

Self-reported sinus headaches are associated with neck pain and cervical musculoskeletal dysfunction: a preliminary observational case control study

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ABSTRACT

Objectives: Headaches can be associated with rhinosinusitis and may present a diagnostic challenge because of symptomatic overlap with other recurring headaches. Neck pain has received extensive attention in migraine, tension-type and cervicogenic headache but not as a comorbid feature of headache in those with rhinosinusitis. This study investigated the occurrence of neck pain and cervical musculoskeletal dysfunction in individuals with self-reported sinus headaches (SRSH).

Methods: Participants with and without SRSH attended a single data collection session. Participants completed the Headache Impact Test (HIT)-6 and the Sino-Nasal Outcome Test (SNOT)-22. Cervical range of motion (ROM), segmental examination, muscle endurance and pressure-pain threshold (PPT) were measured.

Results: Participants included 31 with SRSH (77.4% female; age 43.7 (9.9) years) and 30 without headache. Average symptom duration was 89.7 (± 85.6) months. Mean SNOT-22 and HIT-6 scores were 36.2 (15.3) and 56.7 (7.1), respectively. In the SRSH group, 83.9% ($n = 26$) reported neck pain. There was a significant difference between groups for cervical sagittal (14.3° [5.3° , 23.3°], $p = 0.002$) and transverse plane ROM (21.5° [12.4° , 30.6°], $p < 0.001$), but no difference in frontal plane motion ($p = 0.017$). There were significant between groups difference in neck flexor endurance (19.5 s [10.1 s, 28.9 s], <0.001), segmental dysfunction O-C4 ($p < 0.001$) but not in PPT ($p = 0.04$).

Discussion: Neck pain and cervical musculoskeletal dysfunction are common among persons with SRSH and may be a comorbid feature or contributing factor to headaches attributed to rhinosinusitis. Further research is needed to understand these associations.

KEYWORDS

Sinus; rhinosinusitis; headache; neck pain; range of motion; muscle strength

Introduction

Rhinosinusitis is defined by the Sinus and Allergy Health Partnership Task Force as ‘... a group of disorders characterized by inflammation of the mucosa of the nose and paranasal sinuses’ [1]. One symptom of disorders of the nose or paranasal sinuses is headache, and headaches attributed to both acute and chronic rhinosinusitis have been classified by The International Classification of Headache Disorders (ICHD-3) [2]. Other major characteristics of chronic rhinosinusitis include facial pain/pressure, facial congestion/fullness, nasal obstruction/blockage, nasal discharge/drainage and hyposmia/anosmia [3,4].

Differential diagnosis of benign recurrent headaches can be challenging. Symptoms often overlap reflecting common pathways in the trigeminal system. The diagnosis of sinus headaches whether by a physician or self-diagnosis, is often given erroneously to people who actually have migraine or tension-type headaches [5–9]. This is a concern in that people who misdiagnose themselves seek over-the-counter remedies that may not be appropriate.

Potential reasons for misdiagnosis include patients with migraine reporting typical symptoms of rhinosinusitis such as nasal symptoms including congestion, rhinorrhea or ocular lacrimation, attributed to the trigeminal-autonomic reflex [5,6]. Symptoms that appear rhinosinusitis-related such as facial pain and pressure can also be reported by patients with tension-type headache [6,9]. Neck pain is another common symptom which overlaps benign recurrent headache types and presents in 60–80% of persons with migraine and tension-type headache [10–12], reflecting the convergence of upper cervical and trigeminal sensory pathways in the trigeminocervical nucleus. There is a bidirectional interaction, meaning that the neck pain associated with, for example, migraine may either be part of the headache symptomology or may be a local symptom of comorbid cervical musculoskeletal dysfunction [11,13,14]. Clinical observation suggests that neck pain is common in patients with self-diagnosed or physician-diagnosed sinus headaches. Whether this neck pain is associated with neck

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dysfunction or is a comorbid feature of sinus headache has not been investigated.

