doi: 10.2490/prm.20240034 Progress in Rehabilitation Medicine 2024; Vol. 9, 20240034

ORIGINAL ARTICLE

Association between Shoulder Dysfunction and Concomitant Neck Disability in Patients with Shoulder Disorders

Mizuki Fujiwara, MS, RPT [a,b], Kensuke Oba, PhD, RPT [c,d] and Kazuaki Suzuki, PhD, MD [e]

Objectives: This study aimed to investigate the impact of shoulder dysfunction on concomitant neck disability in patients with shoulder disorders. **Methods:** The participants were patients with subacromial impingement syndrome (SIS) and frozen shoulder (FS). Twenty patients with SIS and 21 with FS without cervical radiculopathy were enrolled. The participants were assessed for the 4-week prevalence of neck pain, Neck Disability Index (NDI), shoulder strength and range of motion, a short version of the Disabilities of the Arm, Shoulder, and Hand questionnaire (quick-DASH), and the Pain Catastrophizing Scale (PCS). **Results:** The 4-week prevalence of neck pain was 12 out of 20 (60%) in patients with SIS and 13 out of 21 (62%) in patients with FS. The median NDIs were 13 and 12 for SIS and FS, respectively, with no statistically significant difference. About 41% (17/41) of the participants displayed an NDI greater than the cutoff value for disability in daily living. Although shoulder abduction strength correlated with the NDI in patients with SIS, the PCS score correlated with the NDI in patients with FS. **Conclusions:** Concomitant neck disability is a critical concern for patients with shoulder disorders. The clinical factors related to concomitant neck disability differ between SIS and FS, with specific interventions recommended for each condition.

Key Words: frozen shoulder; neck disability; neck pain; Pain Catastrophizing Scale; subacromial impingement syndrome

INTRODUCTION

Neck and shoulder pain is a common musculoskeletal problem. An epidemiologic survey in Japan found that neck and shoulder pain accounts for 55% of total chronic pain.[1] High-intensity neck and shoulder pain leads to long-term absenteeism from work.[2] In Sweden, neck and shoulder problems have been reported to account for 18% of disability payments.[3] Therefore, appropriate neck and shoulder pain management is important to maintain social activities and reduce healthcare costs.

Although clinical research has primarily focused on individual bone joints, the relationship between joints of the neck and shoulder has also been a topic of discussion for some time.[4] Cervical radiculopathy, a common condition, leads to shoulder disability through neurological pathways.[5] Various clinical tests have been developed to differentiate cervical radiculopathy from other shoulder disorders.[4] Conversely, neck disability may be caused by primary shoulder disorders such as subacromial impingement syndrome (SIS) and frozen shoulder (FS). However, the relationship between specific shoulder dysfunction and concomitant neck disability in patients with SIS and FS can only be discussed based on indirect evidence.

Overactivity of the upper trapezius is a candidate for the cause of concomitant neck disability in primary shoulder

Received: July 17, 2024, Accepted: September 27, 2024, Published online: October 8, 2024
[a] Graduate School of Biomedical Engineering, Tohoku University, Sendai, Japan
[b] Department of Rehabilitation, Sendai Hospital of East Japan Railway Company, Sendai, Japan
[c] Department of Rehabilitation, Hitsujigaoka Hospital, Sapporo, Japan
[d] Faculty of Health Sciences, Hokkaido University, Sapporo, Japan
[e] Department of Orthopedic Surgery, School of Medicine, Tohoku University, Sendai, Japan
Correspondence: Kensuke Oba, PhD, RPT, N12-W5, Kita-ku, Sapporo, Hokkaido 060-0812, Japan, E-mail: obaknsk@gmail.com

disorders. In Japan, pain related to the upper trapezius muscle is referred to as *katakori*.[6] Upper trapezius overactivity is observed in patients with chronic neck pain when they perform tasks with the upper extremities.[7] Similarly, overactivity of the upper trapezius occurs in SIS and FS patients to compensate for shoulder function.[8,9] The upper trapezius elevates the scapula and can compensate for a deficiency of the glenohumeral range of motion (ROM) through a shoulder-shrugging motion.[10] In addition, the upper trapezius can prevent narrowing of the subacromial space by working against hypermigration of the humeral head caused by rotator cuff dysfunction. Therefore, shoulder dysfunction, such as ROM restriction and weakened rotator cuff muscles, can be associated with concomitant neck disability.

