

# Therapy Options for Winged Scapula Patients: A Literature Review

2016

Samantha L. Normand  
*University of Central Florida*

Find similar works at: <http://stars.library.ucf.edu/honorsthesis>

University of Central Florida Libraries <http://library.ucf.edu>

 Part of the [Alternative and Complementary Medicine Commons](#), [Family Practice Nursing Commons](#), [Medical Anatomy Commons](#), [Medical Education Commons](#), [Medical Neurobiology Commons](#), [Musculoskeletal, Neural, and Ocular Physiology Commons](#), [Other Medicine and Health Sciences Commons](#), [Other Rehabilitation and Therapy Commons](#), [Physical Therapy Commons](#), and the [Sports Sciences Commons](#)

## Recommended Citation

Normand, Samantha L., "Therapy Options for Winged Scapula Patients: A Literature Review" (2016). *Honors in the Major Theses*. 78. <http://stars.library.ucf.edu/honorsthesis/78>

This Open Access is brought to you for free and open access by the UCF Theses and Dissertations at STARS. It has been accepted for inclusion in Honors in the Major Theses by an authorized administrator of STARS. For more information, please contact [lee.dotson@ucf.edu](mailto:lee.dotson@ucf.edu).

THERAPY OPTIONS FOR WINGED SCAPULA PATIENTS: A LITERATURE  
REVIEW

by

SAMANTHA L. NORMAND

A thesis submitted in partial fulfillment of the requirements  
for Honors in the Major Program in Nursing  
in the College of Nursing  
and in the Burnett Honors College  
at the University of Central Florida  
Orlando, FL

Summer Term, 2016

Thesis Chair: Dr. Joyce Burr

## **ABSTRACT**

Winged scapula is a condition characterized by lateral or medial protrusion of the scapula caused by nerve damage leading to muscular paralysis. The purpose of this systematic review of literature is to evaluate the current research literature related to the effectiveness of therapy options for winged scapula. Eleven peer reviewed English language research articles published from 1998 to present were included for evaluation. Study results revealed positive therapeutic outcomes for physical therapy and scapular bracing. Results also showed positive outcomes for the use of transcutaneous electrical nerve stimulation and acupuncture for the treatment of nerve related conditions similar to winged scapula. Additional research is needed to evaluate the effectiveness of transcutaneous electrical nerve stimulation and acupuncture for winged scapula patients specifically.

## **DEDICATIONS**

For Jaqueline Avery and Michael Normand for always encouraging and empowering me to strive for and achieve my goals.

For Alexander Howell who supports me throughout all of my endeavors.

## **ACKNOWLEDGEMENTS**

I would like to thank my committee members for their guidance and support which was key in the completion of this project. Dr. Joyce Burr, your knowledge and wisdom have been invaluable in the completion of this literature review. Thank you for all the opportunities that would not have been possible without your guidance.

## TABLE OF CONTENTS

List of Tables .....	vii
INTRODUCTION .....	1
BACKGROUND .....	3
PROBLEM .....	8
PURPOSE.....	10
METHOD .....	11
RESULTS .....	12
Physical Therapy.....	12
Scapular Bracing.....	15
Transcutaneous Electrical Nerve Stimulation.....	16
Acupuncture .....	18
DISCUSSION.....	26
Physical Therapy.....	26
Scapular Bracing.....	27
Transcutaneous Electrical Nerve Stimulation.....	28
Acupuncture .....	29

LIMITATIONS.....	31
IMPLICATIONS FOR NURSING.....	32
Nursing Research .....	32
Education .....	32
Nursing Practice .....	33
Conclusion .....	34
APPENDIX A: Figure 1: Flow Diagram of Study Selection .....	35
APPENDIX A: Figure 1: Flow Diagram of Study Selection .....	36
APPENDIX B: TABLE .....	38
APPENDIX B: TABLE .....	39
REFERENCES .....	46

## **List of Tables**

Table 1: TENS therapy outcomes (Koca et al., 2014).....	17
Table 2: Acupuncture therapy outcomes (Schroder et al., 2006) .....	20
Table 3: Electro-acupuncture baseline (Inoue et al., 2011).....	22
Table 4: Electro-acupuncture outcomes (Inoue et al., 2011).....	23

## INTRODUCTION

Winged scapula is a rare, and often misdiagnosed, condition characterized by either medial or lateral winging of the scapula (Roren et al., 2013). Winged scapula is an abnormality that results from idiopathic, iatrogenic, or traumatic causes, leading to weakening or paralysis of the serratus anterior, rhombus, or trapezius muscles, causing deviation from normal scapular function. The muscular dysfunction commonly occurs secondary to a lesion or injury to a nerve. The long thoracic nerve is the most prevalent site of injury, influencing the serratus anterior muscle, and causing medial winging (Roren et al., 2013). Lateral winging manifests from injury to the spinal accessory nerve disrupting the trapezius muscles, or from an injury to the dorsal scapular nerve affecting the rhombus muscles (Martin & Fish, 2008). Without damage to the long thoracic, spinal accessory or dorsal scapular nerves, scapular winging may also arise from continuous abnormal posture, repetitive movements that require a deviation from normal scapulohumoral rhythm, muscular imbalance, or muscular weakness (Martin & Fish, 2008). This condition is often seen in athletes, particularly gymnasts, weight lifters, and wrestlers, where repetitive movements are common and immense amounts of stress are placed on the body on a regular basis (Martin & Fish, 2008).

Winged scapula can lead to many complications, from pain and functional debilitation to aesthetic concerns (Orrell et al., 2003). Winged scapula generates mild to severe pain in the majority of cases. Damage, lesions, compression, or stretching of the spinal accessory, long thoracic, brachial plexus, or dorsal scapular nerves result in sensitization and stimulation of the nociceptors within the myelin sheath. These nociceptors send signals to the brain indicating the

damage or abnormality of the nerve, leading to the sensation of pain (Sultan & Younis, 2013). Winged scapula may also lead to the inability to perform activities of daily living such as brushing one's teeth or washing hair. The weakened or paralyzed muscles result in difficulty or inability to lift the affected arm beyond a certain point depending on the severity and location of the impaired muscles (Martin & Fish, 2008). Normal range of motion of the shoulder allows for 180 degree flexion (Derek et al., 1999). The serratus anterior is a primary muscle used in maintaining normal scapular rhythm and therefore normal range of motion. Lack of strength in this muscle allows the scapula to lie in a downward rotated position causing the inferior boarder of the scapula to protrude- presenting as a winging scapula (Derek et al., 1999). In addition to pain and functional complications, a pronounced scapular protrusion may also induce body image distress due to the cosmetic abnormality (Orrell et al., 2003).

## **BACKGROUND**

With proper information on clinical manifestations, the diagnosis of winged scapula is easily achieved through an initial physical examination followed by referral for an electromyography and a nerve conduction study (Srikumaran, 2014). Manifestations present during initial assessment may include pain, decreased range of motion, inability to lift the affected arm overhead, and protrusion of the scapular border. An electromyography consists of needle electrodes that are inserted into the muscle to read muscle and motor neuron activity and display the intensity of activity on a graph (Mayo Clinic, 2012). A nerve conduction study uses surface electrodes to measure the strength and speed of nerve signals traveling from one point to another (Mayo Clinic, 2012). If these diagnostic studies confirm nerve damage and muscular paralysis, the diagnosis of winged scapula is then verified.

Post diagnosis, treatment plan recommendations for winged scapula suggest conservative care including rest, avoidance of overhead use of the extremity, avoidance of pain provoking movements, and implementation of range of motion exercises for six months to two years in hopes of ‘spontaneous recovery’ (Martin and Fish, 2007). After the suggested two years of conservative care, persisting paralysis may be considered permanent and the patient will then be considered a candidate for experimental corrective surgery (Martin and Fish, 2007). Surgical procedure varies based on the etiology and pathophysiology of each specific injury but may include scapulothoracic arthrodesis, scapuloplexy, nerve transfer, dynamic muscle transfer, tendon transfer, neurolysis, or nerve decompression (Atena, 2016). Scapulothoracic arthrodesis involves fusion of the scapula to the thorax, while scapuloplexy involves surgical fixation of the scapula to the chest wall or spinous process of the vertebrae. Nerve, muscle, and tendon transfers

may also be used as well as nerve decompression procedures and neurolysis which will block nociceptors and relieve pain associated with winged scapula (Atena,2016).

Implementation of treatment regimens consisting of conservative therapies including physical therapy, scapular bracing, transcutaneous electrical nerve stimulation, and acupuncture could give winged scapula patients an opportunity to recover productively, effectively, and conservatively within the two years and ultimately avoid surgery.

Physical therapy programs may include stretching and strengthening exercises as well as joint and soft tissue mobility techniques (Onks et al., 2014). Serratus anterior paralysis is the major cause of debilitation in winged scapula patients, suggesting that strengthening and rehabilitation of this muscle may lead to improvement of the condition.

