REVIEW ARTICLE

COUNTERFORCE ORTHOSIS IN THE MANAGEMENT OF LATERAL EPICONDYLITIS

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Background: Lateral Epicondylitis (LE), is a condition characterized by the pain and tenderness over the lateral epicondyle of the humerus. LE is commonly seen among people who are involved in sports such as tennis and golf. Any activity that repeatedly overstrain the extensor carpi radialis brevis tendon can lead to LE. The management of lateral epicondylitis generally involves the use of counterforce orthosis. The aim of this review is to summarize the evidence regarding the effectiveness of counterforce orthoses on the clinical outcomes of patients with lateral epicondylitis. **Methods:** The PubMed, Ovid, and ProQuest databases were searched for potential studies which explored the use of counterforce orthosis in the management of lateral epicondylitis **Results:** To have a better understanding of the effectiveness of various types of orthoses, the review is organized into four sections. The first section explores the use of a single orthotic device, the second section focuses on the combined use of orthotic devices, the third section explore studies that compared the effect of local steroid injection along with orthosis and the last section narrate the studies that compared various types of orthotic devices. The studies support the use of orthotic devices as a treatment modality for lateral epicondylitis. There is rising evidence which supports the use of a comprehensive approach, (by combining routine physiotherapy with orthotic devices) in the management of LE. **Conclusion:** Orthosis alone or in combination with routine physical therapy can be considered as an evidence-based treatment strategy for patients with lateral epicondylitis. However, on the basis of the literature review conducted, the authors recommend that further high-quality clinical trials regarding the management of lateral epicondylitis are necessary to strengthen the evidence-based physiotherapy practice.

Keywords: Lateral Epicondylitis; Tennis Elbow; Counterforce Orthosis; Narrative Review; Literature Review

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INTRODUCTION

Lateral Epicondylitis (LE), commonly known as tennis elbow is a condition characterized by the pain and tenderness over the lateral epicondyle of the humerus. Overstrain at the origins of the flexor and extensor muscles of the forearm results in a non-specific inflammation termed as lateral epicondylitis. LE is commonly seen among people who are involved in sports such as tennis and golf. Any activity that repeatedly overstrain the extensor carpi radialis brevis tendon can lead to LE. Clinical features include pain and tenderness over the lateral epicondyle of the humerus and is usually associated with poor grip strength. Initially, the pain will be mild in severity but gradually worsen over weeks or months.

Even though LE has got a natural recovery, if untreated the complaint may last for six months to two years. LE is managed surgically and non-surgically. The non-surgical measures include the use of; Nonsteroidal Anti-Inflammatory Drugs (NSAIDs), rest, physical therapy, brace and steroid injections. Open or arthroscopic tennis elbow repair surgery is recommended for individuals who don't respond to non-surgical measures.

The use of counterforce orthosis remains as the mainstay non-surgical measure for the management for lateral epicondylitis. Several randomized control clinical trials have been undertaken to evaluate the effectiveness of orthotic devices in the management of LE. The aim of this review is to summarize the evidence regarding the effectiveness of counterforce orthoses on the clinical outcomes of patients with lateral epicondylitis.

MATERIAL AND METHODS

Various randomized controlled trials evaluated the effectiveness of counterforce orthosis as a physical therapy measure for the management of lateral epicondylitis. This review evaluates the evidence pertaining to the use of various orthotic devices and related modalities in the management of lateral epicondylitis. The PubMed, Ovid, and ProQuest databases were searched for potential studies which explored the use of counterforce orthosis in the management of lateral epicondylitis. The search strategy included the keywords and their

combinations. Various keywords used were: tennis elbow, lateral epicondylitis, tendonitis, tendinitis, orthoses, counterforce orthosis, orthosis, and brace. Findings from Randomized Controlled Trials (RCTs) and Non-Randomized Controlled Trials (NRCTs) were included in the review. After title and abstract screening, twenty studies were included in the final review and evidence summarization.

RESULTS

To have a comprehensive understanding of the effectiveness of several types of orthoses, the review is organized into four sections. The first section explores the use of a 'single orthotic device', the second section focuses on the combined use of orthotic devices, the third section explores studies that compared the effect of local steroid injection along with orthosis and the last section narrates the studies that compared various types of orthotic devices.