Patients with SIS show upper and lower trapezius muscle imbalances and abnormal scapula movement,[9] and severe contracture in the glenohumeral joint is rare. In contrast, patients with FS experience severe ROM restrictions, which impair activities of daily living.[11] Therefore, if there is a relationship between shoulder disability and neck disability, patients with FS would show more severe shoulder and neck disabilities than patients with SIS.

In addition to the effects of skeletal function relationships, both shoulder and neck pain are influenced by psychosocial factors such as pain catastrophizing.[12,13] Therefore, psychosocial factors should be evaluated along with shoulder function to determine its impact on concomitant neck disability in shoulder disorders. In this study, the Pain Catastrophizing Scale (PCS) was used to assess psychosocial factors. PCS has been widely applied to orthopedic conditions, including shoulder, neck, knee, and hand pathologies, with higher PCS scores often correlating with poorer outcomes.[12–15]

The purpose of this study was to reveal the underlying shoulder dysfunction influencing concomitant neck disability to help update approaches to neck and shoulder rehabilitation. To achieve these objectives, psychosocial status was also considered in this study. We hypothesized that neck disability is associated with shoulder dysfunction, particularly ROM restriction, and is more severely impaired in patients with FS than in patients with SIS.

MATERIALS AND METHODS

Participants

This cross-sectional observational study was conducted at a single institution between May 2022 and September 2023. The study participants were patients who presented with a shoulder joint complaint to the outpatient department of our hospital. A medical doctor specializing in shoulder joint orthopedics made the final decision regarding enrollment and group classification of each patient. The inclusion criteria of each diagnostic group were defined by referring to previous studies.[16–18] We used the following inclusion criteria for FS: age, 40 years or older; passive flexion ROM, 130° or less; passive external rotation ROM, 50% of the contralateral side or less; disease duration, 1 month or longer; and no radiographic abnormality. We used the following inclusion criteria for SIS: age, 40 years or older; positive test in at least two of the three SIS tests, Neer test, Hawkins-Kennedy test, and Painful-arc test[19]; disease duration, 1 month or longer; absence of a full-thickness rotator cuff tear confirmed by magnetic resonance imaging[20]; and failure to meet ROM criteria for FS. The following exclusion criteria were applied: positive test in either or both of two special tests for cervical radiculopathy (Spurling test and/or Arm Squeeze test),[21,22] traumatic onset, and history of shoulder fracture or neck fracture or surgery. The required sample size was calculated using G*Power software (version 3.1; Heinrich Heine-University, Düsseldorf, Germany) for the Mann–Whitney U test between SIS and FS with an α error=0.05, power=0.8, and effect size=1.00. The effect size was calculated assuming that the difference in scores of Neck Disability Index (NDI) between patients with FS and SIS was equivalent to the difference in the NDI of the general population with neck pain that interferes with daily life and those without.[23] The minimum sample size for the NDI comparison between SIS and FS was calculated to be 14 participants for each group. Of 62 patients, 54 met either FS or SIS criteria. Then, 13 patients were excluded (4 for cervical radiculopathy, 6 for full-thickness rotator cuff tear, and 3 for traumatic onset). After screening for exclusion, 21 FS patients and 20 SIS patients were enrolled in this study. This study was approved by the Institutional Review Board of JR Sendai Hospital (IRB Approval Number: 2022–175). After being informed of the details of the study, the participants provided written informed consent. All the study procedures were conducted according to the principles of the Declaration of Helsinki.

Shoulder Function

Shoulder ROMs of flexion, abduction, external rotation, and hand behind the back were measured with a goniometer. Shoulder flexion was measured as the angle between the humerus and a vertical line in the coronal plane when the participant raised their hand in the sagittal plane with the elbow extended. Shoulder abduction was measured as the angle between the humerus and a vertical line in the sagittal

plane when the participant raised their hand in the coronal plane. External rotation ROM was measured with 90° elbow flexion and arm at the side, defined as the angle between the forearm and a horizontal line in the transverse plane when the participant moved their arm outward. The hand behind the back ROM was measured as the highest vertebral level reached by the extended thumb.

