Spinal manipulation after multiple fusions in an adult with scoliosis: a case report

Christina Cuka^{a,b,c,d}, Amy W. McDevitt^e, Ann Porter-Hoke^b and Steve Karas^{b,f}

^aTrue Physical Therapy, Lakewood, CO, USA; ^bNorth American Institute of Orthopedic Manual Therapy, Eugene, OR, USA; ^cDepartment of Physical Therapy, Andrews University, Berrien Springs, MI, USA; ^dDepartment of Physical Therapy, A.T. Still University, Mesa, AZ, USA; ^eSchool of Medicine, Physical Therapy Program, University of Colorado, Aurora, CO, USA; ^fPhysical Therapy Program, Chatham University, Pittsburgh, PA, USA

ABSTRACT

Background: Spinal fusion (SF) is a common surgical intervention for individuals with idiopathic scoliosis. However, individuals may experience continued pain and disability from suspected mechanical dysfunction.

Case Description: The purpose of this case report was to describe how specific thrust manipulation (TM) was used to treat a patient with scoliosis after multilevel SF. The 25-year-old female patient presented with left-sided pain in the rib, thoracic, and lumbar and sacroiliac joint regions that had been aggravated by trail running. After clearance from her surgeon, physical therapy examination and subsequent diagnosis were consistent with mechanical dysfunction of the ribs, lumbar spine, and sacroiliac joint causing decreased ability to participate in high-level activities, such as running.

Outcomes: The patient was treated for eight visits her 4 months with specific TM, movement analysis, and physiotherapeutic scoliosis-specific exercises. Pain and function were assessed with the Trunk Appearance Perception scale (TAPS), Scoliosis Research Society questionnaire (SRS-22), Numeric Pain Rating Scale (NPRS), Oswestry Disability Index (ODI), and spirometry. Pain and function improved during treatment, but outcomes for the ODI and spirometry remained the same.

Discussion: The current case report suggests specific TM to areas outside of the fused spinal segments may be beneficial for decreasing pain and improving functional activities and participation levels. However, more research is needed to verify the efficacy of this treatment in clinical practice.

KEYWORDS

Idiopathic scoliosis; spinal fusion; physical therapy; manipulation; ribs; lumbar spine

Background

For individuals diagnosed with adolescent idiopathic scoliosis (AIS), spinal fusion (SF) has been performed for decades, and multilevel fusions for AIS may be indicated when Cobb angle curves exceed 45° [1]. The goal of SF is the prevention of spinal deformity progression [1–4]. Surgical procedures to correct scoliosis include anterior SF and posterior SF, and surgical success is defined by reduction of the Cobb angle, cessation of curve progression, and improved cosmesis [1,5,6]. However, underemphasized post-surgical impairments may include changes in respiratory function and long-term pain and disability [1].

There is limited evidence on long-term outcomes for pain and disability in individuals with a history of multilevel SF. Segments inferior and superior to a SF may incur more stress due to inherent stiffness of the fused segments. Degeneration of adjacent segments has been well documented in lumbar SF studies [5,7,8] as adjacent segment disease can occur at mobile segments adjacent to lumbosacral fusions [9]. Further, SF length may be associated with a higher incidence of this disease as movement associated with longer lever arms can induce

more stress at adjacent unfused segments [9]. Mechanical impairments in peripheral joints may contribute to compounded stresses at the adjacent levels [10–12].

Physical therapy is not typically prescribed after SF for the correction of scoliosis [13] and limited studies exist on exercise protocols after SF [14]. Further, thrust manipulation (TM) has not been studied in the SF population. In non-surgical populations, there is disagreement regarding the benefit of regional versus specific TM [15,16]. Therefore, the purpose of this case report was to describe how specific TM was used to treat a patient with scoliosis after multilevel SF. We defined specific TM as a high-velocity, low-amplitude thrust directed at a single spinal segment with the intention to localize manipulative forces through locking techniques and directional forces [17].

Case description

Patient characteristics

A 25-year-old female presented to physical therapy via direct access with a primary complaint of spasms

and pain in her left rib cage during breathing. Secondary complaints were perceived tightness in her left thoracic spine and pain in her low back. Symptoms began 3 weeks prior, following an 8-mile trail run. She became limited in her participation in activities, such as cross fit, weight lifting, yoga, running, and paddle boarding. The patient had ceased all high-level activities, had difficulty sitting or standing for more than 1 h, and was only walking for exercise. A recent radiograph confirmed the fusion hardware was intact. The patient reported a similar episode 6 months prior and was treated with a series of three thoracic facet injections and a regimen of opioid pain medications.

