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Thoracic outlet syndrome affecting high-performance musicians playing bowed string instruments

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Abstract

Thoracic outlet syndrome, a condition due to neurovascular compression in the upper shoulder region, can be caused by chronic repetitive activity of the upper extremities. Studies have linked upper extremity musculoskeletal disorders to high-performance musicians who play bowed string instruments such as the violin or viola. We report herein a case series of five elite musicians, including three violinists and two violaists, who developed neurogenic thoracic outlet syndrome following years of intense practice. Successful surgical treatment including first rib resection, scalenectomy, and brachial plexus neurolysis was performed in all patients. All patients were able to resume their musical career following surgical treatment. Our report represents the first description of thoracic outlet syndrome in high-performance bowed string instrumentalists. Clinicians should be aware of thoracic outlet syndrome as a differential diagnosis when treating string instrumentalists with upper extremity musculoskeletal ailments.

Keywords

Thoracic outlet syndrome, nerve entrapment syndrome, musician, string instrument, violin, viola

Thoracic outlet syndrome, a condition with neurovascular compressive symptoms involving the subclavian vessels and brachial plexus, can occur in individuals who are engaged in repetitive physical motion involving the upper extremities. This condition has been widely reported in elite professional athletes who performed repetitive physical activities in an overhead motion, such as baseball pitcher, tennis player, or swimmer.[1,2] High-performance musicians who play bowed string instruments, such as the professional violinist or violaist, similarly engage in repetitive upper extremity physical activities for years to attain their musical achievement. While many musculoskeletal overuse problems have been reported in these elite string musicians, there has been no published report of thoracic outlet syndrome in these high-performance string instrumentalists. In this report, we described five professional bowed string musicians including three violinists and two violaists who developed neurogenic thoracic outlet syndrome and underwent successful surgical treatment. We postulated that the pathogenesis of their TOS condition is related to their chronic repetitive arm maneuver of playing a bowed string instrument.

Patients and methods

With Institutional Review Board approval, a clinical database was maintained on all patients treated with first rib resection and scalenectomy for TOS from 2001 to 2015. All patients included in the database were under the care of the senior author. Data were retrospectively reviewed from a prospectively maintained database. The database includes demographic information, patient's etiological factors and occupation, upper extremity duplex scan results, surgical treatment, and clinical outcome. All patients undergoing surgical treatment were refractory to conservative treatment which consists of a three-month course of

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physical therapy. For the purpose of this study, only patients who were high-performance bowed string musicians were included for analysis.

Results

A total of five bowed string instrumentalists were identified from the database during the study period. Among them, there were three violin players and two viola players. All were professional musicians who were either symphony orchestra or touring chamber orchestra musicians. Four patients developed left neurogenic TOS while one patient developed right-sided TOS. The average duration from the time when they began to learn the stringed instrument to the onset of their TOS symptoms was 26 ± 4.2 years. The average time from the onset of their symptoms to surgical treatment was 2.1 ± 1.4 years. There were no predisposing injury or trauma to their upper extremities. During the five-year period prior to the onset of their TOS symptom, these patients practiced an average of 6 h a day on their string instruments.

Table 1 summarizes demographic and predisposing factors. All patients experienced symptoms consistent with neurogenic TOS. Pertinent ultrasound results and treatment outcomes were summarized in Table 2. Preoperative arterial duplex ultrasound demonstrated diminished subclavian artery flow with arm elevation in all five patients. Venous compression was identified in three patients. Surgical treatment with first rib resection, scalenectomy, and brachial plexus neurolysis was performed on all patients via a supraclavicular incision. The mean operative time was 95 min, and the mean hospital length of stay was 4.25 days. All patients underwent postoperative physical therapy and were able to return to their musical career following treatment. The mean postoperative duration before they resumed their musical career was five months.

Discussion

Thoracic outlet syndrome, a condition which is characterized by compression of neurovascular structures in the thoracic outlet region, can occur in individuals who endure chronic physical stress or repetitive musculoskeletal activity of the upper extremities. Studies have linked this condition to high-performance athletes, such as swimmers, baseball pitchers, or volleyball players,

Table 1. Demographics and relevant predisposing factors.

Patient No.	Age (year)	Sex	String Instrument	TOS type	TOS side	Duration of TOS symptoms (year)	Age when patient started playing Instrument (year)	Estimated weekly playing time (hour)
1	34	Female	Violin	Neurogenic	Right	2.6	5	40
2	36	Female	Violin	Neurogenic	Right	2.8	7	60
3	42	Female	Viola	Neurogenic	Right	3.2	6	50
4	37	Female	Viola	Neurogenic	Left	1.6	6	50
5	29	Female	Violin	Neurogenic	Right	3.8	8	50

Table 2. Clinical parameters and treatment outcomes.

Patient No.	Adson Test	Arterial compression on DU	Venous compression on DU	Operative time (min)	Hospital length of stay (day)	Duration from surgery to return to work (month)	Intra-operative finding
1	Positive	Present	Present	90	4	4	Hypertrophic anterior scalene muscle
2	Positive	Present	Present	90	4	5	Hypertrophic anterior scalene muscle
3	Positive	Present	Absent	90	4	6	Hypertrophic anterior scalene muscle
4	Positive	Present	Present	110	5	5	Hypertrophic subclavius and anterior scalene muscles
5	Positive	Present	Present	100	5	4	Hypertrophic subclavius and anterior scalene muscles

DU: Duplex ultrasound.

who performed rigorous upper body physical activities in their sports.[1,2] Similar to athletes, high-performance musicians who play bowed string instruments routinely engage in strenuous upper extremity physical activity when playing instruments such as the violin or viola, which can predispose them to repetitive musculoskeletal strain to the thoracic outlet region. In our report, all five patients with thoracic outlet syndrome were professional string musicians who played either the violin or viola. Our finding is notable because it represents the first description of high-performance bowed string musicians who developed TOS due in part to their chronic upper extremity repetitive activities associated with bowed string instruments.

