# Star Excursion Balance Training: Effects on Ankle Functional Stability after Ankle Sprain

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***Objectives:*** *To study the effects of Star Excursion Balance training on functional stability of athletes with ankle sprain.*
***Material and Method:*** *Thirty-two male athletes with grade 2 ankle sprain, aged 15 – 22 years old were enrolled. They were random sampling into training group (n = 15) and control group (n = 17). All received conventional physical therapy program for 4 weeks. The training group also underwent the Star Excursion Balance training 3 days per week for 4 weeks. Single leg stance time (SLST) was assessed at pre- and post-training. Re-injuries were recorded during 3 months follow-up.*
***Results:*** *After the program, subjects from both groups demonstrated significant improvement in SLST. The training group gained SLST of the injured sides 2 times more than the control group (p= 0.002 tested with eyes closed, p= 0.007 tested with eyes open), and also improved the SLST during eyes closed of the normal sides (p= 0.015). Re-injuries were found in 1/15 of the training group and 2/17 of the control group.*
***Conclusion:*** *Star Excursion Balance training is more effective than the conventional therapy program in improving functional stability of the sprained ankle.*

***Keywords:*** *Ankle sprain, Ankle stability, Star Excursion Balance, Single leg stance time*

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Ankle sprains are the most common sports injuries among athletes[1,2]. They are often inadequate treated, resulting in chronic instability and recurrent sprains[3-6].The factors responsible for these complications are mechanical and/or functional instability of the ankles[7,8]. The proper rehabilitation program should include proprioception and postural training along with range of motion and strengthening exercises[9-11]. As the Star Excursion Balance test[12,13], which is usually used for dynamic balance assessment is composed of closed kinetic chain controlled motion and ability to balance on one leg; this gave us an idea to modify this test into a proprioceptive and balance training program.

**Objectives**

To study the effects of Star Excursion Balance training on functional stability and recurrent rate in athletes with ankle sprain.

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**Material and Method**

Experimental study was conducted at Armed Forces Academies Preparatory School, Nakornnayok, Ministry of Defense during August 2004 - February 2005. The proposal was approved by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University before the beginning of the study.

Forty male athletes with grade 2 ankle sprain, aged 15 – 22 years old were recruited from the students of Armed Forces Academies Preparatory School. They were diagnosed and treated by the same physician and the same physical therapist. Simple random sampling was used to divide the participants into control group and training group. All received conventional physical therapy program, which included superficial heat, ultrasound therapy, range of motion exercise, stretching exercise, and strengthening exercise. When the

participants could walk without pain and did not receive any medication, the training group underwent supervised Star Excursion Balance training 10 minutes/session, 3 times/week for 4 weeks.

The Star Excursion Balance training was instructed and supervised during every session of exercise. The participants had to balance their body weight on the sprained ankle, while using another foot to reach as far as they could into 8 directions as performed in the Star Excursion Balance test[13]. The exercise session consisted of 12 rounds clockwise and 12 rounds counterclockwise foot reach, with 3 seconds rest between each direction. After training program, the participants were followed up and interviewed at month 1st, 2nd, and 3rd. The symptoms, activities and recurrent injuries were recorded.

Single leg stance test[14] was used to assess ankle functional stability at pre- and post- training. The single leg stance times (SLST) were compared between pre- and post- training, and between the 2 groups, using the paired-t test and unpaired-t test, respectively. The recurrent sprains occurred in both groups were also compared with Fischer's test. The data were analyzed using SPSS program for windows version12, with significance at $p \leq 0.05$, 95% confidence interval.

## Results

There were 8 athletes who did not finish the full treatment program and follow up. So, 15 athletes of the training group and 17 athletes of the control group were studied. Most of them were injured during playing football: 6/17 of the control group, 7/15 of the training group. The second most frequent ankle sprains occurred during jogging: 6/17 of the control group, 3/15 of the training group. The characteristics of both groups were shown in Table 1.

Results from single leg stance test (Table 2) demonstrated no difference in SLST of the control and training group before beginning the program. After 4 weeks training program, SLST of the sprained ankles were significantly increased among the training group to about 2.2 times of the control group; 39.9:18 with eyes closed (P=0.002) and 162.9:72 with eyes open (P=0.007). The end results were approximated to the non-injured side's values; 39.9:39.2 with eyes closed and 162.9:164.4 with eyes open.