At the age of 12, the patient was diagnosed with AIS based on radiographic evidence of a 42° primary left thoracic curve and a 20° secondary right lumbar curve. Anterior SF surgery was performed on levels T6-T12 including a left rib six autograft. Instrumentation included mesh cages from T10-T12, interbody autograft bone placement at T6-T12, and interbody screw fixation with the Moss-Miami™ pedicle screw system (Raynam, MA). At age 15, the patient had a posterolateral SF surgery to further stabilize her curve from T2-T8 including T4-T7 osteotomies, bilateral T2-T8 facetectomies, bilateral hook placement at T2, and pedicle screws and stainless steel rod placement from T3-T8, including autograft bone along the fusion (Figure 1).

Physical exam

A systems review revealed normal vital signs and a negative neurologic screen; red and yellow flags were not identified. Posture was assessed, and functional tests of the lower extremity, range of motion (ribs, lumbar and thoracic regions, hips), manual muscle testing, and accessory motion testing of the ribs, lumbar spine (L3-S1), and hips were performed [16,18–20]. Physical examination revealed hypomobility of left ribs 4/5 and 7/8 with posterior-to-anterior (PA) springing, right L2/L3 and L5/S1 hypomobility with right unilateral PA pressure, and hypomobile caudal glide of the left hip. Palpation findings included left iliacus myofascial trigger points and increased palpable muscle tone in the left diaphragm. Pain was reproducible with left 4th rib springing and unilateral PA pressure to the right L2/3 and L5/S1. Initial physical findings are presented in Table 1.

Diagnostic assessment

Patient reported outcome measures included the Trunk Appearance Perception Scale (TAPS), Scoliosis Research Society questionnaire (SRS-22), Numeric Pain Rating Scale (NPRS), and Oswestry Disability Index (ODI) [4,21–25]. The TAPS measures patient's perception of trunk deformity and self-image using a visual estimate of deformity

Figure 1. View of hardware in the frontal plane showing anterior fusion of T6-T12 and posterolateral fusion of T2-T8.

Table 1. Initial examination findings.

Physical Examination:	Results of Tests and Measures:
Posture Assessment	Left (L) skin fold posteriorly at the lower fusion level (exaggerated with squatting); increased lumbosacral lordosis; anterior deviation in the sagittal plane as determined by plumb line alignment per Kendall et al. [18].
Lumbar Spine Mobility	Passive Physiologic Intervertebral Motion (PPIVM) hypomobile Right (R) L2-3 and L5/S1. [15,18,19]
Rib Mobility	Hypomobile L ribs 4/5 and 7/8. Rib 4 painful with springing and deep inhalation. Rib assessment reproduced 7–8/10 pain with wrap around spasm.
Hip Range of Motion and End Feel	L hip end range of motion (ROM) limitation and 4/10 pain with hip flexion, hard capsular end feel.
Neurological Screen	Negative.

(scores range from 0–15 points) and higher scores indicate less deformity [21]. The SRS-22 is used to evaluate back-related health over time (scores range from 22–110 points) [4]. The NPRS and ODI are common tools used in individuals with musculoskeletal pain [23–26]. The NPRS measures pain from 0 to 10 points (0 = no pain, 10 = most pain imaginable). The ODI measures disability specific to back pain [26,27] and is reported as a percentage score with higher scores indicating higher levels of disability [28]. Pulmonary function can be affected in patients with

AIS [28,29]; therefore, spirometry was used to estimate restrictive lung defects [28].

At the initial visit, the patient scored 11/15 on the TAPS and 85/110 on the SRS-22; NPRS scores were 7–8/10 in the thoracic region and 3–4/10 in the lumbar region. The patient scored 8% on the ODI and measured 2943 mL on spirometry.

Plan of care

Based on patient history and examination findings, it was determined the patient would benefit from a plan of care consisting of specific TM to the ribs and lumbosacral spine, mobilization to the lumbar spine and left hip, soft tissue mobilization, patient education, and a home program of physiotherapeutic scoliosis specific exercises, to achieve the patient's goal of participation in high-level activities, such as running [30–32] (Table 2). The examination reproduced the patient's pain, thus impairments appeared to be mechanical in nature and it was believed the patient would have a positive response to manual therapy focused on improving rib, lumbar spine, and hip mobility.

