

From the Southern Association for Vascular Surgery

Midterm and long-term follow-up in competitive athletes undergoing thoracic outlet decompression for neurogenic thoracic outlet syndrome

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ABSTRACT

Background: Neurogenic thoracic outlet syndrome (NTOS) results from compression of the brachial plexus by the clavicle, first rib, and scalene muscles and may develop secondary to repetitive motion of the upper extremity. Athletes routinely perform repetitive motions, and sports requiring significant arm and shoulder use may put the participant at increased risk for NTOS. Competitive athletes who develop NTOS may require first rib resection and scalenectomy (FRRS) for symptomatic relief. However, the effectiveness of FRRS has not previously been studied in this vulnerable population.

Methods: This is a cross-sectional study of competitive athletes with NTOS who received FRRS by the senior author between 2009 and 2014. Eligible patients were contacted by phone and invited to complete a nine-item survey assessing the long-term effects of FRRS on pain medication use, postoperative physical therapy duration, patient satisfaction, symptom relief, activities of daily living, athletic performance, time to return of athletic performance, and need for other operations. Multivariate analyses of the following risk factors were performed: age, pectoralis minor release, preoperative narcotic use, athletic shutdown, and involvement in a throwing sport.

Results: There were 232 competitive athletes who met the inclusion criteria, and 67 of these (age, 14-48 years; 35 male; 99% white) responded to the survey. The average time between surgery and survey completion was 3.9 years (range, 2.2-7.0 years). The most frequent sports conducted by this group were baseball and softball (n = 44 [66%]), volleyball (n = 7 [10%]), and cheerleading and gymnastics (n = 5 [7%]), ranging from high-school to professional levels. The survey results revealed that 96% were improved in pain medication use, 75% would undergo FRRS on the contralateral side if needed, 82% had resolution of symptoms, and 94% were able to perform activities of daily living without limitation; 70% returned to the same or better level of athletic activity after FRRS, and this occurred within 1 year in 50%. Multivariate regression analysis identified younger age as a predictor of the length of physical therapy and preoperative narcotics use as a predictor of symptom resolution.

Conclusions: At our center, >40% of patients requiring FRRS for NTOS are competitive athletes. The results of this study show that the majority of them are able to return to their precompetitive state after FRRS, and few experience limitations in their daily living activities. Half can return to competition at or exceeding their premorbid ability level within 6 months of surgery. The majority are pleased with their decision to undergo FRRS. Further investigation is needed to identify predictive factors for successful return to competitive athletics. (*J Vasc Surg* 2017;■:1-8.)

Thoracic outlet syndrome (TOS) is manifested in three types, arterial, venous, and neurogenic, which correspond to the respective anatomic element affected.¹ The vascular

(arterial and venous) types are much less common than the neurogenic type. Compression of the structures in the thoracic outlet by the clavicle, first rib, and scalene muscles leads to the secondary complications seen with this syndrome. In arterial TOS, patients may develop aneurysms or thrombosis with or without distal emboli. Venous TOS leads to arm swelling and deep venous thrombosis of the axillosubclavian vein. Patients with neurogenic TOS (NTOS) suffer from shoulder, neck, and arm pain and may develop upper extremity weakness.²

Each of the TOS types develops secondary to repetitive motion of the upper extremity. Athletes perform repetitive motion as a routine in their activities, and certain sports requiring significant arm and shoulder use may put the participant at increased risk for TOS.³ Throwing athletes, in particular baseball pitchers, have been famously treated for arterial TOS.⁴ Weightlifters and athletes who use resistance to train their upper

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Author conflict of interest: none.