This study was conducted to determine the occurrence of neck pain and cervical musculoskeletal signs and symptoms in individuals with self-reported sinus headaches (SRSH). We recruited from the community which could include participants with either self-diagnosed or physician diagnosed sinus headaches as misdiagnosis can occur with both methods [5–9]. Since headaches and neck pain are conditions examined and treated by physical therapists, understanding the relationship between any neck pain accompanying sinus headaches and cervical dysfunction has implications for overall management of this condition, including potential physical therapy implications. This may be particularly true for patients self-referring to physical therapy who may not recognize the neck as a possible cause or contributing factor to their headaches. Specifically, the purpose of this study was to determine if individuals with SRSH reported neck pain and demonstrated any cervical musculoskeletal dysfunction defined here as reduced neck range of movement, reduced muscle function and painful cervical segmental joint dysfunction as typify a neck pain disorder.

Methods

Study design

This was an observational case control study. Data were collected in a university clinical research laboratory. Participants attended one data collection session during which those with SRSH completed questionnaires about their headaches. All participants underwent a physical examination of the cervical region by a physical therapist blinded to their headache or

nonheadache status. Ethical clearance was gained from the Institutional Review Board. Each participant was informed of the purpose and procedures of the study and provided written informed consent.

Participants

Male and female participants aged between 18 and 55 years were recruited from the community through local advertisements. This age span limits the confounder of age-related cervical spondylosis and has been used in previous investigations of musculoskeletal impairment in recurrent headaches [15,16]. Participants with SRSH and healthy individuals of similar age and gender were recruited. Participants with self-diagnosis or self-report of physician diagnosis were recruited in accordance with previous investigations of headache symptomatic overlap in individuals with sinus headaches [5–9] where similar diagnostic accuracy or misdiagnosis was found between diagnostic methods. Recruiting participants with self-diagnosis or self-report of physician diagnosis also ensured timely recruitment for the study. A research assistant screened individuals for inclusion and exclusion criteria (Figure 1). For inclusion in the SRSH group, participants were required to have a minimum of six sinus headaches during the prior 6 months. They were excluded if they had a history of surgery to the cervical spine, a whiplash injury within the past 5 years, or any persistent symptoms directly attributable to a whiplash-associated disorder. Furthermore, they were excluded if they reported any headache types, other than sinus headache, with exception of an occasional, mild headache for which they had not sought medical care. Participants for the nonheadache group (NHA) were