Intervention

The patient was treated for eight visits over 4 months. Visit 1 included a specific rib TM based on findings of hypomobility at rib 4 and reproduction of pain (7/10 on NPRS) with deep inspiration. Pre-manipulative screening included neurological assessment, specific ligamentous stress testing at the identified segments, and a pre-manipulative hold prior to TM interventions [17]. The TM (Figure 2) was performed with the patient in supine, left leg in a hook lying position, right leg straight, and arms crossed. The patient rolled to the right (therapist positioned on right) and the left transverse process of T4 costotransverse segment was contacted with the thenar eminence, forming a lumbrical bridge. The patient was rolled onto the therapist's hand and instructed to look right, which facilitated an indirect posterior lateral glide of the rib. A high-velocity, low-amplitude anterior-to-posterior thrust was applied through the patient's elbows with the force toward the therapist's right hand [17]. The patient was reassessed after the intervention and reported improvement in pain (0/10 with inspiration), and joint mobility was considered to be improved.

One week later (visit 2), the patient reported decreased spasms and increased perceived mobility based on her ability to resume paddle boarding, kayaking, and walking. TM of rib 4 was repeated to address continued hypomobility and a modified TM of right L5/S1 performed based on findings of hypomobility at L5 (Figure 3). The L5/S1 TM was performed with the patient positioned in left side lying. The thoracic spine was maintained in

a neutral position to protect SF hardware while the lower extremities were positioned with the right leg bent 90° and resting on a straight left leg. The lower extremities were slightly extended to create an extension bias. The therapist placed the right thumb on the spinous process of L5 for stabilization, and a superior-anterior thrust was applied through the patient's pelvis [17,33]. Immediately after, the patient reported 0/10 pain in the lumbar spine.

Hypomobility of the left hip was also addressed during visit 2 as limited hip mobility can contribute to LBP [10–12]. Left hip caudal glides were performed with the patient in a supine position using a mobilization belt with left leg positioned in 90° hip and 90° knee flexion [33]. Upon reassessment, the patient had improved accessory motion of caudal glide of the hip, improved lumbopelvic motion with squatting and left hip flexion range of motion appeared to be improved in non-weightbearing and weightbearing.

Visits 3–8 were intended to monitor and guide activity progression between sessions (Table 2). Patient activity progression was based on her response to the previous week's interventions, response to physical activities, and identified goals of returning to pain-free high-level activities. Response to increased activity levels was monitored at 1-month intervals (visits 7–8). Six months after discharge, the patient completed measures for the TAPS, SRS-22, NPRS, and ODI. Spirometry was also measured.

Outcomes

The patient reported reductions in pain on the NPRS (7–8/10–0/10), suggesting positive within-treatment changes after visits 1 and 2 (Table 2). Prior to visit 3, the only reported activity reproducing LBP symptoms was prolonged driving (3 h). The patient reported decreased pain and spasms in the ribs and thorax; therefore, a run/walk and kayaking was attempted between visits 2 and 3 without aggravation of symptoms. The patient reported 0/10 pain at visit 4 and was slowly increasing her activity level (30-min run/walks with 3-min warmup). Resistive band exercises for upper extremities and plank exercises were resumed without aggravation of symptoms. She denied thoracic spasms or low back tightness at visits 5 and 6, and resumed light weight lifting, yoga and running at a 10–15 min/mile pace. The patient was pain-free and returned to all previous activities by visit 7. At visit 8, all previously identified painful areas were reported to be 0/10. The only pain reported at discharge was intermittent LBP after driving for more than 3 h (1–2/10), but the pain quickly resolved with movement.

Table 2. Interventions of the current case report listed by visit, asterisk, interventions performed, and outcomes of the intervention.