A scapular protecting brace is also an option for treating patients with winged scapula. There are multiple designs of scapular braces. The main goal of bracing is to maintain a retracted position of the shoulders and maintain the winging scapula flush against the thoracic cavity. Correcting the positioning of the shoulders and the affected scapula may allow for an increased range of motion and therefore increased functionality, as well as a decreased risk for over use or over stretching of the surrounding muscles (Marin, 1998).

Transcutaneous electrical nerve stimulation (TENS) is the application of electrical currents through electrodes placed on the skin. TENS therapy has been found to induce analgesia and is also known to affect the nervous system centrally as well as peripherally (DeSantana et al., 2009). TENS therapy has been tested on other nerve related conditions with positive results. This literature review will question the possible effectiveness of TENS therapy for winged scapula recovery.

Acupuncture involves the insertion of tiny needles into strategic points in the body depending on the variation and location of the ailment being treated. It is technique originating in ancient Chinese medicine used to balance one's life force or flow of energy and restore balance and function (Mayo clinic, 2015). Western medicine applications of acupuncture include stimulating nerves, muscle, and connective tissue (Mayo clinic, 2015).

The review of literature identified therapies applied to patients with other nerve conditions including carpal tunnel syndrome, Bell's palsy, and notalgia parasthetica. These conditions are all result of nerve lesions, nerve compression, or traumatic or pathologic nerve injury. Similarly, the most common causes of the muscular dysfunctions that present as winged scapula are nerve lesions or injury to the nerve (Roren et al., 2013). Research on effectiveness for therapies on these conditions has been included due to the identification of the similarities in etiology with winged scapula.

Carpal tunnel syndrome results from compression and traction of the median nerve which can lead to disorders of the intraneuronal microcirculation and lesions in the axon and myelin sheath of the nerve (Aboonq, 2015). While the damaged peripheral nerve is in a different location than in carpal tunnel syndrome, winged scapula can also occur due to the compression, traction, or axonal or myelin sheath lesion on the long thoracic, brachial plexus, or spinal accessory nerves (Roren et al., 2013). Due to their etiologies, the treatment goals for both of these conditions are to decompress the nerve, reduce traction, or repair the axon or myelin sheath (Roren et al, 2013; Arroll & Goodyear-Smith, 2004). This relationship may suggest that a treatment option that proves effective for carpal tunnel syndrome may have the same effect if applied to the affected nerve of a patient with winged scapula.

Bell's palsy, a condition that causes weakness or paralysis of the facial muscles, can also be caused due to compression or traction of a nerve as well as by axonal or myelin sheath lesions leading to ischemia of the nerve, axonal changes, and myelin degeneration (Mayo Clinic 2016). Winging of the scapula is due to weakness or paralysis of the serratus anterior, rhombus, or trapezius muscles and can also be caused by compression, traction, lesions, or ischemia of the related nerve (Roren et al., 2013). The treatment goals for Bell's palsy are the same as those for winged scapula including decompression, traction reduction, and myelin and axonal repair depending of the cause of the case (Mayo Clinic, 2016; Roren et al., 2013). This relationship may suggest that a treatment option that works for Bell's palsy may also work for winged scapula.

Notalgia paresthetica is another chronic neuropathy that, which involves a sensory rather than motor neuron. It is thought to derive from similar mechanisms of injury as winged scapula. The signs and symptoms of notalgia paresthetica including chronic pruritus and pain are believed to manifest due to degeneration and/or compression of spinal nerves (Richardson et. al, 2009). Regeneration of the damaged axon or myelin sheath, or decompression of the nerve could reduce symptoms in both conditions, suggesting that the same treatment options would be effective for both notalgia paresthetica and winged scapula.

Conservative care, rest, and range of motion exercises are encouraged for six months to two years following diagnosis of a winged scapula injury. However, many conservative therapies that have been proven effective for other chronic neuropathies are not suggested as options for patients diagnosed with winged scapula. Implementing physical therapy, scapular bracing, transcutaneous electrical nerve stimulation, and acupuncture as treatment for patients with

winged scapula may increase recovery during the first six to twenty-four months therefore decreasing the number of patients requiring surgery.

## **PROBLEM**

Winged scapula is considered to be a rare disorder, although the true incidence is unknown (Srikumaran et al., 2014). Winged scapula may be a more common cause of shoulder dysfunction than previously thought due to a myriad of misdiagnoses or cases remaining undiagnosed (Srikumaran, 2014). When winged scapula is diagnosed, it is often after a long delay, suggesting that current clinical signs are inadequate and that a more specific evaluation is necessary (Roren et al. 2013). Tibaek and Gadsboell (2015) indicate that due to gaps in literature and education, not all health care providers are aware of the manifestations of winged scapula. This suggests that first line providers, physicians and midlevel practitioners may not be well versed in the clinical presentation and diagnostic criteria for winged scapula.

Winged scapula has been reported over many years in adults, and more recently in children; however, prevalence studies are lacking (Tibaek and Gadsboell, 2015). Without the ability to recognize and diagnose winged scapula, cases may be under reported, undiagnosed, and untreated, and lack the of prevalence studies further complicates the clinical picture (Srikumaran, 2014).

Education is essential for recognition and treatment for clients presenting with this condition; especially for orthopedic and primary care nurses who may perform initial assessment on patients presenting with winged scapula, as well as physicians and midlevel practitioners who provide the medical diagnosis. Understanding clinical manifestations leads to the presumptive diagnosis of winged scapula and confirmation via electromyography, and a nerve conduction study (Srikumaran, 2014).

Once diagnosed, recommended treatment options for winged scapula are often limited to rest, avoidance of aggravating activities, and range of motion exercises (Martin and Fish, 2007). In some cases physical therapy is recommended in order to attempt to strengthen the weakened or paralyzed muscles. However, as a condition resulting from nerve related pathology in the majority of cases, stimulation of the damaged nerve as opposed to the affected muscle may provide a more effective therapy in many cases. There are no outcome-based treatment programs or guidelines to aid clinicians in treating winged scapula currently (Tibaek & Gadsboell, 2015). Scapular winging also often mimics a variety of other shoulder dysfunctions clinically, which may also lead to unsuccessful and unnecessary surgical treatment (Srikumaran , 2014).

## **PURPOSE**

The purpose of this study is to evaluate the current research literature related to the effectiveness of therapy options for winged scapula. Analysis and synthesis to evaluate the possible use of physical therapy, scapular bracing, transcutaneous electrical nerve stimulation, and acupuncture in management of winged scapula will be presented.

## **METHOD**

A systematic integrative review of scholarly literature relating to winged scapula and therapy options was conducted for this thesis. Eleven research articles were chosen from the one hundred and ten initially reviewed from CINAHL plus full text, MEDLINE, PubMed, and EBSCOhost databases. Initial criteria for research included key words: medial winging, lateral winging, scapula, pain, integrative, and alternative, and focused on the adult population (over 18 years of age). No results were found regarding integrative or alternative therapies for winged scapula. The search was expanded to include all nerve related pathologies and key words nerve damage, nerve dysfunction, nerve regeneration, and nerve recovery were added. Inclusion criteria included: English language, full text, and articles dated 1998-2015. See appendix A for flow diagram of study selection.

## **RESULTS**

Three studies focused specifically on treatment for winged scapula using physical therapy exercises and interventions. Two studies revealed outcomes of Transcutaneous Electrical Nerve Stimulation (TENS) therapy on nerve related conditions including notalgia paresthetica and carpal tunnel syndrome. Four studies focused on acupuncture therapies and their effectiveness on nerve related conditions including Bell's palsy, and spinal cord injury. Two studies explored the efficacy of scapular bracing for patients with winged scapula. Overall, the literature review revealed four therapies to be evaluated for treatment of patients diagnosed with winged scapula.

### **Physical Therapy**

Tibaek and Gadsboell (2015), studied twenty-two patients diagnosed with winged scapula due to long thoracic nerve injury who were referred to a physical therapy program which included a physical examination, thoracic brace treatment, and muscular rehabilitation aimed toward scapular recruitment and intermuscular and intramuscular balance ratios. Treatment length and frequency was determined on an individual basis. Outcomes of the case series and retrospective study were measured by a shoulder-specific quality of life questionnaire, the Western Ontario Rotator Cuff (WORC) index. The WORC index consists of five domains including physical symptoms, sports/recreation, work, lifestyle, and emotions. The results showed a statistically significant improvement from a pre-test score of 932 to a post test score of 159 (Tibaek and Gadsboell, 2015). The higher the score of the WORC index, the more quality of life is affected by the condition, therefore, the difference in score from 932 to 159 shows significant improvement (Tibaek and Gadsboell, 2015). Increase in quality of life scores show promising potential of thoracic bracing in addition to muscular rehabilitation as a treatment

protocol for winged scapula patients, the researchers recommend that this program be evaluated in a randomized control trial to further evaluate its effectiveness (Tibaek and Gadsboell, 2015).

