DIFFERENCES IN DYNAMIC STABILIZATION BETWEEN VOLLEYBALL AND RUGBY PLAYERS

Kimitake Sato, Gary D. Heise, and Kathy Liu

University of Northern Colorado, Greeley, CO. USA

The purpose of this study was to examine differences in the time to stabilization (TTS) between volleyball players (n=8) and rugby players (n=7). With no footwear, all participants performed 4 different hopping tasks (medial, lateral, and two forward hops) onto each foot. The AP and ML ground reaction force data were collected and used to compute the TTS for each condition. The TTS measures were averaged within the groups and compared by using eight independent-sample T-tests ($p<.05$). Two out of eight conditions showed differences between the volleyball group and the rugby group. The rugby group stabilized more quickly on the R-foot 50% forward hop task ($t(13)=3.722$, $p<.05$) and the volleyball group more quickly on the L-foot medial hop task ($t(13)=-2.431$, $p<.05$).

KEY WORDS: hopping-tasks, time to stabilization, neuromuscular control.

INTRODUCTION:

During the course of an athletic contest, athletes make quick and explosive agility movements, while maintaining the appearance of fluidity. The contributions behind this balance are the focus of trainers and researchers alike. Although field coverage is different between volleyball (small) and rugby (large), each sport requires various movements in quick and explosive fashions. Additionally, stabilization of the body plays an important role in agility movements. If athletes take longer to stabilize at single-leg (1-leg) landings, it may take longer to make the next action or may increase the chance of non-contact lower extremity injuries. Thus, testing their time to stabilization (TTS) would be an appropriate assessment for their potential athletic improvement. TTS measures how long it takes an individual to attain a stable condition after landing from dynamic movements (Ross & Guskiewicz, 2004).

TTS has been used as a diagnostic tool to analyze the lower extremity stabilization based on the force measures using various tasks such as 1-leg static stance, forward and medial/lateral drop jumps, and 50% of maximum vertical jump reach to landing method (Butcher-Mokha, Jacobs, Sato, & Ludwig, 2006; Colby, Hintermeister, Torry, & Steadman, 1999; Ross & Guskiewicz, 2004; Ross, Guskiewicz, & Yu, 2005; Ross & Guskiewicz, 2006; and Wikstrom, Tillman, & Borsa, 2005). Numerous landing kinetics and kinematics studies have been conducted to understand the differences in male and female characteristics in landing technique, and what types of stabilization mechanisms can be an indicator for people with functional ankle instability (FAI), or people who received anterior cruciate ligament (ACL) reconstructive surgery (Colby, et al., 1999; Jacobs, Uhl, Mattacola, Shapiro, & Rayens, 2007; Ortiz, Olson, Libby, Trudelle-Jackson, Kwon, Etnyre, & Bartlett, 2007; Ross & Guskiewicz, 2004; Ross, et al., 2005; Ross, & Guskiewicz, 2006; and Yu, Lin, & Garrett, 2006).

A shortcoming in much of the existing literature which focuses on TTS in athletic populations is the fact that most researchers study landings from vertical jumps (Butcher-Mokha, et al., 2006; Myer, Ford, McLean, & Hewett, 2006; Ortiz, et al., 2007; Jacobs, et al., 2007; Ross & Guskiewicz, 2004; Ross, et al., 2005; Ross & Guskiewicz, 2006; Wikstrom, et al., 2005). Through pilot testing and observing the competitive matches in volleyball and rugby, the tasks chosen for this study focused on changing the position of center of mass (COM) in the horizontal directions (medial/lateral and forward). In order to detect possible weakness of neuromuscular control in the lower extremity, it is necessary to test the athletes' TTS after landing from horizontally directed movements. In this study, it is appropriate to analyze if the difference in field coverage in sports influences TTS in various hopping tasks. Therefore, the purpose of the present study was to identify difference in TTS in various hopping tasks between rugby players and volleyball players. Because these sports have different overall field coverage, TTS may show the difference. It was hypothesized that volleyball players would be better in all hopping tasks because they often change directions from a static position to initiate movements, whereas rugby players change directions while they are in running at various speeds.

