Enhancing Flexibility in Gymnastics

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Most gymnastics coaches would agree that flexibility is an essential aspect of gymnastics training and performance. Flexibility is frequently included in talent identification and screening measures for gymnasts, divers, and dancers (2, 10, 11, 16, 20, 21). In spite of a fairly universal recognition of the need for flexibility in gymnastics, surprisingly little research has been done on enhancing flexibility among elite performers. The simple answer to how one develops flexibility (i.e., range of motion) is to stretch. However, the problem of increasing flexibility to enhance gymnastics performance may be more complicated. Clearly, because the rules of assessment in gymnastics performance call for deductions when a gymnast cannot achieve a specific position, the role of flexibility training to achieve certain positions is important (13).

Some years ago, Dr. Gerald George provided a thought-provoking lecture regarding the expression of strength and flexibility, starting with these characteristics as separate and finally showing that they were conceptually very similar. That range of motion is dependent on both strength and flexibility is commonly understood, but how to train both qualities for the elite gymnast in particular, has not been well researched. Interestingly, stretching activities of various types may be the single exercise activity in gymnastics that consumes the greatest percentage of conditioning time. In spite of this, our gymnasts are often viewed as being inflexible when evaluated by the National Coaching Staff and judges.

Training elite gymnasts with regard to flexibility proves problematic for at least two reasons. First, highly trained athletes are usually near their performance ceiling in many physical abilities (ceiling effect), and therefore are unable to show consistent improvement of large magnitude. Second, flexibility training has consisted almost exclusively of stretching exercises with little attention devoted to strengthening the prime movers in the extreme ranges of motion (one dimensional thinking). Perhaps only proprioceptive neuromuscular facilitation techniques (PNF) have found much of a following in elite gymnastics training (1, 14, 15). The research literature on flexibility has offered paradoxical results when compared to typical coaching understanding of flexibility. For example, Russell (18) compared six methods of stretching and found that passive stretching approaches were superior to active stretching approaches in increasing hip flexion range of motion. Another study by Cornelius and Hayes (3) showed that when using PNF techniques, multiple maximal contractions at the extreme range of motion were not better than a single contraction. Hutton showed that much of the current understanding of the neuromuscular activity during stretching (i.e., PNF) was poorly understood or simply incorrect (12). In a comparison of pelvic position and static versus PNF stretching techniques, Sullivan, *et al*., found that pelvic position was more important than the stretching technique in improving hamstring flexibility. Our current simple understanding of "flexibility" as the range of motion of a joint, or a related series of joints, may be misguided and betray a more complex mechanism (7-9).

The purpose of this investigation was to determine if a ballistic stretching/strengthening approach would improve already highly trained gymnasts' split leap leg positions. A simple split leap was chosen due to its fundamental nature and the fact that gymnasts rarely do a simple split leap in their typical routine training. The split leap served as a skill that all gymnasts had performed in the past, but suitably novel that improvement could still be possible. Through the cooperation of seven gymnasts at the Olympus School of Gymnastics and their head coach, we undertook a training study using Theraband(tm) elastic strips. The gymnasts were all Level 10 and Elite gymnasts currently training approximately 25-30 hours per week. The training lasted one month. The athletes were in the combination preparation stage of their yearly periodized program (19, 22, 25).

The elastic bands consisted of the **black** commercially available Theraband strips. Each strip was approximately 5 ft, 6 inches in length (167 cm) and was cut from a standard commerical roll. (Theraband strips can be purchased at a Medical Supply store or ask an athletic trainer to help you find it.) Black Theraband represents the second stiffest Theraband. We attempted all the other colors of Theraband before settling on black. The other colors (representative of their varying stiffness) appeared to be too easily stretched to provide the gymnast with sufficient stimuli for strengthening the hip muscles. We used trial and error to determine that black was the appropriate resistance. The next higher resistance Theraband (Gray), would also be appropriate in later stages of training and for those athletes already strong in the extreme ranges of motion. After cutting the Theraband, double knots were tied in each end forming a small loop for the athlete's foot to enter. The loop was small so that the fit was snug to the gymnast's ankle. The small loop helped prevent the Theraband from sliding up the gymnast's leg while performing the stretching exercises. The gymnast placed a loop of the Theraband around each ankle.

Following placement of the Theraband, the gymnast performed the following movements on both legs:

1. Kicks forward
2. Kicks sideward
3. Kicks rearward
4. Straddle jumps
5. Split jumps

The gymnasts began with 5 repetitions per set and 3 sets. The number of repetitions gradually increased to 15 repetitions per set for 3 sets. The increasing number of repetitions per set was spread over the four week training period. We were initially concerned about potential hip flexor or other groin injuries and chose to cautiously proceed. The exercises were performed at the end of practice approximately daily, with a few exceptions due to individual and program schedules. The athletes were encouraged to "kick" rather than "lift" their leg, maintain good form and alignment, and maximize their effort during the kick -- trying to kick as high as possible.