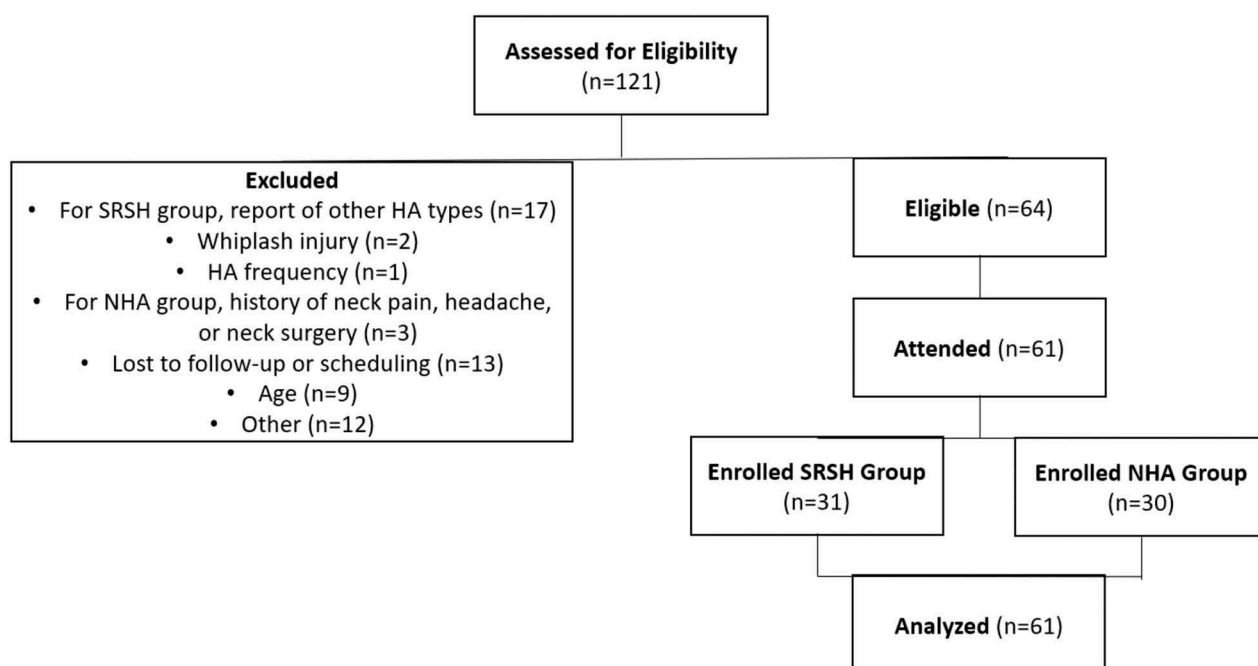


Figure 1. Flow diagram of participant enrollment.

excluded if they reported any history of neck pain or headaches for which they had sought medical care. All participants who were enrolled in the study were offered financial compensation for their time.

Questionnaires

Participants in the SRS group completed the Headache Impact Test (HIT6), and the Sino-Nasal Outcome Test (SNOT-22). They answered questions about headache characteristics including headache duration and the presence of associated neck pain. The HIT-6 is a six-item questionnaire designed to assess the negative impact of headaches on quality of life. The score range is 36–78 with scores of 36–49 indicating little-to-no impact, scores 50–55 moderate impact, scores 56–59 substantial impact and scores 60–78 severe impact. It is a reliable and valid tool, with previous reports of ICC = 0.77 for patients with migraines [17]. The SNOT-22 is a quality of life questionnaire developed for patients with rhinosinusitis. It consists of 22 items each rated on a 0–5 scale where a score of 8–20 is regarded as a mild impact, 21–50 as a moderate impact and >50 as a severe impact [18]. The SNOT-22 is a valid and reliable tool (Chronbach's alpha 0.91; test-re-test reliability coefficient 0.93) [19]. It also has the ability to discriminate between those with known rhinosinusitis and healthy controls as it includes questions on the major and minor factors associated with a diagnosis of chronic rhinosinusitis [3] (with the exception halitosis and dental pain). Thus, in addition to data on the impact of SRS, responses were examined to determine if they were consistent with these rhinosinusitis criteria. This required the presence of at least two major factors or the presence of one major and at least two minor factors with or without the findings of a physical examination [3]. While current Otolaryngology guidelines recommend the physical examination of nasal endoscopy as part of the diagnostic work up [20], it was not undertaken in this study of persons with SRS.

A research assistant administered all questionnaires. The examiner performing the physical examination tests and measures was blind to the results of the questionnaires and was blind to the headache or nonheadache status of participants. The sequence of tests and measures was randomized between participants to decrease the possibility of any cumulative effect a set order of testing might have.

Tests and measures

Tests of cervical joint and muscle function were conducted. Pressure pain thresholds were also tested over the cervical spine as they have been shown to correlate to pain-disability in patients with neck pain

[21]. Participants were familiarized and practiced the tests before measurements were taken.

Active range of motion (ROM)

Active cervical ROM was measured in each primary plane of movement using a Cervical Range of Motion Device (CROM). This device has good reliability in measurement of neck ROM [22]. Participants were seated in a chair and were asked to move their head and neck as far as possible into cervical flexion, extension and lateral flexion and rotation both to the left and the right. Two trials were performed, and the average was used in analysis.

Manual segmental joint examination

The examiner performed a clinical manual examination to detect cervical segmental pain and dysfunction according to the Maitland approach [23]. A posteroanterior oscillatory pressure was applied over each cervical segment to assess tissue resistance to joint displacement and pain provocation. A joint was rated as symptomatic if it met both of the following criteria: (1) the examiner graded the quality of resistance as 'moderate' or 'marked' on a four-point scale (Normal, Slight, Moderate, Marked Resistance) and (2) the participant rated local or referred pain provoked as >2 on a 0–10 Numeric Rating Scale. Combining examiner assessment and patient report has been previously used and found to be reliable for segmental examination in patients with neck pain and headaches [10,24,25].

