Asymmetries in Flexibility, Balance and Power Associated with Preferred and Non-Preferred Leg

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Abstract: The uninjured limb is commonly used as a pre-injury model because of the assumption that the limbs are symmetrical. However, this may not be true in all athletes. One-legged athletes (1LA) (e.g., jumpers) may develop bilateral asymmetries as a result of specific training. The purpose of this study was to determine whether asymmetries in flexibility, balance and power existed in the preferred and non-preferred legs of 1LA athletes. Three characteristics were measured in three groups of subjects: non-athletes (NAS) (n=10, age 21.0±1.2 y, height 170.1±6.8 cm, weight 68.5±13.1 kg); two-legged athletes (2LA) (n=10, age 21.4±1.4 y, height 169.9±8.6 cm, weight 66.3±10.0 kg) and one-legged athletes (n=10, age 22.3±1.4 y, height 179.7±11.0, weight 72.9±13.9 kg). Quadriceps and hamstring flexibility were measured using a Leighton Flexometer during a passive prone knee-flexion test and a supine passive straight-leg raise, respectively. Balance was assessed by stork standing test. One-legged hop distance (OLH) represented power. Leg preference was determined using soccer ball kicking task. 2x3 ANOVAs were used to determine if differences existed in the legs (preferred, non-preferred) by group (NAS, 1LA, 2LA) for flexibility, balance and OLH. Tukey’s HSD post hoc test was performed to locate any significant differences. Results revealed no significant interactions in leg preference by group (NAS, 1LA, 2LA) for flexibility, stability and OLH. However, main effects among groups were revealed when the means of both legs were combined. Tukey’s post hoc test revealed that 1LAs were jumped significantly farther compared to the NASs and 2LAs. The lack of significant asymmetries between preferred and non-preferred legs suggests that an inadequacy in training elicited asymmetrical adaptations. Therefore, a bilateral comparison is a valid pre-injury model for the injured lower limb allowing clinicians to accurately organize rehabilitation goal and return-to-play criteria.

Key words: Asymmetry %Flexibility %Balance %Power

INTRODUCTION

Sport injury rehabilitation centers on restoring functional abilities to normal, optimal, or a pre-injury state of health [1]. Using the uninjured limb as a pre-injury model is very common because of the assumption that the limbs are physically and functionally symmetrical [1-3]. Using a bilateral comparison, clinicians assume limb symmetry and use the uninjured limb as a comparison model for the injured limb.

The limbs may not be perfectly symmetrical when observing left and right physical characteristics [3, 4]. This is apparent in the upper extremity, where the dominant arm is usually stronger and more versatile [5, 6]. In the lower extremity, the differences may not be as obvious in two-legged athletes [7-9] (e.g., sprinters and swimmers) and non-athletes [10, 11] (e.g., sedentary population). However, one legged athletes (e.g., long jumpers and high jumpers) may develop a significant bilateral asymmetry due to a constant training overload on the jumping leg [12, 13]. Logically, superior physical characteristics should be seen in the jumping leg of one-legged athletes like long jumpers, high jumpers and football kickers [12].

Clinically, a bilateral comparison is performed between limbs with the assumption that the limbs are symmetrical. However, pre-injury asymmetries between the limbs may invalidate this bilateral comparison and
complicate the rehabilitation process. Assuming pre-
injury symmetry or asymmetry when the opposite exists
sets erroneous functional progression criteria. Establishing incorrect functional rehabilitation
progression criteria may delay an athlete’s progress
through the rehabilitation process. For the clinician,
problems of misinterpretation arise when incorrect
assumptions are made. Depending on the type of activity,
level of participation, or training regimen, the limbs may or
may not be symmetrical. As a result, rehabilitating athletes
are affected. Therefore, this study attempted to answer
the following questions:

Are there physical and or functional asymmetries
between the right and left legs of one legged athletes?
And are these asymmetries associated with the preferred
leg?

MATERIALS AND METHODS

This investigation is a cross sectional, two-way
ANOVA design. The dependent variables for this
investigation are flexibility (hamstring, quadriceps),
balance and power (OLH). The independent variables for
this investigation are leg preference (left, right) and group
(NAS, 1LA, 2LA).

Three groups of subjects: non-athletes (NAS) (n=10,
age 21.0±1.2 y, height 170.1±6.8 cm, weight 68.5 + 13.1 kg);
two-legged athletes (2LA) (n=10, age 21.4 + 1.4 y, height
169.9 + 8.6 cm, weight 66.3 + 10.0 kg) and one-legged
athletes (n=10, age 22.3 + 1.4 y, height 179.7 + 11.0, weight
72.9 + 13.9 kg) gave their informed consent and
volunteered to participate in the study, which had the
approval of the University’s Ethical Advisory
Commission. All participants were informed verbally and
in writing about the nature and demands of the study as
well as the known health risks. Subjects completed a
health history questionnaire and were informed that they
could withdraw from the study at any time, even after
giving their written consent. Athletes had trained for a
minimum of three years (part or full time) and all them
participated for at least 16 hours/week of training for the
six months before testing.

