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# Effects of two stretching methods on shoulder range of motion and muscle stiffness in baseball players with posterior shoulder tightness: a randomized controlled trial

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**Background:** The cross-body stretch and sleeper stretch are widely used for improving flexibility of the posterior shoulder. These stretching methods were modified by Wilk. However, few quantitative data are available on the new, modified stretching methods. A recent study reported the immediate effects of stretching and soft tissue mobilization on the shoulder range of motion (ROM) and muscle stiffness in subjects with posterior shoulder tightness. However, the long-term effect of stretching for muscle stiffness is unknown. The objective of this study was to examine the effects of 2 stretching methods, the modified cross-body stretch (MCS) and the modified sleeper stretch (MSS), on shoulder ROM and muscle stiffness in baseball players with posterior shoulder tightness.

**Methods:** Twenty-four college baseball players with ROM limitations in shoulder internal rotation were randomly assigned to the MCS or MSS group. We measured shoulder internal rotation and horizontal adduction ROM and assessed posterior shoulder muscle stiffness with ultrasonic shear wave elastography before and after a 4-week intervention. Subjects were asked to perform 3 repetitions of the stretching exercises every day, for 30 seconds, with their dominant shoulder.

**Results:** In both groups, shoulder internal rotation and horizontal adduction ROM were significantly increased after the 4-week intervention. Muscle stiffness of the teres minor decreased in the MCS group, and that of the infraspinatus decreased in the MSS group.

**Conclusions:** The MCS and MSS are effective for increasing shoulder internal rotation and horizontal adduction ROM and decreasing muscle stiffness of the infraspinatus or teres minor.

This study has been approved by the Ethics Committee of the Kyoto University Graduate School and Faculty of Medicine: No. E2331.

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**Level of evidence:** Level II; Randomized Controlled Trial; Treatment Study

**Keywords:** Shear wave elastography; modified sleeper stretching; modified cross-over stretching; posterior shoulder tightness; baseball; infraspinatus; teres minor

In the throwing motion in baseball, significant force is generated in the posterior shoulder, especially in the release to follow-through phases.[10] Because of this force generation, baseball players often exhibit glenohumeral internal rotation deficit (GIRD) and glenohumeral horizontal adduction deficit (GHAD) in their throwing arm.[3,4,25,34,35] Limitation in range of motion (ROM) may be caused by reduced soft tissue flexibility in the posterior shoulder region, referred to as posterior shoulder tightness.[4,25] Baseball players with shoulder disease have previously been reported to exhibit GIRD or GHAD,[6,24,32,33] and those with GIRD or GHAD have been reported to be at high risk for development of shoulder disease[34,37]; posterior shoulder tightness is therefore considered to be related to throwing injuries.

In regard to the relationship between posterior shoulder tightness and soft tissues in the posterior shoulder region, several studies have focused on the posterior glenohumeral joint capsule.[11-13,22,23,35] On the other hand, several other studies have correlated certain muscles and posterior shoulder tightness, with some of them suggesting that baseball pitching and exercises involving shoulder external rotators are associated with immediate development of GIRD or GHAD along with exhaustion or mobility deficits of shoulder external rotators.[8,28,31,40] In addition, some reports have shown increase in shoulder internal rotation (IR) or horizontal adduction (HA) ROM with physical therapy aimed at improving extensibility of the posterior shoulder muscles[2,4,21,30,41] or with dissection of the infraspinatus and teres minor muscles in cadaveric shoulders.[5] A recent study by Bailey et al showed that the decrease of the infraspinatus stiffness leads to acute gain in shoulder ROM.[2] Therefore, not only the posterior glenohumeral joint capsule but also the posterior shoulder muscles may be related to posterior shoulder tightness. However, few studies have examined the differences in muscle stiffness between the throwing and nonthrowing sides.[2]

Among the various stretching methods developed with the aim of reducing posterior shoulder tightness, the cross-body stretch, in which the shoulder is horizontally adducted, and the sleeper stretch, in which the shoulder is internally rotated, are used widely.[17-20,27] Recently, a few authors proposed that scapular stabilization during the cross-body stretch enhanced the stretching effects on the posterior glenohumeral joint.[27,37] Indeed, Salamh et al demonstrated that manual scapular stabilization increases the effects of stretching when the shoulder is horizontally adducted by a therapist.[33] On the other hand, these stretching methods can be painful in some cases.[20] For these reasons, Wilk et al developed the modified cross-body stretch (MCS) and the modified sleeper stretch (MSS).[37] However, little is known about the effects of these stretching methods for reducing GIRD and GHAD. In addition, the effects of these stretching exercises on muscle stiffness, which can be measured as shear elastic modulus using ultrasonic shear wave elastography (SWE) imaging,[26] are not clear.

Therefore, this study aimed to compare baseline glenohumeral ROM and muscle stiffness between the throwing and nonthrowing sides and to examine the effects of an intervention using the MCS and MSS in baseball players with posterior shoulder tightness of the throwing side. This information will help clinicians select the appropriate stretching method for preventing and improving posterior shoulder tightness in baseball players.

## Materials and methods

This is a randomized controlled study examining the effects of the MCS and MSS performed for 4 weeks in college baseball players with posterior shoulder tightness.

### Subjects

Twenty-four college baseball players volunteered for this study. They were randomly assigned to the MCS (N = 12) or MSS (N = 12) group. The inclusion criterion for selection of players was that they were participating in daily practice and had posterior shoulder tightness, which was evaluated as the presence of GIRD >10° on the throwing side compared with the nonthrowing side.[20,29] The exclusion criteria were inability to perform stretching exercises because of injury or pain, a history of surgery of the upper arm, and being rehabilitated for the disabled throwing shoulder. By use of previously published changes in muscle shear elastic modulus after stretching intervention,[26] a power of 0.80, an alpha level of .05, and $F$ of 0.4 were assumed for the 2-way factorial analysis of variance, which determined the sample size of 13 per group. Those who were injured during the intervention and were unable to perform stretching exercises were excluded from the analysis. Written informed consent was obtained from each participant.

### Procedures

The testing was conducted in a laboratory at the Kyoto University. Twenty-four participants were randomized by computer-generated permuted block randomization. The permutation lists were CCSS, CSCS, CSSC, SSCC, SCSC, and SCCS (C: MCS; S: MSS). A series randomization procedure was conducted after the recruitment. All measurements were performed by 1 tester with 1 or 2 assistants, who were not blinded to the group assignment. Bilateral preintervention and postintervention (4 weeks) glenohumeral ROM and muscle stiffness were assessed in each subject. To reduce deterioration of reproducibility, the preintervention and