Neck flexor muscle endurance

The neck flexor muscle test was conducted according to Harris et al. [26]. Participants were supine in the hook-lying position. They first flexed their chin toward their throat (i.e. a craniocervical flexion position) and while maintaining this position, lifted their head until the back of the head was about 1 inch from the surface. They were asked to maintain this combination of craniocervical and cervical flexion. The examiner placed their hand on the supporting table, just below the participant's occiput and as well monitored anterior skin folds in the neck. The test was terminated if the participant's occiput touched the examiner's hand for greater than 1 s (loss of the cervical flexion position), or if separation of neck skin folds occurred due to loss of the craniocervical position. The number of seconds the participant maintained the test position was recorded. This test has reliability and construct validity [26,27].

Pressure-pain threshold (PPT)

PPTs were examined bilaterally over the posterior cervical spine just lateral to the spinous process of C2 using a hand-held algometer with a 1 cm² probe (JTECH Medical, Salt Lake City, UT, USA). Participants

pressed a hand switch to indicate the moment they perceived the pressure of their neck as pain. Two trials were conducted, and the average was used in analysis; if there was a 15% or greater discrepancy between the trials a third was conducted.

Sample size

Reduced neck ROM is a feature associated with neck pain disorders. Reduced neck ROM is also a criterion for diagnosis of cervicogenic headaches which are headaches associated with disorders of the neck [2]. Since there are no previous investigations of neck ROM in people with SRSH, the estimate of sample size for this study was based on cervical rotation ROM in participants with and without cervicogenic headaches as documented by Zwart [28] with an effect size of 1.06. The effect size of SRSH versus NHA was conservatively assumed to be 75% of that of cervicogenic headaches versus control, which means an effect size of 0.8. Assuming an effect size of 0.8 for ROM, 25 participants per group (total of 50 participants) were needed to achieve 80% power to show the difference between the two groups (SRSH and NHA) at 5% significance level. The estimated size was increased by 20% to account for potential participant loss after initial screen, bringing our target to a total sample size of 60 participants.

Data reduction

ROM values were recorded for planar movement. Both left and right rotation, left and right side flexion and cervical flexion and extension values were summed to represent total transverse, frontal and sagittal plane motion, respectively. Analyzing data as planar movements allows the measured value of each participant to impact the overall value regardless of the side of headache or the direction of dysfunction.

Statistical methods

Each variable was analyzed for assumptions of parametric statistics. Data analysis included descriptive statistics and correlations for relationships between headache classification and classification of cervical

segmental dysfunction. Between group differences were analyzed, with independent samples t-tests for age and Pearson chi-square (χ^2) for sex. Scores for HIT, SNOT-22, symptom duration and neck pain, were reported for the SRSH group. Cervical ROM for transverse, frontal and sagittal planes were compared between groups with independent t-tests as were PPT and cervical flexion endurance outcomes. Manual segmental examination results for each cervical level and an occiput to C4 composite variable was examined by group using Fisher exact tests. A Bonferroni correction was performed to accommodate the high number of comparisons performed $\alpha = 0.003$. All analyses were performed on SPSS 24 (IBM, Armonk, NY).

Results

One hundred and twenty-one potential participants were screened for eligibility; 57 were excluded as they did not fulfill the inclusion/exclusion criteria; 64 were confirmed eligible to participate; 61 (31 with SRSH and 30 NHA) attended the data collection session and were included in the analysis.

Table 1 presents participant demographics for the SRSH and NHA groups and duration of headache history, presence of neck pain and outcomes of questionnaires for the SRSH group. Table 2 presents the frequency with which participants with SRSH reported each major and minor feature of chronic rhinosinusitis according to the factors appearing on the SNOT-22 [3,19]. Of the participants with SRSH, 30 (96.8%) reported symptoms which met the criteria for diagnosis of chronic rhinosinusitis (at least two major factors or one major and at least two minor factors). Table 3 presents neck pain behavior and headache location for subjects in the SRSH group.

Between group differences

There were no statistically significant differences between groups for age or gender (Table 1). With the correction for potentially inflated type I error rate, there were no significant differences between groups for frontal plane ROM ($p = 0.02$), but there were significant differences for sagittal (14.3° [5.3° , 23.2°], $p = 0.002$)

Table 1. Participant demographics for the self-reported sinus headache (SRSH) and nonheadache (NHA) groups. Headache duration, neck pain and disability scores for SRSH group.