A. Research studies that use a single orthotic device

A few studies evaluated the use of a single orthotic device in bringing about beneficial effects in patients with LE. Faes *et al*[1] developed and evaluated the efficacy of a new dynamic extensor brace, patients with lateral epicondylitis (n= 63) were randomized into a 'brace group' or to a 'no brace group'. The brace treatment was provided for a period of 12 weeks. The outcome assessment at twelve weeks revealed that the brace treatment was effective in reducing pain, improving functional ability and pain-free grip strength.[1]

Najafi *et al*[2] evaluated the impact of a spiral hand forearm splint. The splint was designed in such a way that it restricted the movement of wrist and forearm. The study employed a quasi-experimental methodology and the outcomes evaluated were; grip strength, pain, and hand function. Outcome measures were evaluated at baseline and subsequently after four weeks. Results pointed out that forearm spiral splint was effective in relieving pain, improving hand function as well as the grip force.[2]

Shamsoddini *et al*[3] evaluated the immediate effects of counterforce brace among patients with tennis elbow. The immediate effect on parameters such as grip strength, wrist extension muscle force, and range of motion were evaluated. Significant differences were observed in grip strength as well as in the wrist extension muscle force. However, the effect of counterforce orthosis in improving the range of motion was not statistically significant.[3]

In a landmark study by Wadsworth *et al*[4] the researchers evaluated the effect of a counterforce armband. Outcome measures such as wrist extension, grip strength and pain were evaluated. Parallel effects were observed in both the affected & unaffected arms in terms of increase in grip strength as well as wrist extension. However, the greatest effect was observed in the affected arm.

A statistically significant improvement in wrist extension strength was observed with the use of an armband.[4] Effect of elbow taping technique was investigated by Vincenzino *et al.*[5] In this single-blinded, placebo controlled, randomized, crossover study, the outcome measures such as 'pain-free grip strength' and 'pressure pain threshold' were assessed at baseline, immediately after, and 30 minutes after elbow taping.

In comparison to baseline, a statistically significant improvement was observed in the pain-free grip strength. Even though the changes in pressure pain threshold was positive, the results didn't fetch a statistical significance.[5] A summary of studies evaluating the effect of single orthotic devices are outlined in table-1.

Table-1: Characteristics of studies in which single orthotic device was used.

Author & Year	Methodology	Sample size	Orthotic device used	Outcome measures
Faes *et al*[1] 2006	Randomized Controlled Trial	63	Dynamic Extensor Brace	• Pain • Pain-free grip strength • Maximum grip strength • Arm functionality
Najafi *et al*[2] 2016	Quasi-experimental design	15	Spiral hand-forearm splint	• Pain • Grip force • Function
Shamsoddini *et al*[3] 2010	Quasi-experimental	15	Forearm brace	• Grip strength • Wrist extension muscle force • Range of motion
Wadsworth *et al*[4] 1989	Experimental design	14	Counterforce armband	• Wrist extension • Grip strength • Pain
Vicenzino *et al*[5] 2003	Randomized crossover study	16	Elbow taping	• Pain-free grip strength • Pressure pain threshold

B. Research studies evaluating the combined use of orthotic devices

Several studies[6–09] explored the efficacy of combined use of an orthotic device with conservative physiotherapy modalities. Strujis *et al* [6] compared braces with physiotherapy. Physiotherapy sessions comprised of pulsed ultrasound, friction massage, exercises, and stretching programs. One eighty subjects were randomized into three groups; brace group, physiotherapy group, and a brace + physiotherapy group. At six weeks, 'brace group' demonstrated significant improvements in their Activities of Daily Living (ADLs). Physiotherapy group demonstrated improvements in parameters such as pain, disability, and satisfaction. In comparison to both the groups, the brace + physiotherapy (combination) group demonstrated better outcomes in areas like severity of complaints, disability scores and satisfaction.[6]

In the study by Clement & Chow[7] 'standard physiotherapy,' modalities were compared with 'below elbow lateral counterforce splint + physiotherapy' treatment. After an intervention period of four weeks, statistically significant improvements were observed in pain and maximum grip strength among subjects in the 'splint + physiotherapy' group. The authors emphasized the value of splint as a management strategy for lateral epicondylitis. [7]

In a longitudinal study of 185 patients conducted by Solveborn[8], stretching exercises were compared with proximal forearm bands. Both the treatment modalities resulted in a clinically significant symptom reduction, improvement of range of motion and reduction in pain scores. But the statistical significance was in favor of stretching exercises.[8] These findings were in divergence to the study findings of Strujis *et al*[6] and Clement & Chow.[7]

A randomized comparative therapeutic trial was conducted by Burton[9], to test the hypothesis that forearm straps or topical anti-inflammatory cream will improve therapeutic response in subjects with tennis elbow treated by manipulation. In this study, 33 adults with tennis elbow received various combinations of treatment modalities. Grip strength and pain score were the outcomes of interest in this trial. At the end of three weeks, the majority of the subjects improved significantly, yet the results do not demonstrate any therapeutic benefits with the use of add-ons such as forearm strap or topical anti-inflammatory cream.[9] Table-2 depicts the characteristics of studies evaluating the combined use of orthotic devices.

