this team sport has the aim to carry the ball forward, with players being able to avoid an opponent and go ahead toward the in-goal area. Moreover, this angle has been used in previous investigation in team-sport players.\(^\text{1}\)

In addition, based on the description of developmental agility strategy,\(^\text{7}\) all COD performances were classified in 1 of 2 types of technical execution: “rounded” or “sharp.”

**Subjects**

Young male rugby players (\( N = 157 \), age 8–19 y) belonging to one of the most prestigious youth Italian rugby clubs (Unione Rugby Capitolina, Rome) were recruited for this study. The entire sample was split into 6 youth age categories (U9, U11, U13, U15, U17, U19) based on those used by the Italian Rugby Federation.

Before data collection, the university ethical committee approved the study, and written informed consent was obtained from parents and individual subjects.

**Methodology**

The testing sessions took place on artificial turf, with the participants wearing rugby shoes, at the same time of the day (4 PM) with temperature between 20°C and 24°C, humidity between 55% and 60%, and light winds and no rain.

All subjects performed a first session to practice the tests and become familiar with the procedures, followed by the experimental session during which a 15-m straight sprint (15SS) and a 15-m sprint with two 60° changes of direction (15COD) were executed.

Before each session, the subjects received a verbal explanation of the experimental procedures and performed a 15-minute standardized warm-up involving general running, shuffling, and multidirectional movements and a submaximal trial of the test.

For the 15SS, the subjects began in a standing position with their preferred foot forward and the front toe on a start line. Once ready, they sprinted as fast as possible to the stop line. The same starting procedure was used for the 15COD. Once ready, the subjects sprinted throughout a 15-m zigzag path performing two 60° changes of direction, one to right and one to left, each around a 1.25-m-high pole.

The sprinting time was measured to the nearest 0.01 second by means of a dual infrared photoelectric-cell system (Polifemo, Microgate, Bolzano, Italy). Subjects performed 2 trials for each test with 3-minute rests between trials, and the best score was used for the statistical analysis.

Moreover, the 15COD trial was recorded by an HD video camera (Sony HDR-FX7E, Tokyo, Japan, 50 Hz) placed in front of the players’ direction 500 cm after the finish line at a height of 90 cm. Once recorded, the footage was analyzed to examine the technical execution of the 2 changes of direction by means of video-analysis software (Dartfish TeamPro, Switzerland). Following the idea of Vescovi,\(^\text{7}\) the 2 technical-execution patterns were identified as rounded (when a subject performed a COD task adopting a slalom running not too close the pole) and sharp (when a subject performed a COD task adopting quick coupling of braking and accelerating, changing direction very close the pole).

**Statistical Analysis**

Data were first presented as mean ± SD. The distribution of each variable was examined for the assumption of normality with the Kolmogorov–Smirnov test.

A univariate ANOVA was conducted to investigate differences between the 6 age categories for the 15SS and 15COD tests. Tukey honestly significant difference (HSD) was used for post hoc analysis. A Levene test for equality of variances was applied. Moreover, the differences in performance between the previous and following age categories were calculated to verify the difference in percentage of sprinting time (\( \Delta \% \)), with a negative \( \Delta \% \) value meaning a decrease in the sprinting time and a positive one meaning an increase.
Correlations between 15SS and 15COD tests were calculated using Pearson correlation coefficients (r). A chi-square test was applied to verify differences between groups for the technical executions of the directional change.

Results

Descriptive statistics with number of subjects for each age category and CVs of the COD test (%) are presented in Table 1. The ANOVA for 15SS and 15COD tests showed significant differences between age categories (P < .0001). Post hoc analysis confirmed differences between age categories, with a continuous increase in 15SS performance with age, while a nonlinear progression of the 15COD performance was evident. This trend was confirmed when difference in performance between the previous and following age categories (Δ%) was considered (Table 2).

Analysis of correlations (Table 3) between the 15SS and 15COD tests revealed significant correlations (P < .01) for every age category (range: r = .55–.90), as well as for the pooled sample (r = .75).

The chi-square test indicated a significant difference for categories (P < .0001), showing up to the U15 category that the performances were characterized by a prevalence of rounded executions, while those in the U17 and U19 categories performed mainly sharp executions (Table 4).

Discussion

Accelerations, decelerations, and COD on short distances are critical motor skills for team-sport players. Moreover, agility is a complex task that requires a combination of technical features, coordination skills, and physical qualities.

