

CASE SERIES

IMPAIRMENT BASED EXAMINATION AND TREATMENT OF COSTOCHONDRITIS: A CASE SERIES

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ABSTRACT

Background: Costochondritis is commonly encountered in primary care, but is not routinely referred to PT. Costochondritis can last from several weeks to several months, limiting the patient's ability to perform tasks at work and home.

Purpose: Identify common impairments and examine the effects of treatment in subjects with costochondritis.

Study Design: Retrospective case series

Case Description: Eight subjects were referred to physical therapy for costochondritis (mean duration of condition 6.3 ± 1.3 months) and reported that their condition restricted their ability to participate in occupational and fitness activities. The numerical pain rating scale (NPRS) and patient-specific functional scale (PSFS) were administered at the initial evaluation and at discharge. The Global Rating of Change (GROC) scale was only administered at discharge. All subjects received treatment directed at the cervicothoracic spine and ribcage and consisting of manual therapy and exercise.

Outcomes: Subjects were seen 4.8 ± 0.9 (mean \pm standard deviation) times. All subjects showed clinically meaningful changes at discharge. The mean NPRS decreased by 5.1 ± 1.7 points; the mean PSFS increased by 5.3 ± 1.4 points; and the mean GROC was 5.9 ± 1.1 points. All subjects were able to return to participation in previous activities without restrictions at discharge.

Discussion - Conclusion: The results of this case series suggests that PT utilizing an impairment based examination and treatment approach including manual therapy and therapeutic exercise may facilitate the resolution of costochondritis.

Level of Evidence: Level IV

Key words: Breathing, chest, manual therapy, ribs, thoracic

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INTRODUCTION

Subjects with costochondritis are commonly encountered in primary care, but are not routinely referred to physical therapy (PT).¹⁻⁵ Whereas there is some speculation, the actual etiology of this condition remains unknown.³ Pain is most commonly localized unilaterally to the second through fifth costochondral junctions, with more than one junction generally affected.³ Typically, local swelling is not noted in costochondritis, unlike Tietze syndrome.³ Whereas this condition is considered self-limiting and normally resolves within one year,^{1,6} it can last from several weeks to several months⁷ or be recurring,⁸ limiting the patient's ability to function in occupational demands and activities of daily living. Pain is often associated with repetitive activities involving the upper extremities or deep breathing, including exertional activities, such as lifting heavy objects or cardiovascular exercise.^{3,9,10} When subjects are referred to PT, their condition has often progressed to a chronic stage with additional impairments, such as reduced endurance and difficulty performing moderate to heavy manual labor duties, have arisen secondary to compensation for costochondritis. Compounding this difficulty is the current lack of evidence/consensus as to the most effective way to manage this condition.

Current recommendations for medical treatment are analgesics and nonsteroidal anti-inflammatory drugs, heat/ice, and possibly anesthetic/steroid injections.^{3,4,8,11,12} The infrequent referral of subjects with costochondritis to rehabilitation has made it difficult for research to be performed regarding the effects of manual therapy or exercise. At this time only a single research trial exists that supports stretching as an intervention using the visual analog scale for an outcome.¹³ All other publications regarding manual therapy and/or exercise specifically for costochondritis have been case reports or case series of no more than two subjects.¹⁴⁻¹⁸

Whereas the results of the stretching study are promising, it was a limited retrospective study with a large number of confounding variables that may have affected the results.¹³ The remaining case reports used an impairment-based approach, which included manual therapy and exercise directed at the upper thoracic vertebrae, rib cage, and surrounding

soft tissues, with significant improvement noted in two or more of the following patient outcomes, the Numeric Pain Rating Scale (NPRS),^{14,15,18} Visual Analog Scale,^{16,17} Dallas Pain Questionnaire,¹⁴ Functional Rating Scale,¹⁴ Patient-Specific Functional Scale (PSFS),¹⁸ and return to previous performance/activity level.¹⁴⁻¹⁸

Given the limited research and lack of a clear consensus regarding optimal treatment strategies, a retrospective review of a series of subjects utilizing an impairment-based approach may provide further insight. It may also provide a better indication of where more formal investigation and research should be directed. The purpose of this case series is to identify common impairments and examine the effect of treatment in subjects with costochondritis.