Table-2: Characteristics of studies evaluating the combined use of orthotic devices

Author & Year	Methodology	Sample size	Treatment modality	Outcome measures
Strujis *et al*[6] 2004	Randomized clinical trial	180	• Brace • Physical Therapy • Brace + Physical therapy	• Pain • Disability • Satisfaction • Activities of daily living
Clement & Chow[7] 1993	Experimental study	16	• Standard physiotherapy • Splint + Standard physiotherapy	• Pain • Maximum grip strength
Solveborn[8] 1997	Prospective study	185	• Stretching exercises • Proximal forearm bands	• Symptom reduction • Range of motion • Pain
Burton[9] 1988	Randomized controlled trial	33	• Forearm strap • Anti-inflammatory cream	• Grip strength • Pain score

C. Research studies that compared the effect of local steroid injection along with orthosis.

Ertuk *et al*[10] evaluated four interventions for the management of tennis elbow. Thirty-six patients were randomly assigned into four groups who received, acemetacin (NSAID), local injection with triamcinolone (corticosteroid), epicondylitis bandage, and epicondylitis bandage along with local triamcinolone injection. Ertuk *et al* concluded that the local triamcinolone injection in combination with epicondylitis bandage as the most effective strategy for the management of lateral epicondylitis.[10]

Hakers & Lunderberg[11] examined the pain ameliorating effect of elbow band, splintage and local steroid injection. Sixty-one patients were randomly assigned into three groups. The results at the end of two weeks supported the use of steroid injections. However, after six months, 42% of subjects treated with steroids had a recurrence. The researchers concluded that steroid injections can be considered as a rapid pain relief strategy and it is no more effective than splint age or elbow bandage in the long-term management of LE.[11]

The effect of an off-shell orthotic device was evaluated against a corticosteroid injection in an RCT by Jensen *et al*.[12] Sixteen patients were randomly assigned to the trial arms and were followed up for six weeks. Outcome measures such as the grip strength and pain scores were evaluated. The study results found that orthotic devices are as

good as steroids in the initial management of tennis elbow. However, the researchers recommended the use of orthosis, as they are simple, effective and are devoid of side effects.[12]

In a recently published systematic review by Olaussen *et al*[13], the authors concluded that even though corticosteroids result in short-term benefits, its long-term effects are conflicting. On the contrary, the manipulation and or exercise therapy will have short-term as well as long-term benefits with minimal side effects.[13] Characteristics of studies that compared the effect of local steroid injection along with orthosis are outlined in table-3.

Table-3: Characteristics of studies that compared the effect of local steroid injection along with orthosis.

Author & Year	Methodology	Sample size	Intervention	Outcome measures
Ertuk *et al*[10] 1997	Experimental study	36	• Acemetacin • Local triamcinolone injection • Epicondylitis bandage • Epicondylitis bandage & local triamcinolone injection	• Pain • Grip strength • Tenderness
Haker & Lundeberg[11] 1993	Randomized controlled trial	61	• Elbow-band • Splintage • Local steroid injections	• Pain score
Jensen *et al*[12] 2001	Randomized controlled trial	16	• Orthotic device • Corticosteroid injection	• Grip Strength • Pain

D. Comparison of different types of orthotic devices

Sadeghi-Demneh & Jafarian[14] conducted a cross-over randomized trial to identify the effect of three orthotic devices on the severity of pain among patients with lateral epicondylitis. Fifty-two participants were randomized and crossed over to four test conditions viz; an elbow band, an elbow sleeve, a wrist splint, and a placebo orthosis. In comparison with placebo orthosis, reported pain scores after the use of all three orthotic devices were significantly lower. The relative pain reduction efficacy of elbow band and elbow sleeve was greater than that of the wrist splint.[14]

The effectiveness of two orthosis devices were compared in a prospective randomized study by Garg *et al.*[15] The effects of a 'forearm strap brace' and a 'wrist extension splint' were compared. Forty-two patients were assigned randomly to the two treatment arms. Results quoted that at six weeks of therapy, forearm straps and wrist extension splints had equal efficacy. However, the 'pain control' was better achieved with the wrist extension splint.[15]