Park et al. (2014), studied twenty-eight men- thirteen presenting with scapular winging and fifteen in a control group in an experimental trial to determine the most effective push-ups plus modification for serratus anterior rehabilitation. The subjects performed push-ups plus, knee push-ups plus, and wall push-ups plus as their pectoralis major and serratus anterior muscle activity was measured via electromyogram which measures and displays the intensity of muscle activity. The push-up plus exercise, regardless of which modification is used, is performed by completing a push-up and then continuing the movement by using the serratus anterior to protract the shoulders and round the upper back. The serratus anterior is the most commonly affected muscle in winged scapula patients (Roren et al., 2013). Push-ups plus exercises show the highest average serratus anterior activation when compared to other serratus anterior activating exercises (Decker et al., 1999). Therefore, push-ups plus are the most commonly used exercise in rehabilitation of winged scapula. The knee push-ups plus and the wall push-ups plus are two modifications of this exercise that are also commonly recommended as they limit the amount of weight bearing during the exercise (Park et al., 2014). While the goal of the push-ups plus exercise is to activate the serratus anterior muscle, studies show that the pectoralis major is often activated as well during scapular exercises (Decker et al., 2003). Due to the muscular imbalance that often accompanies the diagnosis of winged scapula, activating and further strengthening the pectoralis major can be disadvantageous to a patient with winged scapula as a high pectoralis major to serratus anterior ratio can be associated with shoulder joint abnormalities (Park et al., 2014). Park et al. (2014) evaluated which push-ups plus variation is

most beneficial to winged scapula patients by using electromyography to measure the pectoralis major to serratus anterior ratio as participants performed each variation.

Results were consistent for both the winged scapula and control groups and showed that the pectoralis major to serratus anterior ratio showed most serratus anterior activation while performing the unmodified push-ups plus exercise (Park et al., 2014). The unmodified push-ups plus was found to be the most effective in winged scapula rehabilitation as it isolates the serratus anterior most effectively (Park et al., 2014). During the study, Park et al. also found that the wall push-ups plus exercise alters the scapulothoracic and glenohumeral joint movement patterns and may be detrimental to patients with winged scapula. The wall push-ups plus also elicited the highest pectoralis major to serratus anterior ratio indicating that it would be the least effective exercise for serratus anterior rehabilitation (Park et al., 2014).

Yoo and Hwang (2010) studied the serratus anterior to upper trapezius activation ratio of twelve participants while performing physical therapy exercises, specifically push-ups plus, on a wobble board, versus a one-sided wobble board, versus a dual wobble board. The use of wobble boards in this experimental study was implemented under the hypothesis that performing exercises on an unstable surface would increase the neuromuscular activation of the muscles used to complete the exercise (Yoo & Hwang, 2010). The serratus anterior to upper trapezius ratio was measured in order to determine which surface led to the greatest serratus anterior isolation. Dynamic and isometric exercises were performed for this study. Dynamic exercises involve joint movement while isometric exercises involve the contraction of a muscle or group of muscles during which the length of the muscle does not change and the involved joint does not move (Laskowski, 2014). Muscle activity was measured via electromyogram and showed that

the serratus anterior to upper trapezius ratio was greatest when dynamic, exercises were performed using a one sided wobble board and when isometric exercises were performed using a normal wobble board (Yoo & Hwang, 2010). The researchers concluded that isometric exercises performed on an unstable surface and dynamic exercises performed on a stable surface provide the greatest benefit towards the goal of isolated serratus anterior activation and rehabilitation (Yoo & Hwang, 2010).

### **Scapular Bracing**

Within the reviewed literature, only two articles were found studying the effects of scapular bracing for winged scapula. The first study was published in 1998, and the second in 2015, indicating a significant gap in the research.

Marin (1998) performed a case series study on the management of winged scapula caused by long thoracic nerve palsy with a scapular brace. Fourteen patients participated and one hundred percent reported a subjective feeling of increased strength and decreased pain immediately upon application of the brace (Marin, 1998). Manual muscle tests showed that strength increased an average of one grade on a one to five scale in all participants with brace application. A total of six participants maintained compliance and attended a follow up evaluation one to seven months after beginning bracing treatment. All of these six participants recovered brace free shoulder flexion strength to nearly pre-affected levels and reported decreased pain levels. The researcher concluded that scapular bracing is an effective tool for management of winged scapula secondary to long thoracic nerve palsy (Marin, 1998).

Vastamaki et. al (2015) explored the long term effectiveness of scapular bracing in an experimental study. For this study, bracing treatment began a mean of six months after the onset

of symptoms and the brace was worn a mean of twelve hours a day for ten months. Fifty five participants of the original ninety eight were available for a follow up evaluation a minimum of ten years after beginning brace treatment. Physical winging of the scapula disappeared for sixty four percent of participants, eighteen percent were pain free during exertion and thirty three percent were pain free at rest. Flexion improved from 137 degrees  $\pm$  24 degrees to 156 degrees  $\pm$  16 degrees, and abduction improved from 150 degrees  $\pm$  33 degrees to 170 degrees  $\pm$  24 degrees (Vastamaki et. al, 2015). The researchers also found that eighty seven percent of participants complied with exact bracing recommendations and therefore concluded that while compliance was high, recovery was incomplete for many patients, as most continued to suffer from some degree of pain and/or scapular winging (Vastamaki et. al, 2015).

### **Transcutaneous Electrical Nerve Stimulation**

Notalgia parasthetica (NP) is a sensory neuropathy involving dorsal spinal nerves and characterized by pruritus on the back occasionally accompanied by pain, paresthesia, and/or hyperesthesia (Savk et al., 2007). In an experimental study, Savk et al. (2007) evaluated fifteen NP patients with relevant spinal pathology who were treated with transcutaneous electrical nerve stimulation (TENS) therapy. A pre and post survey was obtained to measure the extent of pruritus on a scale from one to ten. At the end of two weeks of TENS therapy, the post survey showed a statistically significant decrease in symptoms in a large majority of patients with the initial pruritus score being 10, and the mean pruritus score at the end of two weeks being 6.80  $\pm$  2.73. (Savk et al., 2007). The researchers state that this evidence shows promise for TENS therapy as an effective tool for management of neuropathy based on the decrease of symptoms including pruritus (Savk et al., 2007).

In a prospective, single-blinded, single-center, randomized, three-group parallel intervention study, Koca et al. (2014) assessed the effectiveness of TENS therapy and interferential current therapy versus the common treatment of splint therapy for carpal tunnel syndrome. Sixty three participants were split into three groups and received either TENS, splinting, or interferential current therapy. Pre and post treatments tests were performed. Outcomes were measured using a visual analog scale (VAS), a symptom severity scale, a functional capacity scale, measurement of median nerve motor distal latency (mMDL), and measurement of median sensory nerve conduction velocity (mSNCV ). While TENS therapy and splinting both showed improvement in pain and functionality, there were no significant differences between the two. However, the interferential current therapy group showed significantly further improvement. The baseline and six week follow up results for each group are shown in the table below.

	Group 1 (Splint) Mean $\pm$ SD	Group 2 (TENS) Mean $\pm$ SD	Group 3 (IFC) Mean $\pm$ SD
VAS			
Baseline	8.31 $\pm$ 0.61	8.06 $\pm$ 0.55	8.25 $\pm$ 0.4
6 weeks	6.37 $\pm$ 1.18	6.68 $\pm$ 1.42	4.80 $\pm$ 1.18
Symptom Severity			
Baseline	4.21 $\pm$ 1.18	4.06 $\pm$ 1.02	3.90 $\pm$ 1.06
6 weeks	3.12 $\pm$ 1.11	3.37 $\pm$ 1.21	2.70 $\pm$ 1.03
Functional Capacity			
Baseline	3.12 $\pm$ 1.28	2.93 $\pm$ 1.26	2.80 $\pm$ 1.24
6 weeks	2.37 $\pm$ 1.38	2.50 $\pm$ 0.78	1.90 $\pm$ 1.21
MDL			
Baseline	4.01 $\pm$ 0.52	4.13 $\pm$ 0.96	4.00 $\pm$ 0.94
6 weeks	4.06 $\pm$ 0.61	4.06 $\pm$ 0.88	3.89 $\pm$ 0.88
SNCV			
Baseline	39.93 $\pm$ 1.78	39.66 $\pm$ 1.02	40.20 $\pm$ 2.04
6 weeks	40.75 $\pm$ 1.48	41.38 $\pm$ 1.78	41.80 $\pm$ 1.76

Table 1: TENS therapy outcomes

(Koca et al., 2014)

These results show that while interferential current was the most effective treatment, TENS and splinting led to statistically significant improvement as well.