Comparing between before and after training (Table 3), the SLST of the sprained ankles were significantly increased in both control and training groups. But the training group gained 3-5 times improvement more than the control group (172%:53% with eyes closed, 117%:23% with eyes open). For the non-injured side (Table 4), the SLST also significantly improved in the training group (P=0.015) during eyes closed test.

Within 3 months follow up, 3 of the 32 athletes (9%) had recurrent sprains: 1/15 of the training group and 2/17 of the control group. The athlete of the training group had his recurrent sprain during the 1st month post training program, while accidentally jumped on another player in a basketball match. The two athletes of the control group had their recurrent

**Table 1.** Characteristics of the participants

| Characteristic | Control (n=17) | Training (n=15) |
|---|---|---|
| Age (years) | 16.94 ± 1.60 | 18.00 ± 1.59 |
| Weight (Kg) | 60.00 ± 5.29 | 65.33 ± 9.09 |
| Height (cm) | 170.74 ± 4.27 | 174.13 ± 7.42 |
| BMI (Kg/m$^2$) | 20.59 ± 1.75 | 21.46 ± 1.89 |
| Injured side | | |
| Right : Left | 8 : 9 | 9 : 6 |
| First episode | | |
| : Recurrent sprain | 14 : 3 | 9 : 6 |

**Table 2.** Mean ± SD of single leg stance times (sec) of the sprained and normal ankle, comparison between control and training group

| Sprained ankle | | Control | Training | p-value | 95% CI |
|---|---|---|---|---|---|
| Eyes closed | Before | 11.76 ± 6.25 | 14.65 ± 18.43 | 0.547 | -6.80, 12.58 |
| | After | 18.10 ± 8.99 | 39.91 ± 22.51 | 0.002* | 8.76, 34.85 |
| Eyes open | Before | 58.68 ± 38.99 | 74.82 ± 73.49 | 0.455 | -27.99, 60.28 |
| | After | 72.39 ± 31.47 | 162.98 ± 108.50 | 0.007* | 29.05, 152.11 |
| Normal ankle | | | | | |
| Eyes closed | Before | 23.54 ± 10.94 | 30.14 ± 16.97 | 0.196 | -3.59, 16.78 |
| | After | 27.44 ± 14.04 | 39.24 ± 20.30 | 0.063 | -0.68, 24.28 |
| Eyes open | Before | 124.54 ± 65.37 | 153.27 ± 63.39 | 0.218 | -17.90, 75.35 |
| | After | 115.28 ± 66.16 | 164.46 ± 76.67 | 0.061 | -2.37, 100.74 |

Before = before training, After = after training, * $p < 0.05$

**Table 3.** Single leg stance time (SLST) change after training of the sprained ankle

| SLST : Eyes Closed | Before | After | % Improved | p-value | 95% CI |
|---|---|---|---|---|---|
| Training group | 14.65 ± 18.43 | 39.91 ± 22.51 | 172.42 | 0.000* | -33.22, -17.31 |
| Control group | 11.76 ± 6.25 | 18.10 ± 8.99 | 53.91 | 0.014* | -11.21, -1.49 |
| SLST : Eyes Open | | | | | |
| Training group | 74.82 ± 73.49 | 162.98 ± 108.50 | 117.83 | 0.000* | -117.34, -58.97 |
| Control group | 58.68 ± 38.99 | 72.39 ± 31.47 | 23.36 | 0.042* | -26.90, -0.54 |

Before = before training, After = after training, * $p < 0.05$

**Table 4.** Single leg stance time (SLST) change after training of the normal ankle

| SLST : Eyes Closed | Before | After | % Improved | p-Value | 95% CI |
|---|---|---|---|---|---|
| Training group | 30.14 ± 16.97 | 39.24 ± 20.30 | 30.19 | 0.015* | -16.12, -2.08 |
| Control group | 23.54 ± 10.94 | 27.44 ± 14.04 | 16.57 | 0.121 | -8.95, 1.15 |
| SLST : Eyes Open | | | | | |
| Training group | 153.27 ± 63.39 | 164.46 ± 76.67 | 7.30 | 0.313 | -34.15, 11.76 |
| Control group | 124.54 ± 65.37 | 115.28 ± 66.16 | -7.44 | 0.293 | -8.81, 27.34 |

Before = before training, After = after training, * $p < 0.05$

sprain during the 2nd and 3rd month follow-up during jogging. However, the recurrent rates of both groups were not statistically different.