METHODS:

Participants: Groups of collegiate volleyball players (n=8, age, 20.6+0.7yr.; height, 175.6+8.8cm; weight, 72.3+7.3kg) and rugby players (n=7, age, 21.2±1.3yr.; height, 179.9±8.3cm; weight, 92.9±14.2kg) agreed to participate in this study. They were free of injuries at the time of the data collection. However, all participants experienced various types of lower extremity injuries within the last three years. This project was approved by the university's institutional review board.

Procedures: All participants reported to University Biomechanics Laboratory for data collection and provided consent after hearing and reading about the purpose and procedures. They had an adequate amount of stretching and warm-up. The data collection was done in bare-foot condition. All hopping tasks were visually demonstrated and verbally instructed to all participants before the tests.

Medial / Lateral Hopping Tasks: sideways to left / right: Participants stood on the right side of an AMTI force plate (Advanced Mechanical Technologies, Inc., Watertown, MA) on their right foot. They were instructed to hop medially (to the left) onto the center of the force plate and land on their right foot as right medial hop (R-med). Approximate distance of this hop was 23 cm (from the edge to the center of the force plate). Then they were instructed to do the same hopping procedure to lateral direction from the other side of the force plate (to the right) as right lateral hop (R-lat). After completing the two right-footed hopping tasks, they performed left-footed hopping tasks in an identical fashion.

Forward Hops over Obstacle: After measuring their leg length (from ASIS to medial malleolus), we placed a soft rubber hurdle (15 cm high) at a distance of 50% of their leg-length (50% hop) from the center of the force plate. This hurdle is a safety-oriented tool that in case the participants hit it while hopping over, it bends or rolls to the hopping direction. The participants were asked to take two steps prior to the hurdle and hop over the hurdle in order to land on the force plate on one leg (step-step-hop method). They repeated this task for the opposite foot. Then the hurdle was placed at 100% of their leg-length distance (100% hop) from the center of the force plate. They performed the same step-step-hop method with right foot and left foot in an identical procedure.

After landing in both the above tasks, force data were collected for 10 seconds. Some practice trials were given to ensure an adequate level of understanding of the tasks. If a participant lost balance or touched the floor with the other foot in the trials, the trial was repeated. The order of the hopping tasks was randomly chosen for each participant.

Data Analysis: The anterior-posterior (AP) and medial-lateral (ML) components of the ground reaction force were measured by an AMTI force plate. Vicon Motus software (ver. 9, Vicon, Centennial, CO) was used to collect data (200 Hz) and to smooth the data with a Fast Fourier. Procedures described by Colby et al. (1999) and Butcher-Mokha et al. (2006) were used to calculate TTS. The analysis uses an algorithm that first calculates cumulative averages of both AP and ML force data. The cumulative average was compared with the overall series mean. When the sequential average reached under 0±.25 standard deviations of the overall series mean, a participant was considered stable (Figure 1).

TTS data of volleyball and rugby players were statistically analyzed using eight independent-sample T-tests (left and right foot conditions of 1) medial hop, 2) lateral hop, 3) 50% forward hop, and 4) 100% forward hop). The Statistical Package for Social Sciences (SPSS) was used for the analyses (SPSS, Inc., Chicago, IL).

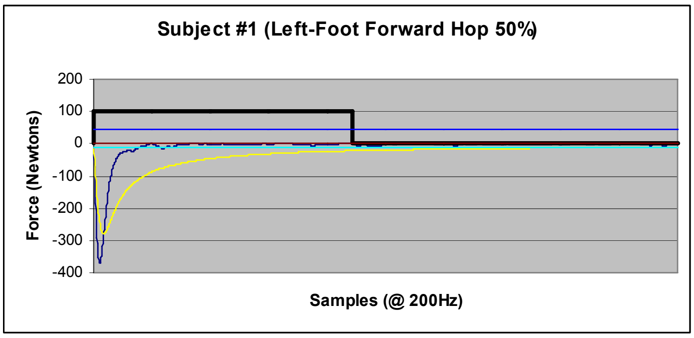

Figure 9: Sample data: the dark line drops to zero indicates the TTS point.