CASE DESCRIPTIONS

The University of Jamestown Institutional Review Board approved this study and informed consent was obtained from the subjects prior to the collection of data. Eight subjects with costochondritis were retrospectively reviewed for similarities in their evaluative findings and interventions. The subjects were referred to physical therapy by their primary care physicians over a four-month period after having been screened for non-musculoskeletal causes of their symptoms. All subjects had undergone a full medical evaluation for cardiopulmonary issues, including electrocardiography secondary to their reports of "chest pain". All subjects were referred to PT secondary to demonstrated inability to perform full military duties and participate in mandatory fitness training, particularly push-ups and running, without exacerbation of symptoms. Subject demographics are shown in Table 1. The majority of cases were due to either physical activity or respiratory infection. In two subjects, there was an insidious onset and additional questioning during the patient interview and examination did not suggest any possible causes. Patient's primary pain was isolated to the costosternal junctional area on at least two unilateral consecutive costosternal joints of the second through seventh ribs. The common primary aggravating factors reported by the subjects were any activity that caused heavy breathing and/or end-range horizontal abduction and adduction of the shoulder.

Table 1. Patient Demographics

| Patient | Age (years) | Sex | Military Occupation | Duration (months) | Dominant Hand | Cause |
|-------------|-------------|------------|----------------------|-------------------|---------------|-----------------------|
| 1 | 23 | Male | Security forces | 7 | Right | Fitness Activity |
| 2 | 38 | Male | Aircraft Maintenance | 5 | Right | Respiratory infection |
| 3 | 23 | Female | Security forces | 8 | Right | Insidious Onset |
| 4 | 37 | Female | Munitions technician | 7 | Left | Fitness Activity |
| 5 | 28 | Male | Security forces | 6 | Right | Respiratory infection |
| 6 | 32 | Male | Aircraft Maintenance | 7 | Left | Insidious Onset |
| 7 | 28 | Female | Security forces | 4 | Right | Fitness Activity |
| 8 | 31 | Male | Security forces | 6 | Right | Respiratory infection |
| Mean | 30.0 | 62.5% Male | | 6.3 | | |
| SD | 5.7 | | | 1.3 | | |

SD, standard deviation.

INITIAL EVALUATION

All subjects were screened and evaluated using a standardized PT examination for cervicothoracic conditions.¹⁹ All examination, evaluation and treatment was conducted by a single physical therapist with six years of clinical experience, board certified as an orthopedic clinical specialist, and fellowship trained in orthopedic manual physical therapy.

Outcomes Instruments

None of the subjects reported any radicular or referred symptoms. The subjects reported an average of the best, worst and current rating in the prior 24 hours on NPRS of 5.6 (range, 4–8) with specific activities noted to increase pain by an average of 2.0 points. The NPRS has been demonstrated to be valid in chronic musculoskeletal pain conditions with a change of 1.0 point, or 15%, identified as the minimal clinically important difference (MCID)²⁰ and excellent ($r=0.79-0.92$) test-retest reliability when administered at least two times during the week.^{21,22} The NPRS was completed by all subjects at each visit to monitor condition.

The PSFS was administered to all eight subjects with an average score of 4.5 (range, 3–6). The PSFS has been demonstrated to be valid in neck pain and cervical radiculopathic conditions, with a change of 2.0–2.2 points as the MCID^{22,23} and excellent ($r=0.82-0.92$) test-retest reliability.²³⁻²⁵ The PSFS was

completed per standard operating procedures at initial evaluation and discharge. Two common patient specific functions noted with all subjects were to be able to perform all duties without restriction and to be able to participate in fitness training without restriction.

The Global Rating of Change (GROC) was administered to all eight subjects at the last appointment prior to the cessation of the episode of care. The GROC has been demonstrated to be valid in cervical and upper extremity conditions. A score between ± 1 and ± 3 indicates a small change; a score between ± 4 and ± 5 indicates a moderate change; and a score between ± 6 and ± 7 indicates a large change.²⁶

If treatment duration had lasted longer than four weeks a formal re-evaluation and completion of the PSFS and GROC would have been completed at that time per clinic standard operating procedures.

Observations/Palpations

All subjects positioned themselves with varying degrees of a forward head, shoulder protraction, and increased upper (T3–5) and middle (T5–10) thoracic kyphosis.^{27,28} Additionally, all subjects performed splinting of upper torso by the upper extremities when seated for symptomatic relief if an elevated surface such as chair arms or a table was available. Palpation with anterior to posterior pressure up to

the point of initiation of rib movement at the costosternal joints reproduced the subjects' symptoms and demonstrated tenderness of at least two consecutive costosternal junctions from the second to the sixth ribs unilaterally, with pain present on the patient's dominant side in six of the eight cases.²⁹ All subjects reported reproduction of pain with deep inhalation and six of eight-reported pain with normal exhalation (Table 2).