Presented in the plenary session at the Forty-first Annual Meeting of the Southern Association for Vascular Surgery, Naples, Fla, January 18-21, 2017.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

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extremities are well known to develop venous TOS; they respond well to thrombolysis and rib resection with or without venoplasty.⁵ Similarly, athletes using repetitive arm and shoulder motion for their training and sport may develop NTOS.⁶ Competitive athletes may require first rib resection and scalenectomy (FRRS) for symptomatic relief so that they can continue in their respective sports.⁶

Although NTOS is the most common form of TOS, the effectiveness of the FRRS procedure as a treatment for NTOS has not been extensively studied in this vulnerable population of competitive athletes, and many questions remain to be answered. For example, what types of athletes develop NTOS? How old are they? Does physical therapy benefit them? Are they able to return to their respective sports? How satisfied are they with the outcome? We proposed to review our experience with FRRS for treatment of NTOS in competitive athletes to better understand this population, the treatment outcomes, and the risk factors for poor outcomes or dissatisfaction.

METHODS

This is a cross-sectional study of competitive athletes who had undergone FRRS performed by the senior author (C.P.) in the past. The research protocol was approved by the Institutional Review Board of Baylor University Medical Center. Informed consent of the patients was not required for this retrospective collection of data. Potential study subjects were identified by reviewing our office records for all patients treated for TOS between July 2009 and May 2014. Demographic, historical, athletic, procedural, and follow-up data were entered into a study database. We then selected only the competitive athletes for review; recreational athletes and coaches were excluded. If patients participated in multiple sports, their primary, secondary, and tertiary sports were recorded in that order.

All FRRS procedures were performed through a supraclavicular approach with complete anterior and partial middle scalenectomy, brachial plexus neurolysis, and first rib resection with attention to identification and excision of fibrocartilaginous bands and scalenus minimus attachments if present. Patients were hospitalized for an average of 48 hours and quickly transitioned from intravenous pain medication to an oral medication regimen on which they were discharged. They were encouraged to use the ipsilateral extremity with avoidance of lifting, pushing, pulling, or repetitive activities and started on a course of supervised physical therapy at 1 week postoperatively, which would initially include active and passive range of motion and progress into a stretching and strengthening program. The postoperative therapy program was performed at a facility geographically convenient to the athlete or directed by the experienced training staff affiliated with the

ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center retrospective review combined with a patient satisfaction survey
- **Take Home Message:** A nine-question survey of 67 (29%) of 232 competitive athletes who underwent first rib resection and scalenectomy for neurogenic thoracic outlet syndrome revealed that at a mean of 3.9 years (range, 2.2-7.0 years) later, 82% self-reported resolution of symptoms and 70% returned to the same or better athletic activity.
- **Recommendation:** This survey suggests that up to three-quarters of competitive athletes with neurogenic thoracic outlet syndrome can expect to return to at least their previous level of performance after surgical decompression.

athlete's athletic department or professional organization on a case by case basis. For throwing athletes, a throwing program was initiated at 8 weeks, initially with short toss and progressing to a long toss program during 4 to 6 weeks, at which time pitchers may begin throwing from the pitching mound. Nonthrowing athletes would begin activities associated with the movements involved in their sport and progress into their full sport-related activities as tolerated under the supervision of trainers and coaches. Return to full unrestricted activity would be expected 3 to 12 months after the surgical procedure.

A nine-item survey (Table 1) was constructed to assess the long-term effects of FRRS on pain medication use, postoperative physical therapy duration, patient satisfaction (willingness to undergo the operation again), symptom relief, effect on activities of daily living, athletic performance, time to return of athletic performance, and need for other operations (of the neck, shoulder, or arm). Items 1, 3, 4, 5, 6, and 9 were scored on a 5-point Likert scale. As part of an ongoing quality improvement process in our practice, all patients undergoing FRRS for TOS have been contacted by phone to complete the survey. Patients who could not be contacted by phone were sent a link to the online version of the survey by e-mail. All survey results were subsequently collected and entered into the study database.

Multivariate logistic regression was used to identify predictors for the most favorable response ("strongly agree") to survey items 1, 3, 4, 5, 6, 8, and 9. Independent risk factors considered included age, pectoralis minor release, preoperative narcotic use, athletic shutdown, and involvement in a throwing sport to identify risk factors for continued pain medication use, noncompliance with physical therapy, patient-centered outcome, and ability to return to athletic competition. For survey item 2, a multivariate linear model was considered, and the same predictors were assessed.

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