The main findings of this study were that the 15SS and 15COD performances showed a different progression in relation to age categories, the 15SS and 15COD tests were significantly correlated, and the COD executions were strongly influenced by age, with the younger players performing rounded executions compared with the sharp ones of the older players.

Generally speaking, the improvement of sprinting time could be expected to be linearly related with the age categories. The time should become gradually shorter with increasing age. However, in our study this was the case only for the 15SS. In fact, the straight-sprint test showed a clear trend with a continuous increase in performance (the older the age, the shorter the time), with a higher negative value of Δ% between U13 and U15.

Table 1  Results of Sprinting Tests (Mean ± SD) for Each Age Category

<table>
<thead>
<tr>
<th>Category</th>
<th>n</th>
<th>15SS (s)</th>
<th>15COD (s)</th>
<th>CV(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U9</td>
<td>25</td>
<td>3.37 ± 0.21*</td>
<td>4.23 ± 0.37*</td>
<td>8.8</td>
</tr>
<tr>
<td>U11</td>
<td>24</td>
<td>3.34 ± 0.27*</td>
<td>4.44 ± 0.39*</td>
<td>8.9</td>
</tr>
<tr>
<td>U13</td>
<td>55</td>
<td>3.10 ± 0.22*</td>
<td>3.96 ± 0.29*</td>
<td>7.4</td>
</tr>
<tr>
<td>U15</td>
<td>26</td>
<td>2.78 ± 0.21*</td>
<td>3.76 ± 0.23*</td>
<td>6.0</td>
</tr>
<tr>
<td>U17</td>
<td>13</td>
<td>2.76 ± 0.15*</td>
<td>3.96 ± 0.23*</td>
<td>5.7</td>
</tr>
<tr>
<td>U19</td>
<td>14</td>
<td>2.69 ± 0.11*</td>
<td>3.96 ± 0.14*</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Abbreviations: 15SS, 15-m straight sprint; 15COD, 15-m sprint test with 2 changes of direction; CV(%), coefficient of variation for the 15COD.

*P < .01.

Table 2  Differences in Performance Between the Previous and Following Age Category

<table>
<thead>
<tr>
<th>Categories</th>
<th>15SS (Δ%)</th>
<th>15COD (Δ%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U9 and U11</td>
<td>–0.6</td>
<td>+4.9</td>
</tr>
<tr>
<td>U11 and U13</td>
<td>–7.9</td>
<td>–12.0</td>
</tr>
<tr>
<td>U13 and U15</td>
<td>–11.6</td>
<td>–5.3</td>
</tr>
<tr>
<td>U15 and U17</td>
<td>–0.7</td>
<td>+5.0</td>
</tr>
<tr>
<td>U17 and U19</td>
<td>–2.7</td>
<td>0</td>
</tr>
</tbody>
</table>

Abbreviations: 15SS, 15-m straight sprint; 15COD, 15-m sprint test with 2 changes of direction. –Δ% means a decrease in the sprinting time; +Δ% means an increase in sprinting time.

Table 3  Correlation Coefficients Between Sprinting Tests

<table>
<thead>
<tr>
<th>Category</th>
<th>r (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U9</td>
<td>.55 (.004)*</td>
</tr>
<tr>
<td>U11</td>
<td>.90 (.001)*</td>
</tr>
<tr>
<td>U13</td>
<td>.77 (.001)*</td>
</tr>
<tr>
<td>U15</td>
<td>.63 (.001)*</td>
</tr>
<tr>
<td>U17</td>
<td>.90 (.001)*</td>
</tr>
<tr>
<td>U19</td>
<td>.72 (.003)*</td>
</tr>
<tr>
<td>Pooled sample</td>
<td>.75 (.001)*</td>
</tr>
</tbody>
</table>

*P < .01.