Tangavleu & Moorthy [16] evaluated the effectiveness of a 'modified elbow brace' over a 'custom made elbow binder, in reducing pain, improving grip strength and enhancing hand function among subjects diagnosed with tennis elbow. A pretest-posttest research design was utilized for the study. Thirty subjects were randomly assigned into the study groups. Subjects in the modified elbow brace group demonstrated better outcomes in terms pain reduction, grip strength improvement and enhancement of hand function.[16]

The effects of kineso taping and athletic taping were compared in a cross-over study conducted Goel *et al.*[17] Muscle performance and pain scores were the outcomes of interest. Sixteen patients with lateral epicondylitis were included in the study. Significant pain reduction and an increase in grip strength were observed among the subjects after the taping techniques. The study recommended that athletic taping and kineso-taping can be utilized as non-surgical management strategies for lateral epicondylitis.[17]

In a double-blinded RCT conducted by Bisset *et al*[18], the immediate effect of two kinds of counterforce braces were evaluated. Thirty-four patients were tested at three conditions; a forearm brace condition, a forearm-elbow-brace condition, and a control (no brace) condition. Pain-free grip strength, as well as pressure pain threshold, showed statistically significant improvements in all three conditions. No significant differences were found between the braces and the control conditions.[18]

Adding on to this, came up the results of a repeated measures study conducted by Wuori *et al.*[19] Fifty patients participated in this repeated measures study. The outcomes were tested with two elbow braces (Count'R-Force Tennis Elbow Brace; Body Glove Airprene Elbow Support), a placebo brace and a no-brace situation. No statistical differences were found in parameters such as pain scores and pain-free grip strength.[19]

An RCT[20] evaluated the effects of two different types of counterforce elbow braces on wrist and forearm muscle force among patients with tennis elbow. Sixteen subjects were randomly assigned into three test conditions; wearing no brace (control condition), brace I (Pro Tennis Elbow Brace) or brace 2 (Aircast Tennis Elbow Brace). Concentric or eccentric muscle force evaluated at the three brace conditions resulted in nonsignificant results.[20]

Streek *et al*[21] randomized 43 patients into two study groups. A 'prefabricated thamert forearm/hand splint' was tested in one study group whereas a 'simple elbow band' was tested in another. Outcomes measures of interest were grip strength, pain scores and a score of "Patient-Rated Forearm Evaluation Questionnaire" (PRFEQ). Orthotic devices were worn for 6 weeks. Statistically significant results were observed in maximum grip strength as well as on the scores on the PRFEQ. The study couldn't observe a difference between the groups. The study concluded that the hand splint is not better than the elbow band as a management strategy for LE.[21]

Table-4 summarizes the features of studies in which orthotic devices are compared. The studies[18–21] concluded that no braces or splint is superior to another one in bringing about clinically relevant outcomes in individuals suffering from lateral epicondylitis and no significant difference was observed statistically when comparing different types of orthotic braces. However, the studies collectively account that orthosis can be used as a treatment modality in the management of lateral epicondylitis.

Table-4: Characteristics of studies in which different orthotic devices were compared.

Author	Design	Sample size	Orthotic devices compared	Outcome measures
Sadeghi-Demneh[14] 2013	Crossover randomized trial	52	• Elbow Band • Elbow sleeve • Wrist splint	• Pain
Garg *et al*[15] 2010	Randomized trial	42	• Forearm strap brace • Wrist extension splint	• Elbow function • Pain relief
Tangavelu & Moorthy[16] 2015	Pretest-posttest design	30	• Modified elbow brace • Custom made elbow binder	• Pain • Grip strength • Hand Function
Goel *et al*[17] 2015	Cross-over study	16	• Kinesio taping • Athletic taping	• Pain • Muscle performance
Bissel *et al*[18] 2014	Randomized controlled trial	34	• Forearm-brace • Forearm-elbow-brace	• Pain-free grip strength • Pressure pain threshold • Wrist angle
Wuori *et al*[19] 1998	Repeated measures study	50	• Elbow Brace • Elbow Support • Placebo brace	• Pain-Free grip strength • Pain score
Anderson *et al*[20] 1992	Experimental study	16	• Pro tennis elbow brace • Aircast tennis elbow brace	• Wrist muscle force • Forearm muscle force
Streek *et al*[21] 2004	Experimental study	43	• Elbow band group • Splint group	• Maximal grip strength • Pain score