VISIT	ASTERISK	INTERVENTION PERFORMED	OUTCOMES
1	Hypomobile L rib 4, 7–8/10 Pain on NPRS Hypomobile R L2/3, 4/10 Pain on NPRS	Thrust manipulation L rib 4 for inhalation [17,33] Grade II/III oscillatory Extension Mobilizations to R L2/3	Improved Mobility; 0/10 on NPRS pain with inhalation 1/10 Pain on NPRS
2	Hypomobile L Ribs T4/5 Hypomobile R sacral base flexion Hypomobile R L5/S1 extension Decreased L hip flexion, 4/10 pain on NPRS at end ROM Decreased L hip inferior glide	PSSE's in sitting and standing [30] Posterior to anterior (PA) rib mobilizations grades III/IV to the L costotransverse joints ribs 4 and 5 [17] R sacral base flexion mobilizations Grades III/IV oscillations R L5/S1 extension grade IV mobilizations and V thrust manipulation [17] MET for L hip flexion 3 sets of 5 reps, 5 s holds Inferior hip glide L grade IV oscillations, 3 sets of 30 s [33] Review of HEP	Demonstration of exercise Improved mobility with 0/10 pain on NPRS With rib springing of the L ribs 4/5 Improved R sacral flexion Improved mobility, 0/10 pain on NPRS Full L hip flexion with firm capsular end feel, 0/10 pain on NPRS Full L hip flexion with firm capsular end feel
3	Hinge point below fusion with Functional squat	Patient education on proper squatting techniques focusing on spinal Stabilization of the lumbar spine and hip hinging. Supine and sitting PSSE	Decreased hinging on visual inspection With functional squat Proficiency with exercises
4	0/10 Pain on NPRS; rib and lumbar spine mobility normal	Review of exercises-added side lying PSSE	Proficiency with exercises
5	Decreased scapular mobility into Retraction and depression	Scapulothoracic mobilizations grade III/IV oscillations into retraction Review of exercises	Improved scapular retraction Proficiency with exercises
6	Questions on exercises, return to Sport, appropriateness of yoga, Progressions of exercises	Patient educated on appropriate activities and progressions. Proper weight training progression, review of yoga poses and Adaptations to her curve pattern	Verbal acknowledgement of understanding Of activity progressions with weights and Return to activities
7	Questions on exercises	Review of HEP exercises	Patient demonstrated proficiency in PSSE
8	Cervical pain with elevated first rib	Cervical spine pain treated with in the session	Full function restored with no pain

Abbreviations: HEP: home exercise program; L: left; MET-Muscle energy technique; PSSE: physiotherapeutic scoliosis specific exercises; ROM: range of motion; R: right.

At 6 months, the patient's overall TAPS score improved from 11/15 to 12/15. The SRS-22 improved from 85/100 to 96/110. This 11-point change surpassed the minimal important difference for the SRS-22. The NPRS improved from 7–8/10 in the thoracic spine and 3–4/10 in the lumbar spines to 0/10 and 1–2/10, respectively. ODI (8%) and spirometry (2943 mL) measurements remained unchanged.

Discussion

The current case report described how specific TM was used to treat pain and disability in a patient with scoliosis including multilevel SF. Red flags were not identified and based on examination findings, it was hypothesized that the patient exhibited mechanical dysfunction in the form of hypomobility in the ribs, thoracic, and lumbar spines; therefore, intervention including specific TM was considered appropriate. Initially, the patient had marked within-session and between-session reductions in pain, as measured by the NPRS, suggesting a positive trend toward improvement on patient specific outcomes measuring pain and disability [34]. Decreased hip flexion was initially observed with the patient's squat and the assumption was therefore made that impaired mechanics at the hip may contribute to LBP [35]; therefore, hypomobility at the left hip was addressed. The patient's pain remained at low levels throughout visits 3–8, and her ability to

participate in vigorous physical activities improved. The patient's perception of pain and deformity decreased, indicated by improved scores on the NPRS and TAPS between initial and post-treatment assessments. Improvements in back-related health also improved over time as evidenced by an 11-point score change on the SRS-22. ODI scores were unchanged, which may be the result of the ODI's sensitivity to activities of daily living over sport-specific activities. Spirometry results remained unchanged. Research suggests SF can negatively affect pulmonary function due to transection and scarring of the respiratory muscles and postoperative pleural adhesions of the intercostal muscles and diaphragm [36–39].

Research investigating differences between TM and non-TM as an intervention remains inconsistent. In a study by Hadler et al. [40], TM was a more effective treatment over non-TM in specific populations of individuals with LBP. Cook et al. reported minimal differences in pain, disability, rate of recovery, total visits or days in care when comparing TM and non-TM in individuals with acute LBP [41]. However, both studies considered a history of spinal surgery an exclusion criteria in their study populations [40,41]. Thus, it would appear these findings are not generalizable to a post SF population.

Owing to limited and inconsistent evidence, physical therapists should exercise caution when performing TM in individuals with a known history of SF.

Figure 2. Example of high-velocity, low-amplitude anterior-to-posterior grade V thrust manipulation to rib 4.

Figure 3. Example of modified high-velocity, low-amplitude superior/anterior thrust manipulation of S1 on L5 with neutral rotation above and an extension lock below.