The shoulder strength of external and internal rotation and abduction in the scapular plane was assessed with a handheld dynamometer (μ-Tas F1, OG Wellness Company, Okayama, Japan) in the seated position as described previously. Internal and external rotation strength was measured with the arm at the side, neutral rotation, and elbow flexion of 90°. A sensor was placed proximally to the ulnar styloid process, and a towel was placed between the arm and thorax. Abduction strength was measured in the plane of the scapula at 45° of abduction. A sensor was placed on the insertion of the deltoid on the humerus. Participants were instructed to gradually exert maximum force for over 5 s to avoid acute pain. If compensatory movements of the scapula or trunk were confirmed, an additional measurement was conducted after instruction. The highest measurement of three successive measurements was recorded.

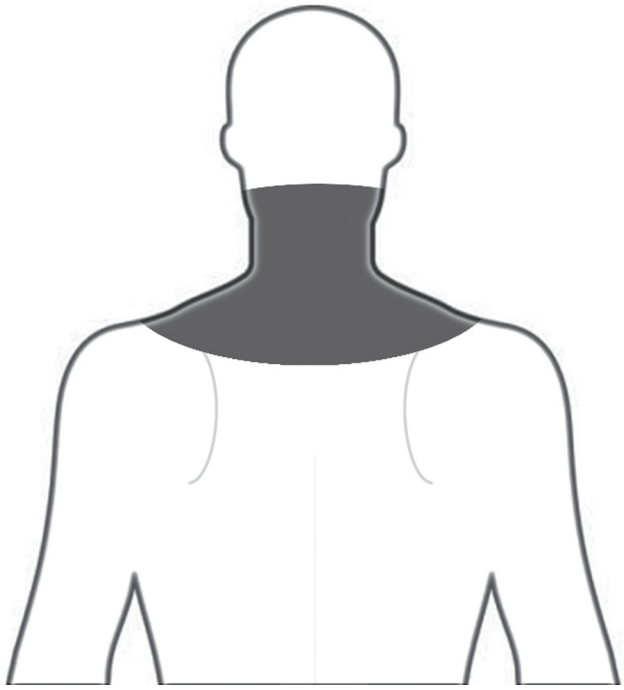

Fig. 1. Diagram (posterior view) used to indicate the location of neck pain. Pain within the grey area was defined as neck pain.

Patient Reported Outcomes

All participants were asked about episodes of neck pain during the previous 4 weeks. A diagram with the neck region shaded (**Fig. 1**) to define the location of neck pain was used as previously described.[23] Neck disability was assessed using the NDI, which is based on a ten-item questionnaire. Each item is assessed on a scale of 0 to 5, where 0 indicates no disability and 5 indicates severe disability. Either the total score out of 50 or the percentage score, which doubles the total score, is used for the outcome. In this study, percentage scores were used according to a previous study, in which a percentage NDI of 15% was defined as the cutoff value for predicting neck pain interfering with daily life.[23] A short version of the Disabilities of the Arm, Shoulder, and Hand questionnaire (quick-DASH) was used to evaluate shoulder disability. This is an 11-item questionnaire, with responses ranging from 0 to 5. Scores are calculated as a percentage and may range from 0 (no impairment) to 100 (most severe impairment). The Pain Catastrophizing Scale (PCS) was used to assess the psychosocial status of the study participants. The PCS consists of 13 items with scores ranging from 0 to 52, where higher scores reflect greater pain catastrophizing. Catastrophizing refers to an exaggerated negative orientation toward actual or anticipated pain, involving magnification of its threat, helplessness, and rumination.[24] Pain intensity was measured using a visual analog scale (VAS) with a maximum possible score of 100.

Statistical Analysis

All continuous values were tested for normality using the Shapiro–Wilk test. Non-normality was observed for external rotation ROM in FS ($W=0.86$, $P<0.01$), external rotation strength in FS ($W=0.89$, $P=0.02$), and abduction strength in SIS ($W=0.86$, $P<0.01$). We conducted a group comparison between SIS and FS. A chi-square test was used to confirm sex distribution. Depending on the data type and distribution, either the Mann–Whitney U test or the independent *t*-test was used to compare demographic data, shoulder function, and patient reported outcomes. Spearman's coefficient was calculated to confirm the relationship between NDI and other outcomes. The significance level was set at 5%. All statistical calculations were performed using R for Windows software (version 4.0.1; R Development Core Team).

RESULTS

Group Differences

Table 1 shows a group comparison of demographic data.