Although the prevalence of TOS among professional musicians, particularly among violin or viola players, has been a subject of debate,[3,4] it is indisputable that elite musicians endure similar postural and physically demanding repetitive stress similar to athletes who are at risk of developing TOS. It has been estimated that 80% of professional musicians have experienced some form of occupational health problems during their careers.[5] In a recent survey of 76 adolescent string musicians from the West Australian Youth Orchestras, 73.5% of these string instrumentalists report upper extremity musculoskeletal symptoms including joint ailments.[6] Studies report that professional string musicians typically practice between 3 and 8 h daily.[3] Orchestral rehearsal typically last about 3 h, while musical performances can last for more than 2 h. In our patients, the average duration from the onset of their musical career to TOS symptoms was 18 years. We estimate that our patients have practiced an average of at least 20,000 h of violin when they developed TOS symptoms. It is conceivable that these long and arduous playing times led to musculoskeletal strain resulting in their neurogenic TOS.

Previous reports have linked upper extremity ailments to musicians using terms such as overuse syndrome, repetitive strain injury (RSI), or work-related upper limb disorder (WRULD) to describe their musculoskeletal injuries.[7] To play a violin or viola, a musician must maintain the left hand in an elevated position to support the instrument which is pressed against the left clavicle. The musician's head is tilted to the left so that it presses against the chin rest of the instrument for stabilization. The right hand is raised to hold the bow whereby the elbow moves in a repetitive flexion and extension motion to create music on the strings. These repetitive physical activities create a strenuous musculoskeletal strain to the bilateral upper extremities and cervical spine, particularly in high-performance musicians who practice many hours daily. Because viola is a heavier instrument compared to a violin, the added weight potentially can result in greater physical strain to the left arm and left clavicle region in these musicians. These kinesiological factors may in part explain the left-sided TOS in our bowed string instrumentalists. Interestingly, a recent report by Worz-Bilfinger postulated that female professional musicians have a higher likelihood of musculoskeletal ailments due to their gender-specific anatomy and physiology.[8] Although all of our patients were females, we were unable to collaborate this gender-specific health problem.

Bowed string musicians such as the violinist or violaist have been linked to a myriad of upper extremity-related musculoskeletal ailments. Clemente et al. used infrared thermal image which documented temporomandibular joint disorder in a professional violinist, and the authors attributed it to abnormal postures due to muscular hyperactivity of the head and cervical muscle.[9] Other studies have found evidence of ulnar nerve entrapment at the elbow among violin players, as evidenced by abnormal nerve conduction and electromyography studies.[10–12] Studies have noted greater peripheral nerve entrapment in the viola player than the violin player due to the heavier instrument which likely resulted in greater musculoskeletal strain in the left shoulder region.[11,12] Researchers have reported an abnormal contour of the cervical and thoracic spines among violin players, and coined the term "the droopy shoulder syndrome" to characterize the clavicle compression in these musicians due to chronic pressure exertion by the stringed instrument against the left clavicle.[13] Another study found that string musicians frequently develop functional dystonia of the upper extremities and cervical spine, due in part to abnormal posture and prolonged musculoskeletal strains.[14] Several reports have similarly described a high incidence of musculoskeletal problems with the neck, spine, and left arm among string instrumentalists.[3,4,12,14] Taken altogether, we postulated that many of these clinical descriptions of musculoskeletal or nerve compression symptoms in these string musicians may have shared common etiological factors leading to the development of TOS.

Although researchers have advocated the importance of physical therapy and scapulothoracic rehabilitation in patients with neurogenic TOS,[15] such treatments were initiated but failed to provide improvement in all of our patients. They were all subsequently treated surgically with first rib resection, scalenectomy, and brachial plexus neurolysis via a supraclavicular approach. In our patients, four developed left-sided TOS while one patient developed TOS involving the right arm. We observed a markedly hypertrophic anterior scalene muscle or subclavius muscle intraoperatively with significant brachial plexus compression in all five patients. This finding suggests that playing a

bowed string instrument such as a violin or viola can result in neurogenic TOS with scalene muscle hypertrophy in either upper extremity. Additionally, all of our patients exhibited subclavian artery and venous flow disturbance with extrinsic compression despite a lack of clinical symptoms related to either arterial or venous TOS. This finding resonates with a recent study by Orlando and colleagues who showed that abnormal arterial or venous duplex ultrasound is a common and helpful diagnostic finding in patients with neurogenic TOS.[16]

Undoubtedly there are several shortcomings to our study. First, the small patient size of these elite musicians limits our ability to perform comprehensive analysis regarding the etiological factors of their TOS condition. Additionally, the retrospective nature of this study may have resulted in both patient selection and treatment selection bias. Lastly, the lack of a control group precludes an objective analysis of our finding. Notwithstanding these study limitations, we believe this report highlighted a possible association between high-performance bowed string instrumentalists and TOS.

In conclusion, elite musicians who play stringed instruments such as violin or viola may be at risk of developing TOS due in part to the rigorous postural demand of playing these musical instruments. Clinicians should be aware of the possible TOS when treating a string musician who suffers from upper extremity musculoskeletal ailments.

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