After height and weight had been measured, the
subject completed a standardized warm up by riding a
bicycle ergometer for five minutes at a comfortable speed.
The subject then stretched the lower extremity muscle
groups. Leg preference was determined using soccer ball
kicking task [14]. Flexibility measurement of the hamstring
was measured using a Leighton Flexometer during the
passive straight-leg raise [13] which its intersession and
intraseesion reliability was reported as 0.97 and 0.88,
respectively. Quadriceps flexibility was measured using
the Leighton Flexometer during passive prone knee
flexion. Intrasession reliability was established during a
pilot test by the primary investigator at 0.98. All flexibility
measures were recorded in degrees and used in the
analysis. Power was represented by the distance hopped
during one-leg hop test (OLH) and was assessed as
described by Bolgla et al. [15]. Hop distance was
measured using a standard tape measure secured to the
floor. The furthest hop distance of the 3 performed was
used in the analysis. Balance was assessed by stork
standing test. For the stork stand the subjects completed
the test on the dominant and non-dominant foot. The
subjects kept their hands on their hips with the
uninvolved foot against the medial side of the knee of the
stance leg. Each subject maintained this position while
standing on the ball of the foot for the maximum possible
time. The trial ended when the heel of the involved leg
touched the floor, the hands came off of the hips, or the
opposite foot was removed from the stance leg. The best
of three trials was recorded for analysis. Outcome
measures were analyzed using 2 x 3 (leg preference x
group) ANOVAs and Tukey’s HSD Post Hoc Tests for
the dependent variables. Data were analyzed using SPSS
11.5 (SPSS, Chicago, IL). The level of significance was set
a priori at p < 0.05.

RESULTS

Table 1 shows descriptive statistics by group. The
ANOVA revealed no significant interactions in leg
preference (preferred, non-preferred) by group (NAS,
1LA, 2LA) for quadriceps [F (54, 2) =0.30, p=0.967] and
hamstring flexibility [F(54,2)=0.546, p=0.583]. The ANOVA
revealed no significant interactions in leg preference by
groups for balance F(54,2)=0.275, p=0.761]. Also the
ANOVA revealed no significant interactions in leg
preference by groups for OLH [F (54, 2) =0.07, p=0.925].
However, a group main effect was revealed [F (54, 2 )
=35.18, p=0.000] when data for both legs were pooled.
Tukey’s HSD post hoc analysis showed that 1LA jumped
significantly farther than 2LA and NAS.

DISCUSSION

The results of this study show no significant
differences in the preferred and non-preferred legs of 1LA,
2LA and NAS in any of the tests. Similar to Agre et al.
[16], Rahnama et al. [17] and Knapik et al. [18] the present
study found no significant differences in the preferred and non-preferred legs for hamstring and quadriceps flexibility. However, neither Agre et al. [16] nor Knapik et al. [18] strictly examined NAS or 1LA. Both Agre et al. [16] and Rahnama et al. [17] used football player athletes; however, Knapik et al. [18] only used female collegiate athletes. The present study is in contrast to Sullivan et al. [19] who reported a significant difference in the legs for hamstring flexibility.

Some ideas may explain why these adaptations did not occur in 1LA. The Overload Principle suggests that physical changes occur in tissues if imposed stresses are greater than what the tissues are accustomed [12]. The volume of exercise and the range of motion (R.O.M) of the movements needed to elicit changes in flexibility may have been inadequate. Additionally, the relative amount of work performed by one leg versus two is minute compared to the relative amount of work performed by one arm versus two. Krahl et al. [20] noted significant structural asymmetries between the arms of tennis players. These athletes during training and activities of daily living (ADL) notably use one arm more than the other. However, jumping and kicking athletes, even during training do not use one leg independently of the other for long periods of time.

Similar to Harrison et al. [21], Ross et al. [22], McCurdy and Langford [23], the present study observed no significant differences in the preferred and non-preferred legs. In contrast, Colby et al. [24] noted significant differences. Contrasting results between present study and Colby study could be attributed to different testing methods and subjects used.

Beling et al. [3] examined lower limb task performance while standing and sitting and suggested that dynamic activity (manipulation) is typically lateralized regardless of posture (e.g., standing or seated). Therefore, the inherent use of the support limb does not determine which leg one chooses to perform a task. Moreover during long jump, high jump, or hurdle training, the 1LA does not focus on improving single-leg standing balance. Therefore, symmetry in stability performance in the legs is expected.

The results of the present study are similar to those reported by Mangine et al. [25], Booher et al. [26] and Jarvela et al. [27]. No studies reporting asymmetrical performance in the preferred and non-preferred legs were found.

The results revealed that 1LA jumped significantly farther than both the NAS and 2LA. This was probably due to the difference in training regimens among the groups. The 1LA group consisted of varsity track athletes that actually trained 6 days per week, 2 hours per day. The 2LA group consisted of athletes that varied weekly volume between 3 and 6 days per week, 1 to 3 hours each day. The large disparity among weekly volumes may have influenced this difference among groups.

Since no asymmetries were revealed in the present study, the preferred leg could not be associated with physical and functional characteristics. Therefore, leg preference does not influence or predict asymmetries in flexibility, balance and power in the lower extremities.

The results of the present study demonstrated that no asymmetries in flexibility, balance and power in the preferred and non-preferred legs existed in NAS, 2LA and 1LA. Hence, limb asymmetry is not associated with leg preference. Therefore, a bilateral comparison is a valid pre-injury model for the injured lower limb allowing clinicians to accurately organize rehabilitation goal and return-to-play criteria.
REFERENCES