	SRSH group ($n = 31$)	NHA group ($n = 30$)	p value
Age mean (SD),	34.7 (9.9)	34.7 (10.6)	0.99
Gender	Female (77.4%)	Female (76.7%)	0.94
History of headache mean (SD) (mths)	89.7 (85.6)	N/A	N/A
Number of headaches per month	3.7 (3.8)	N/A	N/A
Neck pain with headache	26 (83.9%)	N/A	N/A
SNOT-22 mean (SD)	36.2 (15.3)	N/A	N/A
HIT mean (SD)	56.7 (7.1)	N/A	N/A

Abbreviations: SRSH, self-reported sinus headache; NHA, nonheadache; mths, months; SNOT-22, Sino Nasal Outcome Test; HIT, Headache Impact Test.

Table 2. The frequency with which each major and minor factor (adapted from Lanza [3]) on the SNOT was reported by participants in the self-reported sinus headache group (SRSH). Thirty of 31 SRSH participants (96.8%) met the diagnostic criteria for chronic rhinosinusitis: at least two major factors or one major and at least two minor factors.

Major and minor factors associated with chronic rhinosinusitis		SRSH participants (n = 31)
Major factors	Facial pain/pressure	28 (90.3%)
	*Congestion/fullness	26 (83.9%)
	Nasal obstruction/blockage	27 (87.1%)
	Nasal discharge/runny nose	28 (90.3%)
	Hyposmia	17 (54.8%)
Minor factors	Headache	31 (100%)
	Fatigue	28 (90.3%)
	Cough	16 (51.6%)
	Ear pain/pressure	19 (61.3%)

*This number is based on the SNOT item 'Need to blow nose'.

Table 3. Neck pain behavior and headache location for subjects in the self-reported sinus headache group (SRSH).

Neck pain behavior	SRSH participants
Neck pain associated with headaches	26 (83.9%)
Neck pain spreads to head	21 (67.7%)
Headache worsens with neck movements or postures	23 (74.8%)
Headache location	
Unilateral changes sides	10 (32.3%)
Unilateral consistent side	8 (25.8%)
Bilateral	13 (41.9%)

and transverse plane motion (21.5° [12.4°, 30.6°], *p* < 0.001). There was a significant difference between groups for cervical flexor muscle endurance (19.5 s [10.1 s, 28.9 s], *p* < 0.001) but no significant difference between groups for PPT (*p* = .04) (Table 4).

There was a moderate and significant correlation between SRSH and segmental dysfunction in the upper four cervical segments (C0-4) (Spearman's rho 0.591, *p* < 0.001). Painful segmental dysfunction was present in at least one of the upper four segments (C0-4) in 21 of 31 SRSH participants (67.7%) whereas only 3 of 30 NHA participants (10%) demonstrated dysfunction (Table 4). Fourteen of 31 SRSH participants compared to one NHA participant had two or more symptomatic segments in this region. Findings of segmental dysfunction in the lower cervical region

Table 4. Outcomes for physical measures for the self-reported sinus headache (SRSH) and nonheadache (NHA) groups.

	SRSH group (n = 31) mean (SD)	NHA group (n = 30) mean (SD)	<i>p</i> value
Flexor muscle endurance (s)	20.4 (10.9)	39.9 (23.1)	<0.001
Cervical ROM (°)			
Sagittal plane (Flexion, extension)	116.5 (19.8)	130.8 (14.9)	0.002
Transverse plane (Rotation)	124.4 (21.9)	145.9 (12.1)	<0.001
Frontal (Lateral Flexion)	89.9 (20.9)	100.5 (11.5)	0.017
Segmental joint dysfunction (0-4)	21/30	3/30	<0.001
O-C1	5/31	0/30	0.053
C1-2	13/31	1/30	<0.001
C2-3	14/31	2/30	0.001
C3-4	6/31	1/30	0.10
PPT (lbs)	22.8 (6.9)	27.5 (10.5)	0.043

Abbreviations: SD, standard deviation; PPT, pressure pain threshold; ROM, range of motion

(C4-T1) were negligible with a single incidence in both the headache and NHA groups.

Discussion

Neck pain is a common symptom accompanying benign recurrent headaches such as migraine and tension-type headache and is reported in 60–80% of persons with these headache types [10–12]. This study determined a similar incidence of the complaint of neck pain in persons with SRSH with 84% of them reporting neck pain. It is important from the perspectives of diagnosis and delivering appropriate treatment, to determine whether this neck pain is part of the symptom complex of the sinus headaches or whether it has a local cause in cervical musculoskeletal dysfunction [14]. For this reason, we investigated the presence of cervical joint, movement and muscle dysfunction in the SRSH participants compared to NHA participants with no headache or neck pain.