Precautions and contraindications to TM should be considered with this population, and red flags should not be present. As such, therapists should rely on their knowledge of tissue healing in combination with physical exam findings to determine the appropriateness of TM in this population. Based on principles of tissue healing, bone callus formation may take 6–8 weeks after surgery; therefore, TM is contraindicated during this time [33]. If TM is deemed appropriate for the patient, typical postoperative precautions should be considered, such as confirmation of bony union by radiograph, as healing often continues up to 1 year after fusion [13,14,33]. In general, manipulation in the area of a SF or joint replacement is contraindicated; however, interventions including TM specifically targeted to areas adjacent to the SF may be indicated if symptoms are reproducible and hypothesized to be mechanical in nature. In individuals with AIS and a history of SF, fused regions should be protected by using specific TM over regional techniques while also limiting force applied through the spine by the use of locking techniques.

Investigation of regional and specific TM has not found the use of specific TM to be superior to regional TM in the general population [42–44]. Studies that have demonstrated reduction in LBP from regional manipulations of the thoracic spine typically list spinal surgery as an exclusion criterion [42,43]. Although segment specificity with TM is not superior to regional TM according to the literature, clinically, healthcare providers considered an attempt at localization of a chosen segment important when performing a side-lying lumbar manipulation technique [44].

Individuals with AIS may experience long-term pain and disability due to impairment in areas adjacent to the fusion after surgery [1,4]. Adjacent segment disease refers to any abnormal process that develops in the mobile segment next to a SF, and should be considered a possible complication to spinal arthrodesis. The literature is contradictory regarding the role of biomechanical changes versus normal degenerative processes causing adjacent segment degeneration [9]. To our knowledge, no

article addresses the long-term outcomes of spinal manipulation in a multilevel SF population. It is, therefore, difficult to predict the impact of TM on degeneration on the adjacent segments as more research is needed in this area.

Conclusion

The current case report describes how specific TM was used to treat a patient with scoliosis who had multilevel SF. Specific TM to areas outside the fused segments decreased the patient's pain and improved her function and participation levels. Patients with AIS and SF may continue to experience pain and disability years after surgery. Mechanical dysfunction can occur because of the extensive nature of the SF and regional interdependence. Therefore, physical therapists should be aware of this possible patient presentation, and realize that the specific TM may be a prudent treatment option as SF hardware can interfere with patient positioning for the safe delivery of regional TM techniques. The results of a single case report are not generalizable to a general population; therefore, more research is needed in this area.

Author contribution

Only the authors listed contributed to the article; there were no additional contributors.

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Ethics approval

Subject gave written informed consent.

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Notes on contributors

Christina Cuka is an assistant professor at A.T. Still University. She practiced in outpatient orthopedics for over 17 years, after graduating with a Master in Physical Therapy from Regis University in Denver, CO. She received her Doctorate in Physical Therapy through the Ola Grimsby Institute in 2006, prior to earning the designation of certified orthopedic manual therapist (COMPT) through the North American Institute of Manual Therapy (NAIOMT). She completed her Fellowship through NAIOMT and her Doctor of Science in Physical Therapy through Andrews University in Berrien Springs, Michigan. Additionally, she completed three certification in scoliosis specific schools for treating scoliosis: the Schroth method, the Barcelona scoliosis physical therapy school (BSPTS) and the scientific

exercise approach to scoliosis (SEAS). She is a board certified orthopedic clinical specialist (OCS) and a member of the American physical therapy association (APTA) and American Academy of orthopedic manual therapy (AAOMPT).

Amy McDevitt is an Assistant Professor in the Physical Therapy Program at the University of Colorado School of Medicine. Clinically she practices at the University of Colorado Health, CU Sports Physical Therapy and Rehabilitation. She is a board-certified Orthopaedic Clinical Specialist and a Fellow in the American Academy of Orthopaedic and Manual Physical Therapists. She is currently completing her clinical PhD through the University of Newcastle Australia. Amy is active in clinical and educational research at the University of Colorado and her research interests include shoulder pain, regional interdependence, dry needling and assessment of clinical reasoning.