Table 4  Chi-Square Test between the Rounded and Sharp Executions

<table>
<thead>
<tr>
<th>Category</th>
<th>Rounded</th>
<th>Sharp</th>
</tr>
</thead>
<tbody>
<tr>
<td>U9</td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td>U11</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>U13</td>
<td>42</td>
<td>13</td>
</tr>
<tr>
<td>U15</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>U17</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>U19</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>106</td>
<td>51</td>
</tr>
</tbody>
</table>

Note: Significant differences between age categories, P < .0001.
On the other hand, the test involving COD revealed a different picture, characterized by up and down Δ% values, with negative values between U11 and U13 and U13 to U15 (–12% and –5.3%, respectively). It can be speculated that this trend of performance improvement, although it cannot be sustained in this study by specific data, could be influenced by aspects of growth and maturation. In fact, the improvements registered for both the straight and the COD performances are consistent with those found in young soccer players,17–20 for whom studies reported an approximately age period from 13.5 to 14.5 years during which an increase in physical performances (ie, speed, agility, explosive power, aerobic endurance, anaerobic capacity) is reasonable.

Conversely, the COD performance did not show any improvement between U15 to U17 and U17 to U19 (Δ%: +5% and 0%, respectively). These findings are supported by the results of Spencer et al,21 who showed how the performance of 14- to 16-year-old players could be negatively influenced by disproportional growth and disruption of motor coordination in complex motor-coordination tasks (agility and jumping) compared with simpler tasks (straight sprint). After the age of 18, performance can become better again.21

This study analyzed the relationship between straight- and COD-sprint abilities. All the age categories reported significant correlations (P < .01), with the lowest correlation showed by U9 (r = .55) and the highest by U11 and U17 (r = .90). In addition, when the sample was pooled the analysis of correlation confirmed a high significant value (r = .75, P = .01). These results are consistent with those of Gabbett et al12 in adult male rugby players and by Jakovljevic et al13 in youth basketball players between straight-sprint and COD-sprint tests. Furthermore, these relationships could be explained by the choice to fix the angle of COD of this study at 60°, which confirms the idea of Young et al,8 who argued that the greater the change in direction angle the less the skills have in common. In fact, the use of field tests to explore COD ability in team sports presents some limitations due to the number of changes of direction and time duration required to perform the single trial of the test.22

Moreover, the choice of a COD test with a 90° or 180° angle does not reflect the real performance of team-sport players, since it has been shown that most directional changes performed during Australian football, soccer, basketball, netball, and field hockey games are between 0° and 90°.23–26 Similarly, the aim of the rugby game is to avoid an opponent and go ahead toward the in-goal area. For these reasons in this study a COD test with two 60° changes of direction was used.

The current study introduced an overall investigation of a test of COD performance, considering not only time but also the analysis of technical execution of COD movements. Based on the approach to developing agility,7 2 types of technical execution were identified: rounded and sharp. When the entire sample of this study was evaluated, rounded executions were more prevalent than sharp ones (67.5% and 32.5%, respectively). However, considering the age categories, there was a prevalence of rounded executions from U9 to U15 (rounded 77%, sharp 23%), while the U17 and U19 performed more sharp ones (rounded 23%, sharp 77%). The results of this study are in line with those of Vescovi,7 who suggested that up to 13 years of age, agility training should focus primarily on rounded CODs.

Although a sharp movement in adult athletes can be considered advantageous in real play (ie, a quick COD can enhance overall performance in both proactive offensive and reactive defensive actions), for younger athletes in the early periods of a multiyear youth training plan, rounded COD movements should be emphasized for reasons of safety, injury prevention, and lack of a high level of physical qualities.7

Consequently, it could be speculated that evaluation of the results of a test with CODs requires interpretation with reference to the overall age of the player. In particular, with young athletes, analysis of COD technical execution could yield more information than just performance time.

Practical Applications

Coaches and physical trainers should keep in mind, in their efforts to improve both straight- and COD-sprint abilities, the stages of youth athletic development, to provide appropriate exercise directions that will help young athletes enhance their mastery in agility performance. The differences in COD execution highlighted in this study, with more frequent occurrence of rounded movements in the early age categories and more sharp movements in the late age categories, suggest a different training approach. Performing rounded COD should include basic arm and leg movements and timing and rhythmic drills, executed mainly in a planned condition (ie, weaving between a set of linear cones, learning how to stop and restart). Sharp COD execution should be achieved by increasing the running speed and difficulty of the exercises, implementing unplanned drills to provide reactive abilities, and finally instructing in proper acceleration and deceleration mechanics.

Conclusions

In conclusion, this study demonstrated the relationship between straight- and COD-sprint abilities. These findings are in accordance with those obtained by Gabbett et al12 in rugby players, and they disagree with those found in other team-sport players,8–11 confirming the need for further investigation to clarify a sport-specific influence.

Acknowledgments

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References