Table 1. Demographic data of study participants

	SIS (n=20)	FS (n=21)	P value
Age, years	60.2 ± 10.8	60.1 ± 9.7	0.97
Sex (male/female)	9/11	9/12	0.89
Height, cm	162.9 ± 8.0	162.9 ± 7.9	0.99
Weight, kg	60.8 ± 12.3	64.9 ± 15.7	0.37
Symptom duration, months	5.0 ± 7.5	7.0 ± 6.0	0.28
Affected side (dominant/non-dominant)	11/9	8/13	0.44

Data are given as mean ± standard deviation or number.

Table 2. Shoulder function and patient-reported outcomes in patients with SIS and FS

	SIS (n=20)	FS (n=21)	P value
Shoulder ROM			
Flexion (°)	145.3 ± 12.1	112.1 ± 14.1	<0.01*
Abduction (°)	118.5 ± 30.0	81.2 ± 19.9	<0.01*
External rotation (°)	42.5 ± 17.8	10.7 ± 9.7	<0.01*
Hand behind the back	T12 ± 5 vertebral	L5 ± 3 vertebral	<0.01*
Shoulder strength			
Abduction (kgf)	9.1 ± 2.4	8.5 ± 4.3	0.57
External rotation (kgf)	6.4 ± 2.2	6.8 ± 2.4	0.52
Internal rotation (kgf)	8.6 ± 2.6	8.4 ± 3.7	0.85
Patient reported outcomes			
NDI (%)	13.0 ± 13.0	12.0 ± 18.0	0.68
Quick-DASH	15.9 ± 7.1	25.0 ± 9.1	0.03*
PCS			
Total	24 ± 14	24 ± 17	0.78
Rumination	10.5 ± 3.5	10.0 ± 4.0	1.00
Helplessness	8.5 ± 5.5	9.0 ± 5.0	0.68
Magnification	5.0 ± 4.0	5.0 ± 5.0	0.77
Shoulder pain (VAS)	62.8 ± 26.4	47.9 ± 26.1	0.08

Continuous data are given as mean ± standard deviation. Ordinal scale data (Hand behind the back and Patient reported outcomes) are shown in the median ± interquartile range magnitude. NDI has been corrected to a percentage (see text for explanation).
*P <0.05

The SIS and FS patient group demographic data showed no statistically significant difference. The mean age of all participants was 60.1 years (range 42–86 years). **Table 2** shows a group comparison of shoulder function and patient-reported outcomes. Shoulder ROMs in all assessed directions were significantly more restricted in FS than in SIS. Total NDI and NDI sub-item scores showed no difference between SIS and FS patient groups.

Because shoulder joint symptoms could affect the NDI, all patients were divided into two groups based on the presence or absence of neck pain, and all NDI subitems were compared between them. As shown in **Fig. 2**, items with no significant differences between groups (e.g., headaches, work, sleep) may be influenced by shoulder symptoms rather than neck pain. For the groups with and without neck pain, shoulder pain was 56.9±26.4 and 53.2±28.9, and shoulder disability (quick-DASH) was 20.5±10.8 and 20.5±12.5, respectively, with no significant difference between them.

Prevalence of Neck Pain

The 4-week prevalence of neck pain was 12 out of 20 (60%) in SIS, 13 out of 21 (62%) in FS, and 25 out of 41 (61%) in total. There was no significant difference in neck pain prevalence between the two patient groups.