Ann Porter Hoke received her Diploma in Physiotherapy from St. Thomas' Hospital, London in 1971, her BScPT from the University of British Columbia in 1982 and a post professional doctorate from Pacific University, Oregon in 2008. She is a Fellow of both the Canadian and American Manual and Manipulation Academies and is a Board Certified Orthopaedic Specialist. She has served on numerous national and international OMPT committees and has been involved in the development of the Description of Advanced Specialist Practice in OMPT and Educational Standards. Her awards include: Mercedes Weiss, from the Oregon PT Association (1996) and the John McM. Mennell Service Award from AAOMPT in 2006. She is a distinguished faculty member, senior examiner, clinical fellowship director and clinical instructor with NAIOMT and has 43 years of teaching and 48 years of clinical experience. She teaches all levels of NAIOMT core and specialty classes in mobilization and manipulation.

Steve Karas is a faculty member at Chatham University where he teaches orthopedics and spine, a member of the IRB and maintains consistent clinical practice. He is the Research Director for The North American Institute for Orthopedic Manual Therapy and obtained his Doctorate from Andrews University with a manual therapy certification from NAIOMT. His current research includes grant funded study of techniques and outcomes of thoracic spine manual therapy, stability testing of the upper cervical spine, and treatment fidelity in manual therapy research. Some of his publications include orthopedic special test assessment, spine palpation, knowledge translation, and research fidelity. His work includes collaboration with co-authors from seven different countries. He has presented nationally and internationally on these topics. Dr. Karas is a member of the AAOMPT research committee & education special interest group, and a reviewer for several journals. He is currently pursuing a nutrition certification at Cornell University.

ORCID

Steve Karas <http://orcid.org/0000-0003-2819-1219>

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Appendix 1. Treatment Timeline

HEP- Home Exercise Program; Numeric Pain Rating Scale- NPRS; TM-Thrust Manipulation; Physiotherapeutic Scoliosis Specific Exercises-PSSE.

Appendix 2. CARE Checklist

CARE Checklist (2013) of information to include when writing a case report

Topic	Item	Checklist item description	Reported on Page
Title	1	The words "case report" should be in the title along with the area of focus	<u>1</u>
Key Words	2	2 to 5 key words that identify areas covered in this case report	<u>2</u>
Abstract	3a	Introduction—What is unique about this case? What does it add to the medical literature?	<u>1</u>
	3b	The main symptoms of the patient and the important clinical findings	<u>1</u>
	3c	The main diagnoses, therapeutics interventions, and outcomes	<u>1</u>
	3d	Conclusion—What are the main "take-away" lessons from this case?	<u>1</u>
Introduction	4	One or two paragraphs summarizing why this case is unique with references	<u>3-4</u>
Patient Information	5a	De-identified demographic information and other patient specific information	<u>4-5</u>
	5b	Main concerns and symptoms of the patient	<u>4</u>
	5c	Medical, family, and psychosocial history including relevant genetic information (also see timeline)	<u>4</u>
	5d	Relevant past interventions and their outcomes	<u>4</u>
Clinical Findings	6	Describe the relevant physical examination (PE) and other significant clinical findings.	<u>5-6</u>
Timeline	7	Important information from the patient's history organized as a timeline	<u>20</u>
Diagnostic Assessment	8a	Diagnostic methods (such as PE, laboratory testing, imaging, surveys).	<u>5</u>
	8b	Diagnostic challenges (such as access, financial, or cultural)	<u>NA</u>
	8c	Diagnostic reasoning including other diagnoses considered	<u>5-6</u>
	8d	Prognostic characteristics (such as staging in oncology) where applicable	<u>5-6</u>
Therapeutic Intervention	9a	Types of intervention (such as pharmacologic, surgical, preventive, self-care)	<u>7</u>
	9b	Administration of intervention (such as dosage, strength, duration)	<u>7-8</u>
	9c	Changes in intervention (with rationale)	<u>7-8</u>
Follow-up and Outcomes	10a	Clinician and patient-assessed outcomes (when appropriate)	<u>9</u>
	10b	Important follow-up diagnostic and other test results	<u>9</u>
	10c	Intervention adherence and tolerability (How was this assessed?)	<u>7-8</u>
	10d	Adverse and unanticipated events	<u>NA</u>
Discussion	11a	Discussion of the strengths and limitations in your approach to this case	<u>10-12</u>
	11b	Discussion of the relevant medical literature.	<u>10-12</u>
	11c	The rationale for conclusions (including assessment of possible causes)	<u>13</u>
	11d	The primary "take-away" lessons of this case report	<u>13</u>
Patient Perspective	12	When appropriate the patient should share their perspective on the treatments they received	
Informed Consent	13	Did the patient give informed consent? Please provide if requested	☐ ☐
	Yes		
	No		