## **Acupuncture**

A randomized control trial conducted by Xu et al. (2013) assessed the effectiveness of acupuncture as treatment for Bell's palsy by comparing two intervention protocols. For this study, two groups of participants received acupuncture therapy for twenty 30-minute sessions. One group of one hundred sixty seven participants received acupuncture with a strong focus on de qi. Di qi is defined as one's functional energy activated through a composite of unique sensations integral to clinical efficacy according to traditional Chinese medicine (Hui et al., 2007). Xu et al. (2013) describe De qi as an "internal compound sensation of soreness, tingling, fullness, aching, cool, warmth, heaviness, and a radiating sensation at and around acupoints" (p. 185). The protocol for the di qi group involved the manipulation of the needles once inserted in order to achieve di qi and the acupuncturist asking the participant every ten minutes about the sensations they were experiencing and needles were then again adjusted to maintain di qi. The control group, with one hundred seventy one participants simply had the needles inserted and left in place for the full 30-minute session. Recovery was evaluated using the House-Brackmann scale consisting of grades one through six, grade one indicating normal function and grade six indicating complete paralysis. A House-Brackmann score of grade one was considered complete recovery (Xu et al., 2013). Functional improvement was seen in both groups, but improvement was significantly greater in the group that underwent the di qi manipulation (Xu et al., 2013). At a six month follow up evaluation after twenty sessions of acupuncture therapy for both groups, 94.3 % of the di qi group achieved complete recovery while 77.1 % of the control acupuncture

group reached complete recovery (Xu et al., 2013). The evidence shows that acupuncture with di qi improved facial muscle recovery and disability in patients with Bell’s palsy. Also, stronger intensity of de qi was associated with greater therapeutic effects (Xu et al., 2013).

Schroder et al. (2006) conducted a pilot study to explore the effects of acupuncture on peripheral neuropathy as measured by nerve conduction study as well as assessment of subjective symptoms including reduced or increased sensation, numbness, pain, and loss of motor function. Forty-seven participants diagnosed with peripheral neuropathy of unknown etiology were randomized into two groups. The first group consisted of twenty-one patients who received 20-minute acupuncture therapy sessions once a week for ten weeks. The second group of twenty-six participants received no specific treatment for peripheral neuropathy. At the four month follow up evaluation, seventy-six percent of participants in the acupuncture group were found to have improved symptomatically while only fifteen percent of participants in the control group reported symptomatic improvement (Schroder et al., 2006). The nerve conduction study performed on both groups, before and after the four month treatment period, showed the amplitude and conduction velocities of the sural nerve. Fourteen of the participants in the acupuncture group and ten participants in the control group experienced motor involvement in addition to sensory and therefore had a nerve conduction study on their tibial nerve as well as the sural nerve. Test results are shown in the table below:

	Control Group	Acupuncture Group
Sural Nerve Amplitude		
Baseline	2.92 ± 1.91 μV	1.57 ± 1.68 μV
Post-test	2.43 ± 1.71 μV	3.02 ± 2.52 μV
Sural Nerve Conduction Velocity		
Baseline	37.38 ± 11.43 m/s	27.05 ± 19.75 m/s

Post-test	$36.15 \pm 13.51$ m/s	$36.1 \pm 15.18$ m/s
Tibial Nerve Amplitude		
Baseline	$3.65 \pm 2.24$ $\mu$ V	$2.96 \pm 2.05$ $\mu$ V
Post-test	$2.75 \pm 2.22$ $\mu$ V	$4.96 \pm 2.97$ $\mu$ V
Tibial Nerve Conduction Velocity		
Baseline	$40.1 \pm 3.25$ m/s	$36.21 \pm 13.08$ m/s
Post-test	$40.95 \pm 2.22$ m/s	$37.8 \pm 11.75$ m/s

Table 2: Acupuncture therapy outcomes

(Schroder et al., 2006)

This evidence shows that acupuncture treatment results in statistically significant improvement in the nerve conduction study of the sural nerve when compared to the control group. Nerve conduction study data also showed partial improvement of the tibial nerve with acupuncture treatment. The researchers also noted that the improvement of nerve conduction study values had a strong positive correlation with the subjective improvement of symptoms (Schroder et al., 2006).

Inoue et al. (2011) conducted an exploratory case series to examine the effect of intermittent direct current electro-acupuncture and associated adverse effects in patients with peripheral nerve damage. Among the cases, the etiologies varied consisting of four axonotmesis cases, two neuropraxia cases, and one neurotmesis case. Axonotmesis refers to axonal damage usually due to compression or crush injury while the myelin sheath remains intact, while neuropraxia refers to an interruption in nerve conduction without degeneration, and neurotmesis indicates partial or complete severance of a nerve with disruption to both the axons and the myelin sheath (Merriam-Webster, 2016). Protocol for this method of acupuncture consisted of one needle inserted along the nerve route proximal to the site of injury, and a second needle inserted distal to the motor point in the paralyzed muscle. Treatment was performed in twenty-minute sessions once a week with electrical output adjusted to a minimum intensity at which the

patient could sense the sensation spreading to the area of the target nerve but did not cause discomfort. Duration of treatment varied by case and outcomes were measured via manual muscle tests on a scale of one to five and active range of motion measurements. Baseline test results are shown table 1 below and post treatment test results are shown in table 2.

Case	Injured Peripheral Nerve	Cause	Duration of Symptoms (months)	Action Tested	Manual Muscle Testing Baseline	Active Range of Motion Baseline
1	Peroneal nerve	Compression	5	Ankle dorsiflexion Great toe extension Ankle pronation	1 0 0	0° 0° 0°
2	Peroneal nerve	Compression	1	Ankle dorsiflexion Great toe extension Ankle pronation	2 4 1	10 ° 30° 0°
3	Axillary nerve	Shoulder dislocation	1.5	Abduction of the arm	1	0°
4	Peroneal nerve	Compression	1.5	Ankle dorsiflexion Great toe extension Ankle pronation	3 3 0	18° 20° 0°
5	Ulnar nerve	Incised wound	14	Finger adduction/ abduction	1	0°
6	Peroneal nerve	Compression	5	Ankle dorsiflexion Great toe extension Ankle pronation	0 0 0	0° 0° 0°
7	Peroneal nerve	Following total hip arthroplasty	12	Ankle dorsiflexion Great toe extension Ankle pronation	0 0 0	0° 0° 0°

Table 3: Electro-acupuncture baseline

(Inoue et al., 2011)

Table 4: Electro-acupuncture outcomes

(Inoue et al., 2011)

Case	Duration of Treatment (months)	Action Tested	Manual Muscle Testing	Active Range of Motion
1	4	Ankle dorsiflexion Great toe extension Ankle pronation	4 0 3	40° 0° 15°
2	2	Ankle dorsiflexion Great toe extension Ankle pronation	5 5 5	45 ° 40° 5°
3	2	Abduction of the arm	2	50°
4	3	Ankle dorsiflexion Great toe extension Ankle pronation	5 5 5	60° 50° 10°
5	9	Finger adduction/ abduction	0	0°
6	16	Ankle dorsiflexion Great toe extension Ankle pronation	5 5 5	55° 50° 10°
7	48	Ankle dorsiflexion Great toe extension Ankle pronation	0 0 0	0° 0° 0°

These results show a significant increase in baseline and post treatment manual muscle tests and active range of motion in a majority of cases (Inoue et al., 2011). During the study, the researchers also assessed for adverse effects and two were reported. Skin pigmentation at site of anode needle insertion was noted in three cases, and excess bone formation and reabsorption was also observed in one case although there was no definite causation (Inoue et al., 2011).

The results of this study showed complete recovery in both neuropraxia cases as well as two axonotmesis cases. A third axotmesis case showed improvement but not complete recovery, and the final axonotmesis case showed reinnervation potential without functional recovery. The neurotmesis case showed no improvement (Inoue et al., 2011).

In a randomized control study, Tong et al. (2009) examined the efficacy of acupuncture and steroid treatments in management of Bell's palsy. For this trial, one hundred nineteen participants were randomly divided into a control group, a steroid treatment group, and an acupuncture treatment group. The steroid treatment group received 30 mg prednisolone twice a day and 20 mg pepcidine twice a day for one week. The participants in the acupuncture group attended three 20-minute acupuncture sessions per week until full recovery was achieved or until 3 months had passed. Full recovery was considered a House-Brackmann score of three or greater. After treatment, the overall improvement to a House-Brackmann score of grade three or better was eighty six point nine percent in the steroid group, ninety six point four percent in the acupuncture group, and eighty nine point five percent in the control group (Tong et al., 2009). However, due to the variation in distribution of initial House-Brackmann score between groups, statistical analysis shows no significant difference in the degree or rate of recovery between the steroid, acupuncture, and control groups.