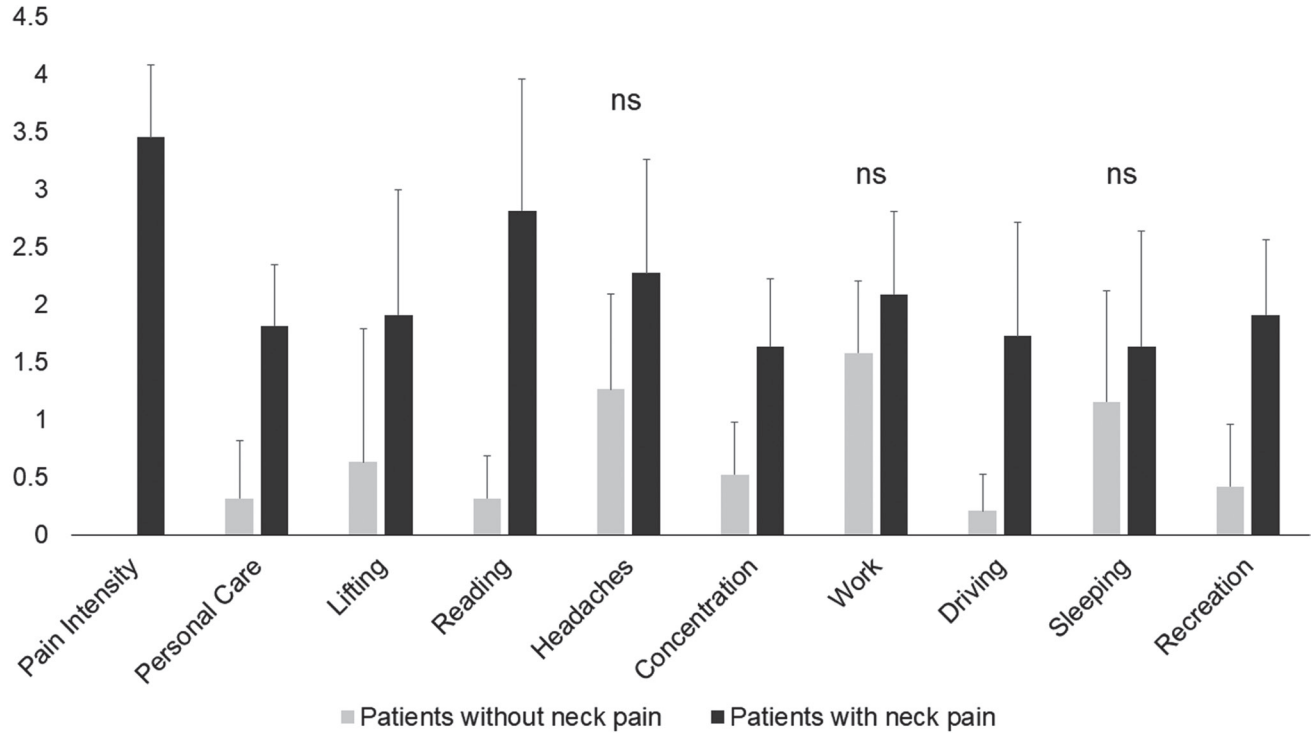

Fig. 2. Comparison of Neck Disability Index sub-items between shoulder disorder patients with neck pain (black bars) and those without neck pain (grey bars). All items except for Headaches, Work, and Sleeping were significantly higher in the group with neck pain ($P<0.01$; ns, not significant).

Relationship between NDI and Shoulder Functions

Table 3 shows the correlation coefficient between NDI and other variables stratified by diagnostic group. Strength in scapular plane abduction and quick-DASH were significantly correlated with NDI in patients with SIS, whereas all shoulder function and quick-DASH scores were not correlated with NDI in patients with FS. For pain catastrophizing, the components of rumination and helplessness and the total PCS were positively correlated with NDI in patients with FS.

DISCUSSION

The present study investigated the prevalence of neck pain in patients with SIS and FS and analyzed the association of NDI with shoulder dysfunction and psychosocial factors in study participants diagnosed with SIS and FS. The demographic data in **Table 1** show that the groups were controlled for such variables. To our knowledge, this is the first study to assess the prevalence of neck pain in patients with shoulder disorders.

A previous study using random Internet-based interviews of the general population found a very high 4-week prevalence of neck pain at 37.8%, with 24.2% of these cases reporting interference with daily activities.[23] The current study found the 4-week prevalence of neck pain in shoulder disorders to be even higher at 61% (25 of 41 patients), where 68% (17 of 25 patients) of these cases reported an NDI greater than 15%, which is the cut-off value for predicting neck pain with disability. However, because factors unrelated to neck pain, such as headaches and sleep disturbances, can be affected by shoulder symptoms, it may not be appropriate to apply general population cutoff data for NDI in this context. Nevertheless, the absence of significant differences in shoulder symptoms between the groups with and without neck pain, along with the significant differences in NDI items directly related to neck pain, suggest that these items correctly reflect the severity of neck disability. Our findings, showing a high prevalence of neck disability in patients with shoulder disorders, emphasize the necessity for a thorough screening process for neck issues, as well as the development of a comprehensive treatment plan for patients presenting with shoulder disorders.