## Discussion

Instability post ankle sprain is a very common problem that leads to chronic physical limitations in sports performance. Mechanical instability may be due to any structural deficits, such as ligamentous laxity or articular degeneration, which sometimes need surgical correction[7]. The functional instability is caused by insufficiencies in proprioception, neuromuscular control, postural control, and strength[7,15]. Proprioception training has been proved as an essential component of rehabilitation after ankle sprain[16]. Static and dynamic balance training techniques has been introduced[17]. Wobble board or ankle disk training were successfully used for rehabilitation after acute and chronic ankle sprains[18-20]. The Star Excursion Balance training is another way to train dynamic balance for the sprained ankle.

The athletes enrolled were very similar in physical status, life style, and environment, thus diminished important confounding factors in this study. Except that the training group had more number of recurrent sprains than the control group. However, the baseline SLST values of both groups were not significantly different.

The Star Excursion Balance training consists of complex closed kinetic chain motions of the stance leg. The participant has to flex his hip, knee, and dorsiflex his foot while balancing on the sprained ankle. Concentric & eccentric muscle contractions, proprioception, as well as postural control simultaneously involved. While using another foot to reach specific directions, the proprioception and co-ordination are also trained in the non-injured side. These motions caused training effects in both sprained and normal ankles, as the improvement of SLST after training not only demonstrated in the sprained ankle, but also detected in the non-injured side as well. This technique is easy to perform and cost - effective. Ten minutes/session x 3 times/week resulted in SLST gained to near non-injured side values within 4 weeks. The strength of the lower extremities should be evaluated in future study.

Although the recurrent sprains reported from both groups were not significantly different. The control group seemed to have more chance to get re-injury with minor impact. To study about the recurrent rate, more sample size must be recruited.

## Conclusion

The 4 weeks program of Star Excursion Balance training is more effective in improving functional stability of the sprained ankle than the conventional therapy program.

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## *การฝึกการทรงตัวด้วยเทคนิคสตาร์เอ็คซเคอชั่น: ผลต่อความมั่นคงของข้อเท้าหลังการเกิดข้อเท้าแพลง*

***ดุจใจ ชัยวานิชศิริ, อี๊ด ลอประยูร, เลอสันต์ หนูมาโนช***

***วัตถุประสงค์:*** *ศึกษาผลของการฝึกการทรงตัวด้วยเทคนิคสตาร์เอ็คซเคอชั่น ต่อความมั่นคงของข้อเท้าในนักกีฬาที่มีข้อเท้าแพลง*

***วัสดุและวิธีการ:*** *ศึกษานักกีฬาที่มีข้อเท้าแพลงระดับ 2 จำนวน 32 คน แบ่งสุ่มเป็นกลุ่มทดลอง 15 คน และกลุ่มควบคุม 17 คน ทุกคนได้รับการรักษาและโปรแกรมกายภาพบำบัด 4 สัปดาห์ โดยกลุ่มทดลองจะได้รับการฝึกการทรงตัวด้วยเทคนิคสตาร์เอ็คซเคอชั่น 3 วัน/สัปดาห์ x 4 สัปดาห์ร่วมด้วย ประเมินความมั่นคงของข้อเท้าด้วยการทดสอบยืนขาเดียว (Single leg stance test) ก่อนและหลังการฝึก ติดตามการเกิดข้อเท้าแพลงซ้ำ 3 เดือน เปรียบเทียบผลที่ได้จากนักกีฬาทั้งสองกลุ่ม*

***ผลการศึกษา:*** *นักกีฬาทั้งสองกลุ่มมีผลการทดสอบยืนขาเดียวของข้อเท้าข้างที่แพลงดีขึ้น โดยกลุ่มทดลองมีค่าการทดสอบสูงกว่ากลุ่มควบคุมถึง 2 เท่า (p=0.002 ขณะหลับตา, p=0.007 ขณะลืมตา) และยังมีค่าการทดสอบขณะหลับตาของข้อเท้าข้างปกติเพิ่มขึ้นด้วย (p=0.015) พบข้อเท้าแพลงซ้ำ 1 คนในกลุ่มทดลอง และ 2 คนในกลุ่มควบคุม*

***สรุป:*** *การฝึกการทรงตัวด้วยเทคนิคสตาร์เอ็คซเคอชั่น สามารถเพิ่มความมั่นคงของข้อเท้าในนักกีฬาที่มีข้อเท้าแพลงได้ดีกว่าการฝึกด้วยโปรแกรมกายภาพบำบัดตามปกติ*