With these results, a greater understanding in the gaps in the literature has been achieved. Although few therapy options have been studied for patients with winged scapula, physical therapy and scapular bracing have demonstrated effective outcomes. Other therapy options including TENS and acupuncture have not yet been tested for patients with winged scapula, but have proven to be effective therapy options for similar nerve related conditions. Further research is needed to explore the efficacy of TENS and acupuncture therapies for treatment of winged scapula, and to further examine the efficacy of a larger variety of physical therapy and bracing protocols.

## **DISCUSSION**

The studies reviewed for this systematic review of literature illustrate the effectiveness of treatment options for winged scapula including physical therapy and scapular bracing, as well as therapy options for similar nerve related conditions including transcutaneous electrical nerve stimulation and acupuncture.

### **Physical Therapy**

The goal of physical therapy for patients with winged scapula is to regain optimal function of the scapulothoracic and glenohumeral joints of the shoulder (Tibaek and Gadsboell, 2015). The scapulothoracic and glenohumeral joints are affected by the weakness or paralysis of the muscles that cause winged scapula or the serratus anterior, trapezius, and rhomboids (Martin and Fish, 2007). Therefore, this goal would be achieved through reversal of the weakness or paralysis of these muscles by performing physical therapy exercises. While few thorough protocols for winged scapula therapy are described in the literature, the research suggests effectiveness of the single physical therapy program that has been tested (Tibaek and Gadsboell, 2015). Research also shows the most effective rehabilitation exercise to be the standard push-ups plus, as well as the most effective method for performing isometric serratus anterior activation exercises- on an unstable surface (Park et al., 2014 and Yoo & Hwang, 2010).

This evidence supports the continued use of physical therapy as a treatment option for winged scapula as at least one organized physical therapy program has proven effective and two specific exercises have been found to activate the target muscle group effectively. Developing additional therapy program protocols and testing these protocols in comparison to the single

protocol currently available may lead to the discovery of a more effective method of physical therapy for winged scapula. Examination of additional exercises and their degree of target muscle activation may also assist in developing the most effective physical therapy protocol for patients with winged scapula.

### **Scapular Bracing**

Research shows that scapular bracing can lead to an increase in muscle strength, increased degree of shoulder flexion, and a decrease in pain, and is therefore an effective management tool for patients with winged scapula secondary to long thoracic nerve palsy (Marin, 1998). In order for scapular bracing to lead to desired outcome, adherence to recommendations for duration and frequency of treatment must be followed. Early research shows conflicting evidence regarding patient compliance with scapular bracing as one study show less than fifty percent patient compliance (Marin, 1998), while current research found that eighty-seven percent of participants complied to exact treatment recommendations (Vastamaki et al, 2015). This evidence suggests that additional studies are needed in order to determine the impact and minimum rate of compliance for positive outcomes.

While compliance with the treatment regimen will impact results of scapular bracing treatment, both short and long term positive results for patients who to maintain compliance have been shown (Marin, 1998; Vastamaki et al., 2015). In his short term study, Marin (1998) found that over one to seven months, scapular bracing for winged scapula led to increased shoulder flexion and muscle strength, as well as decreased pain in one hundred percent of patients who maintained compliance. Long term, Vastamaki et al. (2015) compliance was eighty-seven percent, yet recovery was incomplete for many patients, as most continued to suffer from some

degree of pain and/or scapular winging (Vastamaki et. al, 2015). The results are inconsistent and indicate a need for additional studies in order to reach a conclusion on the degree of efficacy of scapular bracing as a therapy option for winged scapula. While the level of recovery between patients in the studies presented varies, both studies do show positive results to some degree. These results support continued use of scapular bracing for winged scapula and the use of scapular bracing as an adjunct to other therapies.

### **Transcutaneous Electrical Nerve Stimulation**

Transcutaneous electrical nerve stimulation (TENS) has been used to treat pain, and specifically pain related to phantom limbs, sympathetic dystrophy, and peripheral nerve injury (Koca et al., 2014). The research of Savk et al. (2007) and Koca et al. (2014) demonstrate that TENS therapy effectively lowers pain and symptom levels in patients with nerve related conditions including notalgia paresthetica and carpal tunnel syndrome. No studies were found exploring effectiveness of TENS therapy on winged scapula. Winged scapula is known to inflict mild to severe pain in a majority of cases due to the stimulation of nociceptors within the myelin sheath (Sultan & Younis, 2013). Evidence that TENS therapy reduces pain and symptoms of other nerve related conditions of similar etiologies, may suggest that it could be used as a pain reduction and/or symptom management tool for winged scapula. Studies on TENS therapy for winged scapula would be needed in order to explore this suggestion.

Koca et. al (2014) reported a slight improvement in functionality following TENS therapy for patients with carpal tunnel syndrome. The symptoms of carpal tunnel syndrome, including the decrease in functionality, originate from the compression of the median nerve

blocking motor signals to the associated muscles (Aboonq, 2015). An increase in functionality could suggest a decrease in nerve compression and trend towards recovery. However, chronic pain also generally inhibits movement as an attempt to avoid provocation of the pain (Borsook, 2009). Therefore, further research would be needed to decipher the mechanism of action that led to the increase in functionality. Whether the nerve has decompressed or the pain has just been lessened cannot be proven with the research available.

Further research would be required before considering the possibility of nerve recovery stimulated by TENS therapy. It can be concluded from the available research, that TENS therapy is effective in treating pain in musculoskeletal disorders, has also been shown to reduce pain in nerve related disorders, and therefore may also be effective in decreasing pain levels endured by patients diagnosed with winged scapula.

## **Acupuncture**

Acupuncture therapy has been shown to result in increased sural nerve amplitude and nerve conduction velocity, as measured by nerve conduction study, in patients with peripheral neuropathy (Schroder et al., 2006). A strong correlation between improvement of nerve conduction study results and improvement of subjective symptoms including reduced or increased sensation, numbness, pain, and loss of motor function has also been reported (Schroder et al., 2006). Results revealed by Xu et al. (2013) support efficacy of acupuncture for functional recovery of patients with Bell's palsy. Outcomes show that the Traditional Chinese Medicine (TCM) method of acupuncture with di qi significantly furthers functional recovery compared to acupuncture without regard to di qi.

Use of electro-acupuncture has also shown improvement of manual muscle test scores and active range of motion ability in patients suffering from peripheral nerve injury (Inoue et al., 2011). This study however, also took into consideration the specific pathology of each case and found that improvement and in some cases, full recovery was achieved in axonotmesis and neuropraxia cases, but no improvement or reinnervation potential was seen in the neurotmesis case (Inoue et al., 2011). This data suggests that electro-acupuncture may aid in recovery of damaged axons or a damaged myelin sheath, while it is not effective for an injury involving a fully severed nerve (Inoue et al., 2011).

While the majority of research shows positive results for acupuncture treatment of nerve related conditions, the results of one study show no difference in degree or rate of functional recovery in Bell's palsy patients between an acupuncture, steroid treatment, and control group (Tong et al., 2009).

Current research shows positive results for use of electro-acupuncture on axonotmesis and neuropraxia cases of peripheral neuropathy as well as mixed results for use of acupuncture for recovery of patients with Bell's palsy. There is no research available on the use of acupuncture as therapy for winged scapula. The majority of evidence shows positive effects of acupuncture for nerve related conditions similar in etiology to winged scapula. This may suggest that acupuncture therapy would have positive results if used for winged scapula patients. Additional research is needed to support this suggestion.

## **LIMITATIONS**

Several limitations impacted this systematic review of literature including a lack of research directly related to winged scapula, and research design flaws. Initial search results revealed no original research articles on complete, conservative treatment protocol for winged scapula. Few results were found regarding physical therapy and scapular bracing options for patients with winged scapula. No results were found on other conservative therapies for the treatment or management of winged scapula alone. The search criteria were expanded to include therapies for any condition arising from nerve related pathology. This limitation indicates the need for additional studies of the treatment options for winged scapula.

A majority of the studies evaluated were limited by length of study (30 days or less) and small sample size, with the exception of one 10-year study on scapular bracing, long term effects have not been fully examined. Many of the studies were limited to small and targeted populations limiting the generalizability of the findings.

The limitations of small sample size and lack of results specific to winged scapula may limit the opportunities for knowledge and understanding by health care providers and patients. An increased awareness of the condition may lead to a push by providers for research leading to effective treatment options for winged scapula. Increased awareness and greater understanding of diagnostic criteria may provide the prevalence data needed to support larger studies.

## **IMPLICATIONS FOR NURSING**

### **Nursing Research**

Many of the studies reviewed are preliminary studies, indicating that further research may be needed in order to confirm the outcomes of these studies. The use of randomized control trial research designs may also aid in confirming of accuracy and validity of the results.