We found that the severity of neck disability is associated

Table 3. Spearman's correlation coefficient between the Neck Disability Index and other outcomes stratified by diagnostic group

	Neck Disability Index		
	SIS (n=20)	FS (n=21)	All (n=41)
Shoulder ROM			
Flexion	0.20	0.34	0.19
External rotation	0.09	0.28	0.24
Hand behind the back	0.38	0.19	0.21
Shoulder strength			
Scapular plane abduction	−0.51*	−0.04	−0.21
External rotation	−0.32	0.17	−0.08
Internal rotation	−0.04	−0.12	−0.09
Patient reported outcome			
Quick-DASH	0.46*	0.01	0.16
Shoulder pain	0.07	0.10	0.17
PCS			
Total	0.27	0.43*	0.28*
Rumination	0.25	0.44*	0.35*
Helplessness	0.00	0.40*	0.20
Magnification	0.08	0.21	0.17
Symptom duration	−0.03	−0.18	−0.11

* $P<0.05$.

with weakened shoulder abduction strength in patients with SIS. Conversely, a relationship between shoulder function and neck disability was not observed in FS group; instead, the PCS score, particularly in rumination and helplessness, of patients with FS was associated with neck disability. The rumination part of PCS consists of the questions focused on the individual's tendency to repeatedly think about the pain, whereas the helplessness part of PCS reflects the individual's perception that they have no control over their pain or the situation.[12] These aspects should be considered for treatment of concomitant neck pain in patients with FS.

Contrary to our hypothesis, the severity of neck disability did not differ between the two groups, despite differences in shoulder ROM and quick-DASH score. These results suggest that while both patients with SIS and FS require treatment for neck disability, therapeutic approaches should differ between these conditions. The difference in the factors impacting neck disability in the SIS and FS groups may be related to differences in upper extremity activity levels. Although neck disability can be caused by upper trapezius overactivity associated with compensatory movements for shoulder dysfunction in both groups, the frequency of such movements may have decreased in FS patients. Many patients with FS are limited in their basic daily activities, such as washing hair, dressing, and opening doors, because of ROM restrictions.[11] However, as suggested by the significant differences in quick-DASH scores and ROM values, the upper limb is used more frequently in patients with SIS than in patients with FS in activities of daily living. The relationship between shoulder function and neck disability may not have been observed in patients with FS because of reduced use of upper limbs.

The findings of this study suggest that shoulder abduction strength training can improve concomitant neck disability in patients with SIS. Weakened shoulder abduction can indicate rotator cuff dysfunction,[25] and it can cause upper trapezius overactivity. In addition to training rotator cuff muscles, training the lower trapezius and serratus anterior muscles can improve upper trapezius overactivity.[10,26] Although there is wide variation in the protocols for exercise interventions for SIS, such interventions are effective in a dose-responsive manner.[27] Therefore, it is crucial to gradually increase the load according to the abilities and symptoms of each patient.

In patients with FS, neck disability was associated with the PCS score and was not associated with shoulder function. We believe that upper limb disuse is a risk factor for concomitant neck disability in patients with FS. Previous studies have shown that less physical activity negatively

affects not only muscle activity but also the PCS score.[28] In addition, physical treatments, including aerobic, strength, and endurance training, can improve PCS scores to levels that are similar to those obtained using cognitive-behavioral treatments.[29] Therefore, low-impact, whole-body exercise, such as walking, may be recommended to treat concomitant neck disability in patients with FS. Further studies are required to better understand the pathology of neck disability in patients with FS, including the evaluation of upper limb use and lifestyle considerations.

The current study has several limitations. First, we could not use electromyography or cervical imaging, which are strong diagnostic tools, to exclude patients with cervical radiculopathy, although the special tests we used in this study have a known sensitivity and specificity.[21,22] Second, we did not investigate the effects of comorbidities or lifestyle factors. Previous studies have indicated that exercise and sleeping habits are related to the NDI,[23] and participant's occupation may affect the PCS score. Third, because this study focused on investigating the relationship between shoulder joint disorders and neck disability, another study is required to discuss the intensity of neck pain in more detail.

CONCLUSION

This study revealed that primary shoulder disorders (SIS and FS) have a high neck pain prevalence. In addition, the factors associated with neck disability appear to differ between patients with SIS and those with FS. Our results highlighted that neck disability is a critical problem in shoulder disorders and treatment strategies should be tailored to each condition.