The evaluations of the split leaps were done by video recording the leaps from the side with an 8mm camcorder. The gymnasts performed three trials of split leaps using both strong-side and weak-side leaps. The gymnasts were assessed in a pre-test, post-test format. The video tapes were analyzed by first converting them to computer video files (.AVI), and then digitizing the split leap angle drawn from forward knee to the forward leg hip joint center to the rearward knee. Knees were chosen as the angle end points due to some athletes bending their knees during the pre-test evaluation. The angle midpoint (forward leg, hip joint center) was chosen to maintain consistency and due to familiarity with this position via previous digitizing experience. On completing the angle digitization, the computer software (NEAT Systems, Inc.) automatically displayed the angle of the two digitized lines.

Results and Discussion

Analysis of the data from the digitized split leaps began by determining reliability of the trials data. Each gymnast performed three test trials on each side. Because the gymnasts' performances were likely to vary somewhat, it was important to determine an "average" or "overall" performance level for further data analysis (6). Cronbach's alpha statistic was calculated on the three trials for each condition: pre-test strong-side, pre-test weak-side, post-test strong-side, and post-test weak-side. The resulting coefficients ranged from alpha=.84 to alpha=.98 indicating good to excellent reliability or "stability" across the trials (5). The statistical procedure, analysis of variance (ANOVA), was also calculated on the trials data to determine if there were any differences between trials that might reflect a learning or fatigue effect. None of the ANOVAs were statistically significant indicating that none of the trials were uniformly unusual. The trials data was then summarized by calculating the average of the three trials for further data analysis.

In order to determine if there was a difference between the pre-test and post-test measures, or a difference between strong-side and weak-side, or a more complicated result indicating that the results depended on whether one was referring to the pre- or post-test, or the strong- or weak-side, a repeated measures (2x2) ANOVA was used as the statistical test. Repeated measures means that the comparison involved the same people doing the same thing at each testing. The 2x2 information means that there were two levels of "sides"-strong and weak, and two levels of test-pre-test and post-test. The results of the ANOVA calculations showed that the gymnasts improved from pre-test to post-test (F(1)=14.589, p=.009 eta2=.709), and that their strong-side was better than their weak-side (F(1)=20.055, p=.004, eta2=.77). There was no statistically significant interaction.

Figure 1 (right) shows the average and standard deviation information. The improvements were approximately 3.9% for the strong-side, and 3.4% for the weak-side.

Note the range of motion improvement during the split leap on both strong side and weak side. The amount of improvement was similar regardless of side. The average difference between conditions was approximately 6 degrees.

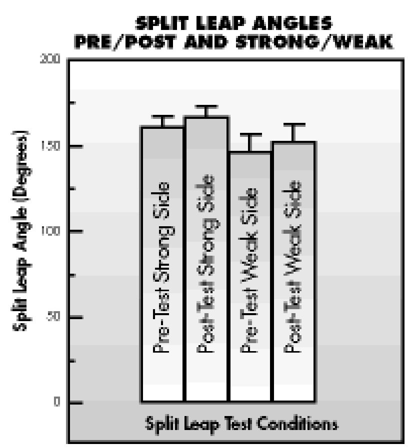

Figure 2. The images (left) show a split at 165 degrees on the left and 170 degrees on the right. The average difference in performance between pre-test and post-test on

the strong side was slightly more than 6 degrees.

The results of this study showed that split leap range of motion can be improved. Although no control group was used due to a perceived ethical problem of withholding a useful technique from teammates, it is clear that these gymnasts have been stretching diligently for several years with only modest improvement, if any. The lack of a control group (which would have tested but not participated in the Theraband stretching) results in an inability to state with certainty the cause of the enhanced split leap performances. However, the cause-effect relationship is strengthened by the temporal ordering of events and the novel nature of the split leap. Subjective observation showed that these athletes demonstrated dramatic improvement in split leaps, kicks, straddle jumps and similar skills. Perhaps the most obvious observation of improvement came on balance beam where the different shape-jumps demonstrated dramatic increases in leg height and amplitude. Although a three to four percent improvement in performance might be considered small, among elite athletes such an improvement is large. A 3.5 percent difference at the most recent World Gymnastics Championships was the difference between 1st and 20th place in the women's all-around (4, 17, 23, 24). **Figure 2** shows two images representative of increasing the angle of the split leap by 5 degrees.

Further research needs to be performed with an adequate control group. A four week training period is rather short, therefore a longer training program is warranted and the gymnastics groups could be expanded to include less highly trained gymnasts.

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