This study determined that the persons with SRSH demonstrated impaired neck function demonstrating less neck flexor muscle endurance, less ROM in the sagittal and transverse planes and a greater frequency of painful segmental dysfunction in the upper cervical region. These findings suggest that the neck pain accompanying the SRSH in the participants in this study was probably related to local neck dysfunction. The musculoskeletal impairments found in this study are all impairments commonly identified and treated by physical therapists in patients with neck pain; however, they have not been previously identified in patients with SRSH. Of relevance, painful upper cervical joint dysfunction is a key criterion for the diagnosis of cervicogenic headache, a headache arising from a local cervical musculoskeletal disorder, according to the IHS and according to Sjaastad et al. [2,29]. In this study, 68% of the SRSH participants presented with upper cervical joint dysfunction which would fit a musculoskeletal picture for associated neck pain. However 84% of participants reported neck pain with headache, which could indicate that in nearly 20% of cases, the neck pain might be part of the headache

symptom complex rather than reflect a local cervical cause [14].

It is not possible from this study to speculate on whether this cervical musculoskeletal dysfunction is an incidental comorbid feature of sinus headaches, a secondary consequence of a sinus headache pain syndrome or represents the presence of a mixed or coexisting headache type. Nor is it possible to speculate on how or whether any pain from the neck dysfunction is contributing to sinus headache pain. Neck sensitivity (PPTs) was not more apparent in the SRS group compared to the NHA group. However, the outcomes of this study do point to the need for further research to explore the incidence and nature of neck pain and cervical musculoskeletal dysfunction in SRS as well as in physician-diagnosed headaches attributed to rhinosinusitis to confirm or refute the relationships potentially determined in this study. Additional investigation is required into the relationship between musculoskeletal impairments and SRS before knowing if intervention trials that include treatment of the neck pain and dysfunction could be justified. It can be argued that optimal management of persons with SRS is warranted as they may have a moderate to substantial impact on quality of life as demonstrated in this study by the SNOT-22 and HIT-6 scores, respectively [18]. Such treatment might include treatment of the neck if it is determined the neck is a contributing factor to the headaches.

This study has limitations. Inclusion was based on SRS either through previous physician diagnosis or self-diagnosis. Although a limitation to the study, misdiagnosis involving sinus headaches can occur with either physician or self-diagnosis [5–9]. We used surrogate methods to supplement self-report. All but one participant in the SRS group met the criteria for diagnosis of chronic rhinosinusitis based on major and minor factors utilized in previous investigations [3,7,30]. Although a quality of life measure and not intended for diagnosis, all participants in the SRS group also had SNOT-22 scores consistent with a diagnosis of rhinosinusitis based on recommended reference values [31,32]. Nevertheless, the results of this study cannot be generalized to all patients with SRS and future studies should include subjects with physician-diagnosed headaches on both symptomatic criteria and physical confirmation of rhinosinusitis by nasal endoscopy [2,20]. Future research could investigate the temporal pattern of neck pain in respect of the temporal pattern of sinus headache as well as have a better understanding of the nature and behavior of the neck pain and its physical presentation.

Conclusion

This study determined that neck pain was a common complaint of persons with SRS and was associated

with local cervical musculoskeletal dysfunction in most cases. The findings suggest that neck dysfunction may be a comorbid or contributing factor. Future research should examine the neck in patients with physician-diagnosed headaches attributed to rhinosinusitis based on diagnostic criteria and investigate more deeply the nature and behavior of the neck pain as well, as that may contribute to neck dysfunction in this population.

Acknowledgments

We would like to acknowledge Laura Burton, Daniel Larson and Christopher Postma for assistance with data collection.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Ethics approval

Ethical clearance was gained from the Des Moines University Institutional Review Board IRB-10-15-02.

Data availability statement

The data collected and analyzed during this study is available through the corresponding author upon reasonable request.

Funding

This work was supported by the Des Moines University Iowa Osteopathic Education Research and Grants under Grant 112-3126.

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