DISCUSSION

The literature indicates that various orthotic devices have been evaluated for its efficacy in improving the outcomes of patients with lateral epicondylitis. Review of the studies[1–5] that focused on the utility of a single orthotic device supports the use of orthotic devices. The outcome measures of interest for most of the studies were pain score, grip strength, and functional ability. The studies[1,2,4] demonstrated a significant reduction in pain scores of individuals treated with an orthotic device. The orthotic devices were also found to improve the pain-free grip strength.[1,3–5] Two studies[1,2] reported an improvement in functional ability. Even though diverse types of devices were developed and utilized by the researchers, the basic principle of an orthotic device was preserved in all the studies, and this would have resulted in positive patient outcomes. Overall the current evidence supports the use of orthotic devices in reducing pain, improving grip strength and enhancing the functional ability among subjects with lateral epicondylitis.

Four studies[6–9] evaluated the combined use of orthotic devices. Forearm bands, splint, and brace where the treatment modalities used. Routine physical therapy or stretching exercise were used in the control arm. One study[9] compared the effect of an anti-inflammatory cream with that of a forearm strap. The pain was the major outcome of interest for all the studies. Two studies[7,9] evaluated grip strength as an outcome of interest. Disability, the range of motion, symptom reduction and the ability to perform ADLs were also evaluated as the outcomes of the study.[6,8] The studies[6,7] concluded that a combination therapy of brace/splint with physiotherapy was more effective than routine physiotherapy alone. The results of these studies[6,7] report that the combination approach resulted in; significant pain reduction, improvement of grip strength, reduction of disability and improvement in the ability to perform ADLs.

Authors could retrieve three studies which compared the effect of local steroid injection along with orthosis. Pain score and grip strength remain as the major outcomes of interest in the aforementioned

studies. Ertuk *et al*[10] reported that a combination of an epicondylitis bandage along with local triamcinolone injection was effective in the management of LE. The studies[10–12] concluded that steroid injections can be considered as a pain relief strategy in the acute management of lateral epicondylitis. However, the results on long-term and short-term effectiveness of steroid injection were paradoxical in nature. The evidence on long-term benefits of steroid injections in comparison to orthotic devices needs further exploration.

Nine studies[14–21] compared the effect of various orthotic devices. All the studies were experimental in methodology. The effect of various orthotic devices such as; elbow bands, elbow sleeves, elbow braces, wrist splints, forearm braces, and kinesio taping were evaluated. Pain, grip strength, hand function, elbow function and muscle force were the major outcomes evaluated. The studies[14–21] collectively supports the use of orthotic devices, but fail to conclude which type of orthotic device is more effective. Since variability is observed in the types of orthotic devices used, a conclusive result cannot be drawn from these reviews.

In the era of evidence-based practice, it is inevitable to base the clinical decisions in high-quality evidence.[22] Rigorously tested best possible evidence must underpin the clinical practice. Systematic reviews and narrative reviews act as sources of evidence summarization and pave the way to evidence based practice.[22–24] This article outlines a narrative summary evidence regarding the management of lateral epicondylitis. However, this review does not involve quality assessment of the included studies. Paradoxical results from a few of the included studies warrants further high powered, methodologically strong studies evaluating the effect of orthosis as a treatment modality for the management of lateral epicondylitis.

CONCLUSION

In the past decade, there has been a growing interest in studying the effect of various kind of orthosis in patients suffering from Lateral Epicondylitis. Those studies which evaluated the use of a 'single orthotic device' support the use of orthotic devices as a nonsurgical modality for lateral epicondylitis. There is rising evidence which supports the use of a comprehensive approach, (by combining routine physiotherapy and orthotic devices) in the management of LE. Studies comparing the utility of various orthotic devices reports the efficacy of orthotic devices in outcomes of patients but fails to conclude which among the orthotic device works better. Hence further explorations in this field might be necessary. Even though randomized controlled trials recommend the use of steroid in the acute management of lateral epicondylitis, their long terms effects seem to be unexplored. Better designed and well conducted randomized control trials in this area are warranted.

Orthosis alone or in combination with routine physical therapy can be considered as an evidence-based treatment strategy for patients with lateral epicondylitis. Even though the orthotic devices are found to be effective, the relative efficacy of different types of orthotic devices points to contradictory evidence. This may be due to the clinical, methodological and statistical heterogeneity between the studies. There is a wide variability between the type of devices used and the nature of outcome measures evaluated. Further high-quality clinical trials, comparing the efficacy of various types of orthotic devices in the management of lateral epicondylitis may be necessary to strengthen the evidence-based physiotherapy practice.

CONFLICT OF INTEREST

The authors have no relevant potential conflicts of interest to disclose.

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