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BASIC SCIENCE

Decreased blood flow in the throwing arm of professional baseball pitchers

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Background: As a consequence of the repetitive forces placed on the throwing arm of a baseball player, various bony, capsuloligamentous, and muscular adaptations occur and have been identified. However, no research has identified whether adaptations also exist in the vasculature of the upper extremity in the competitive baseball player.

Methods: Fifty-one professional baseball pitchers and 34 position players participated. Diagnostic ultrasound was used to measure bilateral blood flow of the brachial artery. These measurements were taken with the participant standing with the test arm resting at the participant's side and again with the test arm in a provocative shoulder position.

Results: The throwing arm of the pitchers had significantly less blood flow volume when in the provocative shoulder position compared with their nonthrowing arm ($P = .01$). Pitchers did not have any bilateral difference while in the resting position ($P = .19$). There were no bilateral differences among the position players while in the resting ($P = .64$) or provocative positions ($P = .63$). Pitchers had significantly less blood flow of the throwing shoulder while in the provocative position compared with position players ($P = .02$). There were no other between-group differences.

Conclusions: While in a provocative shoulder position, pitchers have significantly less blood flow in their throwing arm compared with their nonthrowing arm and with the throwing arm of position players. These results provide a descriptive profile of blood flow volume among baseball players, which may be used in the evaluation and treatment of such athletes with vascular disorders.

Level of evidence: Basic Science Study, Physiology.

Keywords: Vasculature; upper extremity; throwing athlete

"Dead arm syndrome" was used by Rowe and Zarins[23] to describe the sharp arm pain that is often experienced due to repetitive shoulder abduction and external rotation as performed by various overhead athletes, such as baseball players. Although numerous pathologies have been associated with this syndrome,[3,5,22,23] recent evidence suggests that

The study protocol was approved by the Illinois State University Institutional Review Board (No. 2012-0006) before all data collection.

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vascular and neurologic pathologies create similar symptoms and are of a growing concern among baseball players.[1,2,8,14,17,18] From a performance perspective, these athletes often initially complain of arm fatigue as well as decreased ball velocity and decreased ball control while throwing.[1,18,24] Common clinical symptoms may include finger numbness, hypersensitivity to cold, and resting pain.[8,24]

Research conducted at a specialized center for thoracic outlet syndrome (TOS) reported that 19% of the patients treated were baseball players or coaches with arterial TOS in the throwing arm.[8] Specific diagnoses included axillary artery occlusion, focal intimal hyperplasia, aneurysm formation, segmental dissection, branch vessel aneurysms, and thrombosis of circumflex humeral artery aneurysms. Furthermore, these pathologies resulted in an average of 11 weeks of restricted overhead throwing. These findings clearly show that vascular compression pathologies among baseball players can be very debilitating, especially among pitchers. Furthermore, these vascular pathologies may contribute to the 67% of upper extremity injuries reported by major league baseball pitchers and the 32% reported by position players.[20]

Numerous studies have investigated the various adaptations present among baseball players, such as alterations in shoulder range of motion,[7,12] hip range of motion,[11] shoulder strength,[7,16] and scapular kinematics.[13] The repetitive and forceful motions experienced throughout the extremities of these athletes are believed to cause such adaptations. Unfortunately, scant research is available that identifies possible blood flow adaptations among these athletes. Therefore, the purpose of this study was to determine if baseball players present with measurable asymmetric alterations in the blood flow of the throwing arm. More specifically, we compared bilateral brachial artery blood flow volume among baseball pitchers and position players. Firstly, we hypothesized that the throwing arm of pitchers would have diminished blood flow compared with their nonthrowing arm. Secondly, we hypothesized that the blood flow adaptations in the dominant arm of the pitcher would be greater than the adaptations in the position player compared with the dominant side.

Materials and methods

Subjects

Fifty-one professional baseball pitchers and 34 position players volunteered to participate in this study (Table I). No participants had a recent history (past 6 months) of upper extremity injury or upper extremity surgery.

Procedures

This was a cross-sectional study that examined the within-group and between-group differences among baseball pitchers and position players. Each participant attended one testing session conducted at the beginning of the spring training season in the athletic training facility of a professional baseball organization. The same investigators performed all testing, and no testing was performed after an extensive throwing session or strength training program. All participants provided informed consent before testing, as mandated by the university's Institutional Review Board.

Table I Descriptive participant demographics

Group	No.	Age (y) (Mean ± SD)	Height (cm) (Mean ± SD)	Mass (kg) (Mean ± SD)
Pitchers	51	21.0 ± 1.8	172.5 ± 8.3	72.6 ± 12.0
Position players	34	20.4 ± 1.8	169.1 ± 8.1	67.8 ± 11.5

SD, standard deviation.

Bilateral blood flow of the brachial artery was recorded using a Terason t3000 M-series ultrasound system (Teratech, Burlington, MA, USA) during 2 test positions. For each position, the ultrasound head was placed over the brachial artery to determine blood flow. The investigators were blinded to the position played and the throwing arm of each participant. The first position was conducted with the participant standing with the test arm resting at the participant's side (approximately 0° of shoulder abduction). The second position was also conducted standing, but the test arm was moved into a provocative position. More specifically, the radial pulse of the test arm was palpated to establish a baseline. With continued palpation and monitoring of this pulse, the test arm was then abducted, horizontally abducted, and externally rotated until the investigator felt diminution of the pulse. We determined this technique to have good intratester reliability for blood flow volume (intraclass correlation coefficient = 0.92).

Statistical analysis

Separate 1-way analyses of variance tests were conducted to compare the blood flow volume within and between groups ($P < .05$) using IBM SPSS Statistics 20 software (IBM Corporation, Armonk, NY, USA). Effect sizes were calculated to provide an indication of clinical meaningfulness of the differences in blood flow volume. Within-group effect sizes were calculated as [(throwing arm mean blood flow − nonthrowing arm mean blood flow)/largest standard deviation] and between-group effect sizes as [(pitcher's mean blood flow – position player's mean blood flow)/largest standard deviation].

Results

Table II reports the descriptive statistics for bilateral blood flow volume between both groups. The throwing arm of pitchers had significantly less blood flow volume than their nonthrowing arm when in the provocative shoulder position (−5 mL/min; $P = .01$; effect size = 0.47). There was no bilateral difference among the pitchers while in the resting position (−1 mL/min; $P = .19$; effect size = .011). The position players did not report any bilateral differences in the resting (2 mL/min; $P = .64$; effect size = 0.11) or provocative shoulder positions (−1 mL/min; $P = .63$; effect size = 0.11).