The initial literature search revealed a large gap in research related to conservative treatment protocols for winged scapula. This literature review examined the practice of physical therapy and scapular bracing for treatment of winged scapula. One physical therapy treatment protocol for winged scapula has been developed, and two specific exercises have been examined to determine the ideal modification for winged scapula recovery. Additional protocols need to be evaluated to determine the most effective for winged scapula, and additional exercises need to be examined so that the most effective exercises may be used in these protocols. One short term and one long term study of scapular bracing are available. Further research is needed to clarify recovery and compliance rates as mixed results were found. TENS therapy, and acupuncture research outcomes support the use of these treatments for similar nerve related conditions. Studies are needed in evaluate the effectiveness of TENS therapy and acupuncture for treatment of winged scapula specifically. Nurses can perform vital roles in research including recruiting participants and managing treatment protocols and procedures. Nurses are in a position to participate in future research investigations.

### **Education**

Educating nurses about the presentation and manifestations of winged scapula is essential to facilitating diagnosis. The nurses' role in assessment includes the collection of information as

well as the interpretation and validation of data (Potter & Perry, 2013). In order for a nurse to correctly interpret the presenting signs and symptoms of winged scapula, they need to be educated on what these manifestations are and how to accurately recognize them.

Nurses may also be expected to make recommendations to the provider and educate patients on the available treatment options. Evidence based practice is the goal of health care institutions and is an expectation of professional nurses (Ingersoll et al., 2010). In order for nurses to recommend and carry out evidence based practices, they need to be educated on the current research, treatment and management opportunities available for patients with winged scapula. This information is extremely limited at this time. The current lack in research in this area limits awareness, but may also encourage nurses to pursue the research needed to fill this gap in treatment and understanding.

### **Nursing Practice**

Gaining a better understanding of the etiology and pathophysiology of winged scapula and the possible treatment options may affect each aspect of the nursing process while caring for these patients. The first step to effective management is an accurate assessment including the knowledge to recognize the abnormality of a protruding scapular boarder referred to as a winged scapula. Knowing that the patient is suffering from winged scapula will then allow the nurse to form nursing diagnoses related to the symptoms and complaints associated with nerve and musculoskeletal dysfunctions. With these nursing diagnoses in place, the nurse can then plan, implement, and evaluate interventions designed to improve the related complications. The nurses' role also includes recognizing the impact that winged scapula has on a patient's quality of life and ability to perform activities of daily living. This knowledge will allow the nurse to

advocate for additional services a patient may be in need of including but not limited to, occupational therapy, pain management, and mental and emotional therapy.

In addition to bedside patient care, nurses are also often involved in professional organizations that work to initiate and contribute to changes and improvements in health care. Through these organizations nurses can help to raise awareness and educate health care professionals on winged scapula. Nurses may also take a lead in or participate in development of protocols and best practice interventions by becoming leaders in their workplace and professional organizations.

## **Conclusion**

Knowledge of winged scapula and therapy options has the potential to influence nursing practice as well as patient outcomes. Nursing's role can include assessment, utilizing the nursing process, providing evidence based practice, making recommendations, implementing protocols and interventions, advocating for patients, and facilitating research. This systematic literature review illustrates the scant research available for therapy options for winged scapula. The current research does show that TENS therapy and acupuncture have proven effective for multiple nerve related conditions, suggesting that these therapies may also prove effective for winged scapula treatment and/or management. Further research to validate this suggestion will facilitate implementation in clinical practice.

**APPENDIX A: Figure 1: Flow Diagram of Study Selection**

## APPENDIX A: Figure 1: Flow Diagram of Study Selection

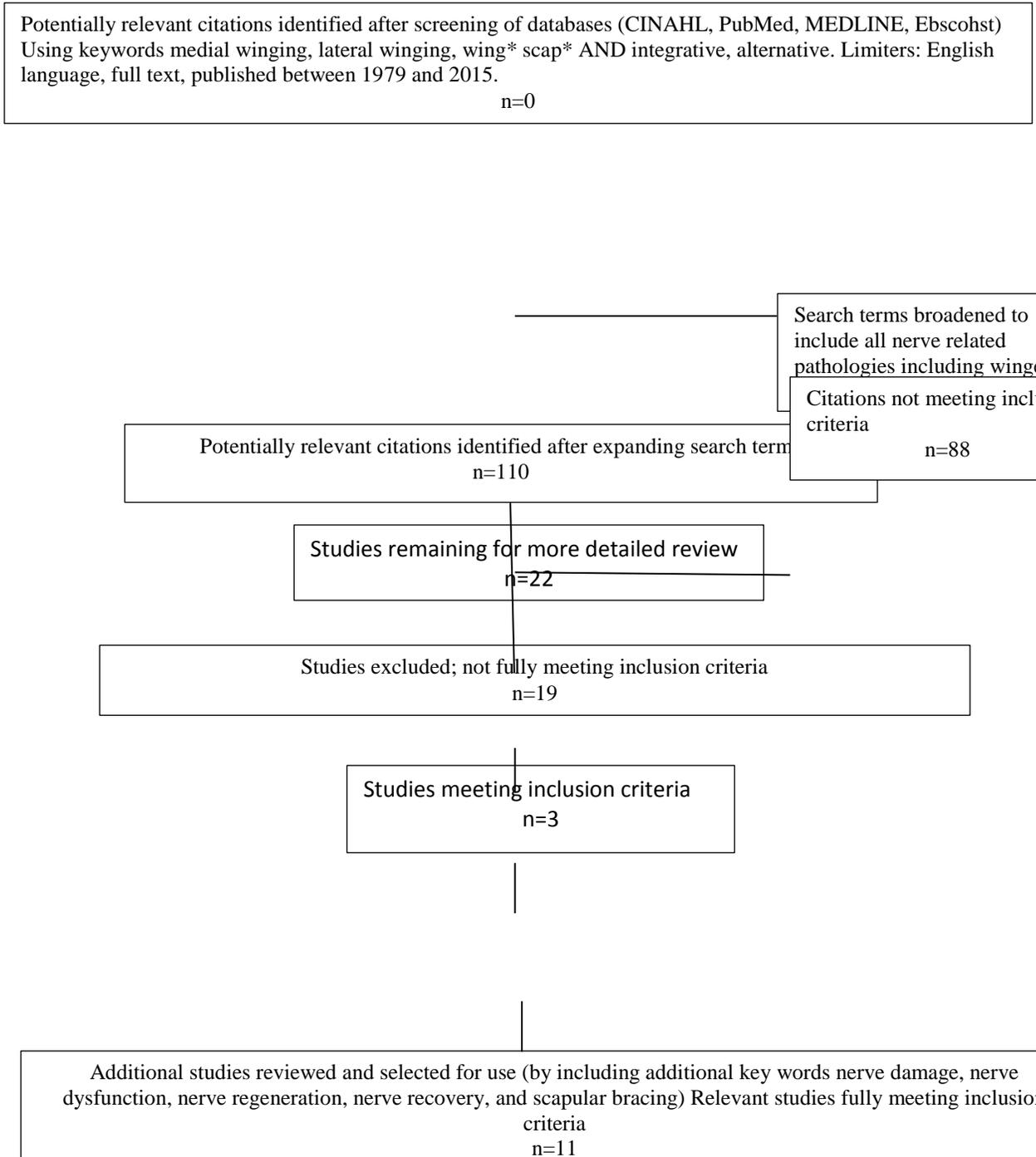


Figure 1: Selection Method of Literature

## **APPENDIX B: TABLE**

## APPENDIX B: TABLE

Author(s) Year Location	Study Design and Purpose	Sample Size	Intervention Protocol	Screening Measures	Outcome Measures	Key Findings and Limitations
Inoue et al. (2011) Japan	Exploratory case series  To examine the therapeutic effect of a method based on electroacupuncture with intermittent direct current and associated adverse events in patients with peripheral nerve damage and a poor prognosis.	n=7	In patients with peripheral nerve damage, direct current electroacupuncture was performed at 100 Hz for 20 minutes weekly. Muscular paralysis was evaluated weekly with manual muscle testing, active range of motion testing, and, when necessary, electromyography.	Inclusion criteria included diagnosis of motor paralysis due to peripheral nerve injury (neuropathy 2, axonotmesis 4, neuromesiasis 1).  Exclusion	Outcome measures included manual muscle tests, active range of motion measurement, and, when necessary, electromyography.	Results showed complete functional recovery in the two neuropraxia cases and in two of the axonotmesias cases. One axonotmesias case achieved partial improvement and the final axonotmesias case showed reinnervation potential with no functional recovery. The neurotmesias case showed no improvement. In three cases an adverse effect of skin pigmentation was found at the anode needle insertion site. While there is no definite causation, one case showed excess bone formation and reabsorption in the area near the cathode needle insertion site.  Limitations in this study include the small sample size, the lack of a control group, the variety of pathologies, and the exclusion of consideration of di qi in acupuncture treatment.
Koca et al. (2014) Turkey	Randomized, single-blinded control trial  To assess the effectiveness of interferential current and transcutaneous electrical nerve	n=63	Group one patients were stabilized with volar wrist splints for 3 weeks. Group two patients received TENS therapy on the palmar surface of the hand 5 times weekly for 3 weeks. Group	Inclusion criteria included signs and symptoms of carpal tunnel syndrome for 6 weeks or longer.  Exclusion	A visual analog scale, symptom severity scale, functional capacity scale, measurement of median nerve distal latency, and measurement of median sensory	While TENS therapy and splinting both showed improvement in pain and functionality, there were no significant differences between the two. However, the interferential current therapy group showed significantly further improvement.  Limitations include the small sample size, and the failure to evaluate the clinical