Palpation with pressure to the point of fingernail blanching applied to the pectoralis major/minor, latissimus dorsi, upper trapezius, and scalene muscles did not reproduce subjects' symptoms. No active trigger points were identified corresponding to the subjects' pain patterns and symptoms; however, it is noteworthy that the pectoralis minor is deep to the pectoralis major, making it difficult to detect trigger points if they are present.³⁰

Range of Motion

Active range of motion was tested for cervical spine, thoracic spine, ribcage, and shoulders bilaterally as described by Flynn et al.¹⁹ Cervical active range of motion was reported to be associated with "stiffness" or "discomfort" at end-range cervical flexion and rotation to the noninvolved side in 50% of subjects. All subjects reported symptom reproduction with overpressure applied with rotation to the noninvolved side. Thoracic extension was observed to be limited both actively and passively in all subjects with symptom reproduction and "stiffness" or "discomfort" at end-range. Excursion of ipsilateral upper and middle ribs was diminished during the subjects' respiratory cycle. Ipsilateral horizontal shoulder

adduction past 10 degrees reproduced symptoms intermittently in all subjects.

Accessory Motions

Unilateral posterior anterior glides of the cervicothoracic junction (C7-T1)^{27,28} and upper thoracic (T1-7) spine²⁹ were hypomobile and reproduced symptoms in all subjects when tested ipsilateral to corresponding symptomatic costosternal joints. The first and/or second ribs were hypomobile in six subjects, with partial replication of subjects' symptoms. Hypomobility in the costovertebral joint of ribs 3-7 was present in only four subjects; however, symptom reproduction, including pain, occurred in all subjects when the symptomatic costosternal joint area was assessed²⁹ (Table 2).

Muscle Length

All subjects were assessed for length of pectoralis major/minor, latissimus dorsi, upper trapezius, and scalene muscles.^{27,28} All eight subjects were found to have increased tightness and/or guarding in the pectoralis major/minor and upper trapezius muscles, with greater tone on the involved side. Six subjects had increased tone/tightness in the scalene muscles of the involved side and 50% of the subjects demonstrated increased tightness in the latissimus dorsi on the involved side (Table 3).

Special Tests

The Upper Limb Tension Test A (ULTT),^{27,28,31} Spurling's Test,^{27,28,31,32} and the Cervical Distraction Test^{27,28,31,33} were performed to rule out any cervical referral and were negative for all subjects, with a negative ULTT decreasing the possibility of the

Table 2. Palpation of Costosternal Joints and Symptom Provocation with Movement

| Patient | Palpation Rib Tenderness | Thoracic Extension | Deep Inhalation | Full Exhalation | CPA C7-T7 | Costotransverse PA 1-7 |
|-------------|--------------------------|--------------------|-----------------|-----------------|-----------|------------------------|
| 1 | Rt R2-4 | Yes | Yes | Yes | C7-T4 | Rt 1-2 |
| 2 | Lt R3-6 | Yes | Yes | Yes | C7-T6 | Lt 2-7 |
| 3 | Rt R3-4 | Yes | Yes | Yes | C7-T4 | Rt 1-2 |
| 4 | Lt R4-5 | Yes | Yes | No | T3-5 | Lt 3-5 |
| 5 | Rt R2-4 | Yes | Yes | Yes | C7-T4 | Rt 1-2 |
| 6 | Rt R4-5 | Yes | Yes | No | T3-6 | Rt 4-5 |
| 7 | Rt R3-4 | Yes | Yes | Yes | C7-T4 | Rt 1-2 |
| 8 | Rt R3-6 | Yes | Yes | Yes | C7-T6 | Rt 2-7 |
| Mean | | 100.0% | 100.0% | 75.0% | | |
| SD | | 0.0% | 0.0% | 46.3% | | |

SD, standard deviation. Rt, right. Lt, left. R, rib. CPA, central posterior anterior glides. PA, posterior anterior glides.