ACKNOWLEDGMENTS

The authors are grateful to the participants of this study. We also thank the medical staff of the Hospital of East Japan Railway Company for their ongoing support in this study. We thank Editage (www.editage.jp) for English language editing.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Nakamura M, Toyama Y, Nishiwaki Y, Ushida T: Prevalence and characteristics of chronic musculoskeletal pain in Japan. J Orthop Sci 2011;16:424–432. https://doi.org/10.1007/s00776-011-0102-y, PMID:21678085
2. Holtermann A, Hansen JV, Burr H, Søgaard K: Prognostic factors for long-term sickness absence among employees with neck–shoulder and low-back pain. Scand J Work Environ Health 2010;36:34–41. https://doi.org/10.5271/sjweh.2883, PMID:19967326
3. Blanpied PR, Gross AR, Elliott JM, Devaney LL, Clewley D, Walton DM, Sparks C, Robertson EK. Neck pain: revision 2017: clinical practice guidelines linked to the international classification of functioning, disability and health from the orthopaedic section of the American Physical Therapy Association. J Orthop Sports Phys Ther 2017;47:A1–A83. https://doi.org/10.2519/jospt.2017.0302, PMID:28666405
4. Katsuura Y, Bruce J, Taylor S, Gullota L, Kim HJ: Overlapping, masquerading, and causative cervical spine and shoulder pathology: a systematic review. Global Spine J 2020;10:195–208. https://doi.org/10.1177/2192568218822536, PMID:32206519
5. Iyer S, Kim HJ: Cervical radiculopathy. Curr Rev Musculoskelet Med 2016;9:272–280. https://doi.org/10.1007/s12178-016-9349-4, PMID:27250042
6. Jimbo S, Atsuta Y, Kobayashi T, Matsuno T: Effects of dry needling at tender points for neck pain (Japanese: katakori): near-infrared spectroscopy for monitoring muscular oxygenation of the trapezius. J Orthop Sci 2008;13:101–106. https://doi.org/10.1007/s00776-007-1209-z, PMID:18392913
7. Szeto GPY, Straker LM, O'Sullivan PB: Neck–shoulder muscle activity in general and task-specific resting postures of symptomatic computer users with chronic neck pain. Man Ther 2009;14:338–345. https://doi.org/10.1016/j.math.2008.05.001, PMID:18606558
8. Lin JJ, Wu YT, Wang SF, Chen SY: Trapezius muscle imbalance in individuals suffering from frozen shoulder syndrome. Clin Rheumatol 2005;24:569–575. https://doi.org/10.1007/s10067-005-1105-x, PMID:15902524
9. Chester R, Smith TO, Hooper L, Dixon J: The impact of subacromial impingement syndrome on muscle activity patterns of the shoulder complex: a systematic review of electromyographic studies. BMC Musculoskelet Disord 2010;11:45. https://doi.org/10.1186/1471-2474-11-45, PMID:20214817