	stimulation therapies in the management of carpal tunnel syndrome compared with splint therapy and standard treatment modality for carpal tunnel syndrome.		three patients received IFC therapy on the palmar surface of the hand 5 times weekly for 3 weeks.	criteria included predisposing etiological factors for carpal tunnel syndrome.	nerve conduction velocity were taken before the trial and after completion of the three weeks.	conditions of patients immediately after administration of study treatments as well as over the longer term.
Marin, R (1998) Germany	Case series  To evaluate the clinical utility of a new scapula winger's brace.	n=14	Patients were evaluated and seen for at least one follow up evaluation 1-7 months after initiation. Evaluations included a history and physical examination as well as manual muscle tests with and without the brace on, nerve conduction velocity tests, electromyogram, and a personal interview on the patient's compliance and satisfaction with the brace.	Patients referred to the tertiary military clinic for thoracic nerve palsy of at least 3 months duration. The mean age of participants was 28. 12 participants were male and 2 were female.	Outcome measures included nerve conduction velocity tests, electromyogram, manual muscle tests, and a patient compliance/ satisfaction interview.	With brace application, muscle strength increased by one grade in all patients. Patients who maintained consistent compliance (n=6) recovered their brace free shoulder flexion strength and/or had reduced pain upon follow up evaluation. All patients reported subjective feeling of increased shoulder flexion strength and decreased pain.  Limitations of this study include the small sample size leading to lack of generalizability as well as use of several subjective outcome measures including patient interviews and manual muscle tests.
Park et al. (2014) South Korea	Experimental  To determine which exercise	n=28	Pectoralis major and serratus anterior activation was measured via	Male volunteers between the ages of 20 and 26 were	Muscle activation was measured via electromyogram and	Results were consistent for both groups and showed that the pectoralis major to serratus anterior ratio was the least while

	induced lowest pectoralis major to serratus anterior ratio in subjects with and without scapular winging.		electromyogram as participants performed push-ups plus, knee push-ups plus, and wall push-ups plus.	recruited from a university population. 13 subjects presented with scapular winging and 15 did not. Exclusion criteria included any history of shoulder injury or abnormality other than scapular winging.	ratios were then analyzed.	performing the unmodified push-ups plus exercise.  Limitations include the small sample size, only male subjects, and lack of generalizability.
Savk et al. (2007) Turkey	Experimental  To investigate the possible effect of transcutaneous electrical nerve stimulation therapy in selected cases of notalgia paresthetica.	n=15	All patients received 10 conventional transcutaneous electrical nerve stimulation sessions in the symptomatic area for a duration of 20 minutes at a high frequency of 50-100 Hz.	Men and women ages 39-73 with notalgia paresthetica duration of 1.5-30 years. The main inclusion criteria was relevant spinal pathology.	Outcome measures included positive or negative cervical traction as well as a subjective pruritus symptom score.	The post survey showed a significant decrease in symptoms in a large majority of patients and no unwanted effects were observed or reported.  Limitations include the study design, the small sample size, lack of generalizability, and the use of a single, subjective outcome measure.
Schroder et al. (2006) Germany	Randomized control trial  To evaluate the therapeutic effect of acupuncture on peripheral neuropathy as measured by	n=47	21 patients received acupuncture therapy according to traditional chinese medicine, while 26 patients received the best medical care but no specific treatment for peripheral	Inclusion criteria included a diagnosis of peripheral neuropathy with unknown etiology and confirmed by	Outcome measures included nerve conduction study measurement of nerve conduction velocity as well as a patient self-assessment of symptom severity.	76 % of the acupuncture group improved symptomatically and objectively as measured y nerve conduction study. 15 % of the control group improved symptomatically and objectively as measured by nerve conduction study.  Limitations of this study include the small sample size, the length of the study

	changed in nerve conduction and assessment of subjective symptoms.		neuropathy. Nerve conduction velocity of the sural and tibial nerves was measured before and after a 4 month period.	neurologic exam and nerve conduction study.		following up only to a four month period, and that the di qi factor of traditional Chinese acupuncture was not considered.
Tibaek, S. & Gadsboell, J. (2015) Denmark	Case series and retrospective study  To describe a physical therapy program for patients with scapula alata and to evaluate its effect using a shoulder specific quality of life measurement.	n=22	Patients participated in an outpatient physical therapy program consisting of a physical examination, thoracic brace treatment, and muscular rehabilitation. Treatment frequency and duration were determined individually	Inclusion criteria included patients diagnosed with scapula alata who were 15 years or older. Exclusion criteria included history of shoulder injury, additional neurologic disorders, and bone abnormality.	Outcomes were measured by a shoulder specific quality of life questionnaire known as the Western Ontario Rotator Cuff Index.	The results of the study showed significant improvement in all five domains of the WORC index including physical symptoms, sport/leisure time, work, lifestyle, and emotional health.  Limitations include the small sample size, lack of generalizability, variance of pathologies of scapula alata between patients, and the missing clinometric quality of the WORC index.
Tong et al. (2009) China	Randomized control trial  To evaluate the efficacy of acupuncture in comparison with steroids in the treatment of idiopathic peripheral facial paralysis or Bell's palsy.	n=119	Participants were randomized into three groups. The first group would act as the control group and not undergo treatment. The second group, the steroid group received prednisolone 30 mg twice daily and pepcidine 20 mg	Inclusion criteria consisted of patients with a diagnosis of idiopathic peripheral facial palsy within two weeks from onset.	Outcome measures included the House-Brackmann facial nerve grading system.	The overall improvement (House-Brackmann score of grade 3 or higher) was 86.9 % in the steroid group, 96.4 % in the acupuncture group, and 89.5 % in the control group. However, the rate of recovery did not differ significantly between groups.  Limitations of this study include the single outcome measure, and the unequal distribution of initial grade throughout the groups.

			twice daily for one week, The third group, the acupuncture group, underwent acupuncture therapy with di qi for three twenty minute sessions a week until recovery was achieved or until 3 months had been reached.			
Vastamaki et al. (2015) Finland	Observational  To determine the average length of time that patients wore the brace. To determine if scapular winging and range of motion improved with brace treatment. To determine if pain decreased with brace treatment. To determine if the duration of symptoms before brace treatment influenced the outcome.	n=55	Patients underwent an initial evaluation including a history and physical examination, electromyogram, measurement of scapular winging, measurement of range of motion, and were asked their pain level. A custom brace was then made and mean duration of use was for 10 months about 12 hours a day. Follow up examinations were then performed for these patients for up to a minimum of 10 years after brace treatment.	188 patients were diagnosed with isolated serratus anterior palsy causing winged scapula. 110 of these patients passed inclusion criteria of scapular winging of 3 cm or more and limited range of motion. 11 of these patients were excluded to do being unavailable for follow up examinations. 67 patients attended the final follow up	Outcome measures included range of motion measurements, specifically flexion and abduction, measurement of degree of scapular winging, and pain scale.	Winging of the scapula resolved in 64% of patients with brace use. 18% of the patients were pain free on exertion and 33% were pain free at rest. However, 67% of patients still experienced pain at rest. Compliance was high for scapular protecting brace treatment but recovery was incomplete for many patients.  Limitations included the lack of a control group, the small sample size, and the lack of follow up electromyogram to determine the serratus anterior muscle activity post brace treatment.

				and 12 of these patients were excluded due to lack of initial range of motion records, having initiated brace therapy longer than 2 years after symptom onset, or wearing the brace for less than 3 months or less than 4 hours a day. The final number of participants was 55.		
Xu et al. (2013) Canada	<p>Prospective multicenter randomized control trial</p> <p>To compare the efficacy of acupuncture with either strong (intended to elicit de qi) or weak stimulation among patients with Bell's palsy</p>	n=338	Both groups received acupuncture: in the de qi group, the needles were manipulated manually until de qi was reached, whereas in the control group, the needles were inserted without any manipulation. All patients received prednisone as a basic treatment.	Inclusion criteria included unilateral facial nerve weakness without an identifiable cause within 168 hours after the onset of symptoms, aged 18-65 years, who had not received any treatment before randomization.	The primary outcome was facial nerve function measured by the House-Brackmann scale. Secondary outcomes include disability (measured by the Facial Disability Index) and quality of life (measured by the World Health Organization's quality of life brief version)	<p>Functional improvement was seen in both groups, but improvement was significantly greater in the group that underwent the di qi manipulation.</p> <p>Limitations of this study include the administration of prednisone which could affect symptoms measured for outcome, and possible misunderstanding of de qi causing 17.1% of patients not to rate de qi in the outcome index measurements.</p>