Table 3. Muscle Length and CRLF Test

| Patient | Pectoralis Major Tightness | Pectoralis Minor Tightness | Latissimus Dorsi Tightness | Upper Trapezius Tightness | Levator Scapulae Tightness | Scalenes Tightness | CRLF |
|-------------|----------------------------|----------------------------|----------------------------|---------------------------|----------------------------|--------------------|-------|
| 1 | Yes | Yes | Yes | Yes | Yes | Yes | Right |
| 2 | Yes | Yes | Yes | Yes | Yes | Yes | Left |
| 3 | Yes | Yes | No | Yes | Yes | Yes | Right |
| 4 | Yes | Yes | No | Yes | Yes | No | No |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes | Right |
| 6 | Yes | Yes | No | Yes | Yes | No | No |
| 7 | Yes | Yes | No | Yes | Yes | Yes | Right |
| 8 | Yes | Yes | Yes | Yes | Yes | Yes | Right |
| Mean | 100.0% | 100.0% | 50.0% | 100.0% | 100.0% | 62.5% | 75.0% |
| SD | 0.0% | 0.0% | 53.5% | 0.0% | 0.0% | 51.8% | 46.3% |

SD, standard deviation. CRLF, cervical rotation lateral flexion

patient's condition being related to cervical radiculopathy to less than 10%.³¹ The Cervical Rotation Lateral Flexion (CRLF) Test was performed, and six subjects demonstrated restriction in motion and an early firm end feel, with symptom reproduction in four of the six subjects, indicating a possible dysfunction that was contributing to the patient's condition at the first/second rib.³⁴⁻³⁶ (Table 3)

As costochondritis is normally a diagnosis of exclusion, no special tests have been identified as valid for differential diagnosis. Palpation of the involved costochondral segments with symptom reproduction is the only recommended physical examination technique cited at this time.³

INTERVENTION

Intervention was an impairment-based model addressing the individual findings for each patient, prioritized according to the approach of treating thoracic spine prior to ribcage.³⁷ Each manual-therapy-based intervention was matched with an appropriate home exercise to improve carry-over (Table 4). All subjects were seen one to two times per week, determined by the subjects' availability and duties, and treated four to six times (average 4.8) over a three to four week period.

The cervicothoracic junction and upper thoracic vertebral region were treated first with a seated manipulation directed toward the identified region of dysfunction. Up to three attempts were made, rechecking of thoracic gross and accessory movement after each attempt, if successful PT progressed to next prioritized area of impairment. All subjects were instructed in performance of a home exercise

consisting of thoracic/rib cage self-mobilization for extension and flexion timed with breathing (Figure 1).

First and second rib restrictions were treated with seated mobilization/manipulation and affected subjects were instructed on self-mobilization with a belt for their home exercise. First/second rib dysfunction received grade 3 to 4 mobilizations for up to three sets of 30 seconds each, unless an appropriate end feel was noted, at which time the technique progressed to a high-velocity low-amplitude manipulation for the appropriate area with a maximum of two attempts. The CRLF was used as asterisk sign and rechecked between sets of mobilizations or attempts at manipulation. The self-mobilization exercise previously instructed for thoracic dysfunctions also provides a self-mobilization for first/second rib dysfunctions, so no specific exercise was matched with this manual intervention (Table 4).

Hypomobile third to seventh ribs were treated with Grade 3 to 4 posterior to anterior mobilization techniques directed toward the costotransverse and/or anterior to posterior mobilization techniques directed toward the costosternal joints for up to three sets of 30 seconds each. Rib mobility was assessed prior to mobilization and reassessed after each set. Subjects were then instructed on an upper thoracic/rib cage extension/flexion/rotation self-mobilization exercise timed with breathing for their home exercise (Figure 2).

Tight muscles, including the pectoralis major/minor, latissimus dorsi, upper trapezius, and scalenes, were treated according to their assessment findings. Contract/relax soft-tissue-release tech-



Figure 1. Thoracic flexion/extension self-mobilization timed with breathing. (A) Patient begins exercise in thoracic flexion sitting on low-back chair with hands interlocked behind cervicothoracic junction and elbows pointing toward ipsilateral knees with full exhale. (B) Patient then performs thoracic extension over back of chair in conjunction with horizon abduction of elbows and full inhalation timed with movement. Return to starting position.