10. Ludewig PM, Hoff MS, Osowski EE, Meschke SA, Rundquist PJ: Relative balance of serratus anterior and upper trapezius muscle activity during push-up exercises. Am J Sports Med 2004;32:484–493. https://doi.org/10.1177/0363546503258911, PMID:14977678
11. Jones S, Hanchard N, Hamilton S, Rangan A: A qualitative study of patients' perceptions and priorities when living with primary frozen shoulder. BMJ Open 2013;3:e003452. https://doi.org/10.1136/bmjopen-2013-003452, PMID:24078753
12. Hirata J, Tomiyama M, Koike Y, Yoshimura M, Inoue K: Relationship between pain intensity, pain catastrophizing, and self-efficacy in patients with frozen shoulder: a cross-sectional study. J Orthop Surg Res 2021;16:542. https://doi.org/10.1186/s13018-021-02693-y, PMID:34470634
13. Park SJ, Lee R, Yoon DM, Yoon KB, Kim K, Kim SH: Factors associated with increased risk for pain catastrophizing in patients with chronic neck pain: a retrospective cross-sectional study. Medicine (Baltimore) 2016;95:e4698. https://doi.org/10.1097/MD.0000000000004698, PMID:27631217
14. Burns LC, Ritvo SE, Ferguson MK, Clark H, Seltzer Z, Katz J: Pain catastrophizing as a risk factor for chronic pain after total knee arthroplasty: a systematic review. J Pain Res 2015;8:21–32.
15. Keogh E, Book K, Thomas J, Giddins G, Eccleston C: Predicting pain and disability in patients with hand fractures: comparing pain anxiety, anxiety sensitivity and pain catastrophizing. Eur J Pain 2010;14:446–451. https://doi.org/10.1016/j.ejpain.2009.08.001, PMID:19729326
16. Ryan V, Brown H, Minns Lowe CJ, Lewis JS: The pathophysiology associated with primary (idiopathic) frozen shoulder: a systematic review. BMC Musculoskelet Disord 2016;17:340. https://doi.org/10.1186/s12891-016-1190-9, PMID:27527912
17. Rangan A, Brealey SD, Keding A, Corbacho B, Northgraves M, Kottam L, Goodchild L, Srikesavan C, Rex S, Charalambous CP, Hanchard N, Armstrong A, Brooksbank A, Carr A, Cooper C, Dias JJ, Donnelly I, Hewitt C, Lamb SE, McDaid C, Richardson G, Rodgers S, Sharp E, Spencer S, Torgerson D, Toye F, UK FROST Study Group: Management of adults with primary frozen shoulder in secondary care (UK FROST): a multicentre, pragmatic, three-arm, superiority randomised clinical trial. Lancet 2020;396:977–989. https://doi.org/10.1016/S0140-6736(20)31965-6, PMID:33010843
18. Witten A, Mikkelsen K, Wagenblast Mayntzhusen T, Clausen MB, Thorborg K, Hölmich P, Barfod KW: Terminology and diagnostic criteria used in studies investigating patients with subacromial pain syndrome from 1972 to 2019: a scoping review. Br J Sports Med 2023;57:864–871. https://doi.org/10.1136/bjsports-2022-106340, PMID:36813537
19. Alqunaee M, Galvin R, Fahey T: Diagnostic accuracy of clinical tests for subacromial impingement syndrome: a systematic review and meta-analysis. Arch Phys Med Rehabil 2012;93:229–236. https://doi.org/10.1016/j.apmr.2011.08.035, PMID:22289231
20. Farley TE, Neumann CH, Steinbach LS, Jahnke AJ, Petersen SS: Full-thickness tears of the rotator cuff of the shoulder: diagnosis with MR imaging. AJR Am J Roentgenol 1992;158:347–351. https://doi.org/10.2214/ajr.158.2.1729796, PMID:1729796
21. Tong HC, Haig AJ, Yamakawa K: The Spurling test and cervical radiculopathy. Spine 2002;27:156–159.
22. Gumina S, Carbone S, Albino P, Gurzi M, Postacchini F: Arm Squeeze Test: a new clinical test to distinguish neck from shoulder pain. Eur Spine J 2013;22:1558–1563. https://doi.org/10.1007/s00586-013-2788-3, PMID:23604976
23. Kato S, Takeshita K, Matsudaira K, Tonosu J, Hara N, Chikuda H: Normative score and cut-off value of the Neck Disability Index. J Orthop Sci 2012;17:687–693. https://doi.org/10.1007/s00776-012-0276-y, PMID:22895822
24. Sullivan MJ, Bishop SR, Pivik J: The Pain Catastrophizing Scale: development and validation. Psychol Assess 1995;7:524–532. https://doi.org/10.1037/1040-3590.7.4.524

25. Sgroi M, Loitsch T, Reichel H, Kappe T: Diagnostic value of clinical tests for supraspinatus tendon tears. Arthroscopy 2018;34:2326–2333. https://doi.org/10.1016/j.arthro.2018.03.030, PMID:29802066
26. Smith M, Sparkes V, Busse M, Enright S: Upper and lower trapezius muscle activity in subjects with subacromial impingement symptoms: is there imbalance and can taping change it? Phys Ther Sport 2009;10:45–50. https://doi.org/10.1016/j.ptsp.2008.12.002, PMID:19376471
27. Østerås H, Torstensen TA, Haugerud L, Østerås BS: Dose–response effects of graded therapeutic exercises in patients with long-standing subacromial pain. Adv Physiother 2009;11:199–209. https://doi.org/10.3109/14038190802239729
28. Zhaoyang R, Martire LM, Darnall BD: Daily pain catastrophizing predicts less physical activity and more sedentary behavior in older adults with osteoarthritis. Pain 2020;161:2603–2610. https://doi.org/10.1097/j.pain.0000000000001959, PMID:32569091
29. Smeets RJ, Vlaeyen JW, Kester AD, Knottnerus JA: Reduction of pain catastrophizing mediates the outcome of both physical and cognitive-behavioral treatment in chronic low back pain. J Pain 2006;7:261–271. https://doi.org/10.1016/j.jpain.2005.10.011, PMID:16618470