				Exclusion criteria included recurrent facial paralysis, asymmetry of the face before the onset of illness, current pregnancy, and any systematic diseases that could effect treatment.		
Yoo W., & Hwang Y. (2010) Republic of Korea	Experimental  To assess the serratus anterior to upper trapezius activation ratio during dynamic and isometric exercises on various support surfaces.	n=12	Push-ups plus and push-ups plus maintenance exercises were performed on three different base surfaces: a bobble board, dual wobble boards, and a one-sided wobble board while activation of the serratus anterior and upper trapezius were measured.	12 male subjects, all right-sided dominant, with no congenital deformities in the upper extremities, and no orthopedic or neurologic disorders were recruited.	Serratus anterior and upper trapezius activity was measured via electromyogram and were compared as a ratio.	The results showed that when performing isometric serratus anterior strengthening exercises, the greatest benefit is achieved using an unstable surface. However, when performing dynamic exercises, the greatest benefit may be achieved when using a stable surface instead.  Limitations of this study include the small sample size, only males were measured, all participants were right-side dominant, and lack of generalizability.

## REFERENCES

- Aboonq, M.S. (2015). Pathophysiology of carpal tunnel syndrome. *Neurosciences*. 20(1), 4-9.
- Atena Inc. (2016). Winged scapular surgery. *Atena Inc*. Retrieved from [http://www.aetna.com/cpb/medical/data/800\\_899/0859.html](http://www.aetna.com/cpb/medical/data/800_899/0859.html)
- Axonotmesis. (n.d.). In Meriam-Webster dictionary online. Retrieved from <http://www.merriam-webster.com/medical/axonotmesis>
- Borsook, D. (2009). Pain and motor system plasticity. *National Institutes of Health: Pain*. 132(1-2), 8-9.
- Decker, M., Hintermeister, R., Faber, K., & Hawkins, R. (1999). Serratus anterior activity during selected rehabilitation exercises. *Medicine & Science in Sports & Exercise*, 27(6), 41-41.
- DeSantana, J., Walsh, D., Vance, C., Rakel, B., & Sluka, K. (2009). Effectiveness of transcutaneous electrical nerve stimulation for treatment of hyperalgesia and pain. *Current Rheumatoid Reports*. 10(6), 492-499.
- Hui, K., Nixon, E., Vangel, M., Liu, J., Marina, O., Napadow, V., . . . Kennedy, D. (2007). Characterization of the 'deqi' response in acupuncture. *BMC Complementary and Alternative Medicine*. 7, 33.
- Inoue, M., Katsumi, Y., Itoi, M., Hojo, T., Nakajima, M., Ohashi, S., & Kitakoji, H. (2011). Direct current electrical stimulation of acupuncture needles for peripheral nerve regeneration: An exploratory case series. *Acupuncture Med*. 29, 88-93.
- Koca, I., Boyaci, A., Tutoglu, A., Ucar, M., & Kocaturk, O. (2014). Assessment of the

- effectiveness of interferential current therapy and TENS in the management of carpal tunnel syndrome: A randomized control study. *Rheumatology International*. 34(12), 1639-45.
- Laskowski, E. (2014). Are isometric exercises a good way to build strength?. *Mayo Clinic*. Retrieved January 2016 from <http://www.mayoclinic.org/healthy-lifestyle/fitness/expert-answers/isometric-exercises/faq-20058186>
- Marin, R. (1998). Scapula winger's brace: A case series on the management of long thoracic nerve palsy. *Archive of Physical Med Rehabilitation*. 79.
- Martin R.M., & Fish D.E. (2008). Scapular winging: Anatomical review, diagnosis, and treatments. *Curr Rev Musculoskeletal Med*. (1), 1-11.
- McCaul, J., Cascarini, L., Godden, D., Coombes, D., Brennan, P., & Kerawala, C. (2014). Evidence based management of Bell's palsy. *British Journal of Oral and Maxillofacial Surgery*. 52(5), 387-91.
- Mayo Clinic Staff. (2015). Acupuncture. Retrieved February 21, 2016, from <http://mayoclinic.org/tests-procedures/acupuncture/basics/definition/prc-20020778>
- Mayo Clinic Staff. (2016). Bell's palsy. Retrieved May 01, 2016, form <http://www.mayoclinic.org/diseases-conditions/bells-palsy/basics/definition/con-20020529>
- Mayo Clinic Staff. (2016). Electromyography (EMG). Retrieved May 01, 2016, from <http://www.mayoclinic.org/tests-procedures/electroconvulsive-therapy/basics/definition/prc-20014183>
- Neurapraxia. (n.d.). In Meriam-Webster dictionary online. Retrieved from <http://www.merriam->

webster.com/medical/neurapraxia

- Onks, C. & Wawrzyniak, J. (2014). The physical therapy prescription. *The Medical Clinics of North America*. 98(4), 869-80.
- Orrell R.W., Copeland S., & Rose M.R. (2010). Scapular fixation in muscular dystrophy. *The Cochrane Library*, (1).
- Park, K., Cynn, H., Kwon, O., Yi, C., Yoon, T., & Lee, J., (2014). Comparison of pectoralis major and serratus anterior muscle activities during different push-up plus exercises in subjects with and without scapular winging. *The Journal of Strength and Conditioning Research*. 28(9), 2546-51.
- Potter, P., Perry, A., Stockert, P., & Hall, A. (2013). *Fundamentals of nursing* (8<sup>th</sup> ed.). St. Louis, MO: Elsevier Mosby.
- Richardson, B., Way, B., & Speece, A. (2009). Osteopathic manipulative treatment in the management of notalgia paresthetica. *The Journal of the American Osteopathic Association*, 109, 605-608.
- Roren, A., Fayad, F., Poiraudeau, S., Fermanian, J., Revel, M., Dumitrache, A., . . . Lefevre-Colau, M. (2013). Specific scapular kinematic patterns to differentiate two forms of dynamic scapular winging. *Clinical Biomechanics*, (28), 941-947.
- Savk, E., Savk, O., & Sendur, F. (2007). Transcutaneous electrical nerve stimulation offers partial relief in notalgia paresthetica patients with a relevant spinal pathology. *Journal of Dermatology*, 34, 315-19.
- Schroder, S., Liepert, J., Remppis, A., & Greten, J.H. (2007). Acupuncture treatment improves nerve conduction in peripheral neuropathy. *European Journal of Neurology*, 14, 276-281.

- Goodyear-Smith, F. (2004). What can family physicians offer patients with carpal tunnel syndrome other than surgery? A Systematic Review of Nonsurgical Management. *The Annals of Family Medicine*, 2(3), 267-273. doi:10.1370/afm.21
- Srikumaran, U., Wells, J., Freehill, M., Tan, E., Higgins, L., & Warner, J. (2014). Scapular winging: A great masquerader of shoulder disorders: AAOS exhibit selection. *The Journal of Bone & Joint Surgery*, 96(14), 122-122.
- Sultan, H. & Younis, E. (2013). Role of dorsal scapular nerve entrapment in unilateral interscapular pain. *Archives of Physical Medicine and Rehabilitation*, 94(6), 1118-25.
- Tibaek S. & Gadsboell J. (2015). Scapula atala: Description of a physical therapy program and its effectiveness measured by a shoulder-specific quality-of-life measurement. *Journal of Shoulder and Elbow Surgery*, 24(3), 482-90.
- Tong, F., Chow, S., Chan, P., Wong, A., Wan, S., Ng, R., . . . Law, C. (2009). A prospective randomized controlled study on efficacies of acupuncture and steroid treatment of idiopathic peripheral facial paralysis. *Acupuncture Med*, 27, 169-173.
- Vastamaki, M., Pikkarainen, V., Vastamaki, H., & Ristolainan, P.T. (2015). Scapular bracing is effective in some patients but symptoms persist in many despite bracing. *Clinical Orthopedics and Related Research*, 473, 2650-2657. doi: 10:1007/s11999-015-4310-1
- Xu, S., Huang, B., Zhang, C., Du, P., Yuan, Q., Bi, G., . . . Wang, W. (2013). Effectiveness of strengthened stimulation during acupuncture for the treatment of Bell's palsy: A randomized control trial. *Canadian Medical Association Journal*, 185(6), 473-479.
- Yoo, W., & Hwang, Y. (2010). Activation and ratio of the upper trapezius and serratus anterior muscles during dynamic and isometric exercises on various support surfaces. *Journal of*

*Physical Therapy Science*, 22, 267-71.