Table 4. Impairment-Based Findings, Prevalence, and Interventions

| Impairment Finding | Prevalence | Intervened | Manual Therapy | Therapeutic Exercise |
|---|------------|------------|--|--|
| Hypomobile C7–T1 | 8/8 | 8/8 | Seated distraction cervicothoracic junction mobilization/manipulation | Thoracic flexion/extension self-mobilization timed with breathing (Figure 1) |
| Hypomobile T2–7 | 8/8 | 8/8 | Seated distraction upper/mid thoracic mobilization/manipulation | Thoracic flexion/extension self-mobilization timed with breathing (Figure 1) |
| Tight pectoralis major/minor | 8/8 | 8/8 | Contract-relax soft-tissue release for pectoralis major/minor | Corner stretch for pectoralis major/minor |
| Tight upper trapezius | 8/8 | 8/8 | Contract-relax soft-tissue release for upper trapezius | Self-mobilization/stretch with belt/towel for first/second rib, anterior/middle/posterior scalenes and upper trapezius |
| Hypomobile rib 1/2 | 6/8 | 4/8 | Seated first/second rib mobilization/manipulation | Self-mobilization/stretch with belt/towel for first/second rib, anterior/middle/posterior scalenes and upper trapezius |
| Tight anterior/middle/posterior scalene | 6/8 | 4/8 | Contract-relax soft-tissue release for anterior/ middle/posterior scalenes | Self-mobilization/stretch with belt/towel for first/second rib, anterior/middle/posterior scalenes and upper trapezius |
| Hypomobile rib 3–7 | 4/8 | 2/8 | Supine costovertebral joint manipulation | Thoracic flexion/extension with unilateral rotation self-mobilization timed with breathing (Figure 2) |
| Tight latissimus dorsi | 3/8 | 1/8 | Contract-relax soft-tissue release for latissimus dorsi | Kneeling prayer stretch with bench for latissimus dorsi |



Figure 2. Thoracic flexion/extension with unilateral rotation self-mobilization timed with breathing. (A) Patient begins exercise in thoracic flexion sitting on low-back chair with one hand placed behind cervicothoracic junction with elbow pointing toward contralateral knee; opposite hand is holding chair seat with full exhale. (B) Patient then performs thoracic extension over back of chair in conjunction with rotation and horizon abduction of elbow to point posteriorly, timed with full inhalation. Return to starting position.

niques were directed at the pectoralis major/minor, anterior/middle/posterior scalene, and/or latissimus dorsi muscles for up to three sets of 30 seconds each, with approximately 25% resistance applied by the patient. Subjects were then instructed in the corresponding self-stretch for their home exercise programs for the affected muscles (Table 4).

Subjects were reassessed at each visit for all previous positive findings to modify each patient's plan

of care based on response to the previous treatment interventions. Manual therapy for specific impairments was discontinued if impairment was no longer present, whereas the specific exercises for the impairment were continued three times per day at home and/or in clinic for a minimum of two weeks after manual therapy intervention for specific impairment was discontinued, to reinforce and maintain the improvements in the patient's condition (Table 5).

Table 5. Number of Times Intervention was Applied to Patient

| Patient | Cervicothoracic Junction | Upper Thoracic | Pectoralis Major/Minor | Upper Trapezius | Rib 1/2 | Ant/Mid/Post Scalene | Rib 3-7 | Latissimus Dorsi |
|---------|--------------------------|----------------|------------------------|-----------------|---------|----------------------|---------|------------------|
| 1 | 3 | 3 | 4 | 3 | 2 | 4 | 0 | 0 |
| 2 | 4 | 4 | 5 | 4 | 4 | 4 | 3 | 3 |
| 3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 |
| 4 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 |
| 5 | 3 | 3 | 4 | 3 | 2 | 3 | 0 | 0 |
| 6 | 3 | 3 | 3 | 3 | 0 | 0 | 3 | 0 |
| 7 | 2 | 2 | 3 | 2 | 2 | 2 | 0 | 0 |
| 8 | 4 | 4 | 5 | 4 | 0 | 0 | 0 | 3 |

Ant, anterior; Mid, middle; Post, posterior.

Table 6. *Visits and Outcomes*

| Patient | Visits (N) | NPRS (Pre) | NPRS (Post) | NPRS Change | PSFS (Pre) | PSFS (Post) | PSFS Change | GRC |
|---------|------------|------------|-------------|-------------|------------|-------------|-------------|------|
| 1 | 5 | 6 | 1 | 5 | 4 | 10 | 6 | +6 |
| 2 | 6 | 6 | 0 | 6 | 6 | 10 | 4 | +7 |
| 3 | 4 | 4 | 0 | 4 | 3 | 10 | 7 | +6 |
| 4 | 4 | 5 | 1 | 4 | 5 | 9 | 4 | +5 |
| 5 | 5 | 7 | 0 | 7 | 6 | 10 | 4 | +7 |
| 6 | 4 | 5 | 2 | 3 | 5 | 9 | 4 | +4 |
| 7 | 4 | 4 | 0 | 4 | 3 | 10 | 7 | +5 |
| 8 | 6 | 8 | 0 | 8 | 4 | 10 | 6 | +7 |
| Mean | 4.8 | 5.6 | 0.5 | 5.1 | 4.5 | 9.8 | 5.3 | +5.9 |
| SD | 0.9 | 1.4 | 0.8 | 1.7 | 1.2 | 0.5 | 1.4 | 1.1 |