RESULTS:

Demographic data (height, weight, & leg-length) showed no correlation with all measured variables indicating that the variables were not related to body structures of the participants. Two out of eight measures were significantly different between the volleyball group and the rugby group. The rugby group stabilized more quickly in the AP direction of R-50% hop ($t(13)=3.722$, $p<.05$), and the volleyball group stabilized more quickly in the ML direction of L-med hop ($t(13)=-2.431$, $p<.05$). Levene's test for equality of variance showed that those two variables were not significantly different in their variance values. The other six variables were not significantly different between the volleyball group and the rugby group. Mean data are shown in Table 1 for the AP direction and in table 2 for the ML direction.

Table 1 Mean TTS for all tasks from AP force (milliseconds).

Foot Conditions	Tasks	Volleyball (*n*=8)	Rugby (*n*=7)
Left	Medial Hop	1472 ±716	2610 ±1297
	Lateral Hop	2274 ±813	2026 ±725
	50% of Leg Length Forward Hop	4590 ±252	4595 ±122
	100% of Leg Length Forward Hop	4596 ±152	4507 ±125
Right	Medial Hop	2331 ±1012	2948 ±917
	Lateral Hop	1800 ±507	1392 ±524
	50% of Leg Length Forward Hop **	4709 ±174	4426 ±105
	100% of Leg Length Forward Hop	4595 ±109	4525 ±93

Note: ** indicates the significant difference at $p<.05$.

Table 2 Mean TTS for all tasks from ML force (milliseconds).

Foot Conditions	Tasks	Volleyball (*n*=8)	Rugby (*n*=7)
Left	Medial Hop **	4217 ±410	4704 ±336
	Lateral Hop	4394 ±363	4219 ±416
	50% of Leg Length Forward Hop	2112 ±1156	2180 ±1032
	100% of Leg Length Forward Hop	1552 ±849	1137 ±256
Right	Medial Hop	4346 ±374	4606 ±358
	Lateral Hop	4400 ±387	4490 ±580
	50% of Leg Length Forward Hop	1761 ±703	1532 ±708
	100% of Leg Length Forward Hop	2537 ±1316	2180 ±1563

Note: ** indicates the significant difference at $p<.05$.

DISCUSSION:

One out of eight variables (ML: L-Med hop) supported our hypotheses that the volleyball group performed better than the rugby group, whereas one variable (AP: R-50% hop) was actually better for the rugby group. However, no differences were found in all other variables. Past studies clearly showed differences in TTS measures between individuals with and without FAI (Ross & Guskiewicz, 2004; Ross & Guskiewicz, 2006). However, it is hard to determine whether the present study can detect which sport is more prone to lower extremity injuries such as ankle sprain. Different field coverage of sports (volleyball & rugby) has different characteristics in movements. Volleyball requires both horizontal (agility) and vertical (jump) movements on the court and frequent direction changes in order to initiate

movements by reacting to the ball, whereas the rugby often deals with horizontal motions at various running speeds. The difference in movement characteristics did not influence the TTS measures in the given tasks.
If they are tested periodically, we are able to have the baselines of their stability levels. As stated in the previous study, the baseline could be a good indicator if they are coming back from future lower extremity injury (Butcher-Mokha, et al., 2006). The TTS in all tasks were greater as compared to the previous studies (Butcher-Mokha, et al., 2006; Colby, et al., 1999; Ross & Guskiewicz, 2004; Ross, et al., 2005; and Wikstrom, et al., 2005). This was expected since the tasks we applied focused on changing the displacement of COM horizontally which was more difficult to stabilize. Thus, this study showed that when participants were challenged to change the displacement of COM horizontally, it is harder to be in the stable condition.

CONCLUSION:
Overall, this study tested two different types of athletes' TTS in various hopping tasks. There were significant differences in two out of eight hopping tasks. Future studies may focus on testing athletes periodically over the long-term to identify possible changes in TTS. TTS may differ depending on the period of the year (off-, pre-, and in-season). Future studies may also focus on athletes in other sports compare the difference in TTS.

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