N, number; NPRS, numerical pain rating scale; PSFS, patient-specific functional scale; GRC, global rating of change; SD, standard deviation.

OUTCOMES

All patient outcome measures indicated clinically meaningful improvements in an average of 4.8 total sessions including the initial evaluation (Table 6). All subjects were able to resume normal duties and military fitness training without symptoms, including running and push-ups, after a standardized 45-day reconditioning phase for fitness training (as directed by USAF instructions), initiated after discharge from physical therapy.

DISCUSSION

This case series provides preliminary evidence that an impairment-based approach addressing motion impairments at the cervicothoracic spine may be beneficial to subjects with costochondritis. All subjects reported the typical signs and symptoms of costochondritis, including tenderness at the costosternal junction of the second to fifth ribs unilaterally, with symptom exacerbation secondary to exertion, and/or horizontal abduction/adduction.

An impairment-based approach was effective with the subjects in this case series, but it remains to be seen if there is a more effective approach to treatment secondary to the limitations presented by a case series, including lack of comparison and control groups. It has been shown that the biomechanics of the thoracic vertebrae and rib cage are interdependent.^{38,39} This interdependence, combined with the patient presentations, provides face validity to the interventions directed to these regions. Seated thoracic manipulation was chosen due to the effectiveness, efficacy, and safety of these techniques.⁴⁰⁻⁴² Manual therapy techniques were selected based on

the authors' experience because they are specific to the identified impairment, easy to perform, safe, and well tolerated by most subjects.⁴³ Manual therapy techniques also allow the clinician to carry on a running dialogue with the patient during treatment, thus permitting a continuous assessment of symptoms and a corresponding modification of amplitude and/or cadence. A maximum of three attempts at manipulation were chosen based on previously published pragmatic studies.⁴⁰⁻⁴²

Four subjects required interventions directed only at the cervicothoracic junction and upper thoracic vertebrae for resolution of their impairments and condition, and there was no need to address the first to seventh ribs. Six of the subjects also had hypomobility and symptom reproduction noted in the first and second ribs, which was addressed with interventions in four subjects when not resolved by intervention at the cervicothoracic junction and upper thoracic vertebrae. This can be explained by the biomechanical interdependence of the ribs and vertebrae in the upper thorax.^{38,39}

Home programs were prescribed based on their ability to address one or more impairments, while being simple to perform and requiring minimal equipment. This ensured that no more than five exercises were prescribed for any of the home exercise programs, in order to improve patient compliance.^{44,45}

It is unclear as to why there was a delay in referral to physical therapy for these subjects of an average duration of 6.3 months. It could be hypothesized, that given the high number cases seen in primary care that clear naturally, that the referring physi-

cians believe that physical therapy intervention was unnecessary for this condition. Another possible hypothesis is that with these subjects presenting with “chest pain” a referral was thought to be inappropriate. However, the exact reason for the delayed in referral of the subjects is still unclear at this time.

Limitations

As is typical in case reports or case series, the study design does not allow for the determination of cause and effect due to lack of a control group. Some methods used in this study, such as accessory motion assessment and symptom provocation, may be significantly limited in their reliability and diagnostic utility, but may be of assistance in directing an impairment based treatment approach. A properly designed randomized controlled study would provide additional information that may help overcome the significant limitations of this case series. Future research also should attempt to identify the MCID of the NPRS and PSFS for this population as well as determine the most appropriate type and dose of manual therapy and home exercise program.

CONCLUSION

The results of this case series suggest that an impairment based approach to examination and treatment of individuals with costochondritis was effective for pain reduction, and patient specific improvements in function. The question remains: “Are the symptoms experienced with costochondritis due to direct injury at the costochondral region or are they the result of compensation for changes in other areas of the axial skeleton? Further research and investigation will be required to answer this question.

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