Review Article
Orthopedics
DOI: http://dx.doi.org/10.1590/1413-785220223005e254358

REVIEW OF ARTICULATED ELBOW ORTHOTICS FOR JOINT STIFFNESS REHABILITATION

REVISÃO DE ÓRTESES ARTICULADAS DE COTOVELO PARA REABILITAÇÃO DE RIGIDEZ ARTICULAR

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ABSTRACT

Joint stiffness is the most common complication in elbow injuries, presenting several etiologies and pathophysiological mechanisms that hinder treatment and prognosis. Prevention and treatment of joint contracture depend on the cause of stiffness, and early intervention should modify its outcomes. The methods used may be conservative or surgical, alone or in combination, according to each individual situation. Objective: Review articles on articulated elbow orthosis for joint stiffness rehabilitation. Methods: A literature review was conducted in journals available at the PubMed, Medline and LILACS databases, using the following Health Science Descriptors (DeCS): orthotic devices; braces; elbow; elbow joint; contracture; joint disorders. It sought to retrieve and analyze studies with the highest level of evidence that have already been conducted on articulated elbow orthosis for joint stiffness rehabilitation. Results: After applying the inclusion and exclusion criteria, four articles were included from PubMed and none from Medline or LILACS. Of the four PubMed articles, two were systematic reviews and two were randomized clinical trials. Conclusion: Articulated elbow orthoses can benefit joint stiffness treatment, improving range of motion and pain, showing superior effect compared to non-articulated plaster orthotics. ***Level of Evidence III, Systematic Review of Level III Studies.***

Keywords: Orthopedic Devices. Braces. Elbow. Elbow Joint. Contracture. Articulation Disorders.

RESUMO

A rigidez articular é a principal complicação do cotovelo, afetando o tratamento e o prognóstico. O manejo da contratura articular se baseia na sua etiologia, e a intervenção precoce deve modificar o desfecho dessa complicação. Objetivo: Revisar artigos sobre órtese articulada de cotovelo para reabilitação de rigidez articular. Métodos: Foi realizada uma revisão bibliográfica em periódicos disponíveis do PubMed, Medline e LILACS, utilizando os Descritores em Ciências da Saúde (DeCS): aparelhos ortopédicos; braquetes; cotovelo; articulação do cotovelo; contratura; e transtornos da articulação. A intenção foi estabelecer e conhecer estudos de alto poder de evidência já realizados, que tenham tido como referência a temática de órteses articuladas de cotovelo para reabilitação de rigidez articular. Resultados: Após a aplicação dos critérios de inclusão e exclusão, revisaram-se artigos indexados no PubMed, Medline e LILACS, encontrando-se quatro artigos pelo PubMed e nenhum pelo Medline ou LILACS. Dos quatro artigos, dois eram revisões sistemáticas e dois eram ensaios clínicos randomizados. Conclusão: Órteses articuladas de cotovelo podem ser benéficas no tratamento de rigidez articular, sendo sugerido que melhoram amplitude de movimentos (ADM) e dor, inclusive com efeito superior em relação às órteses não articuladas gessadas. ***Nível de Evidência III, Revisão Sistemática de Estudos de Nível III.***

Descritores: *Aparelhos Ortopédicos. Braquetes. Cotovelo. Articulação do Cotovelo. Contratura. Transtornos da Articulação.*

Citation: Cavalcanti AMG, Oliveira Filho RS, Gomes HC, Martins ABS, Garcia EB, Ferreira LM. Review of articulated elbow orthotics for joint stiffness rehabilitation. Acta Ortop Bras. [online]. 2022;30(5): Page 1 of 4. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Joint stiffness is a major complication that most commonly affects the elbow, hindering treatment and prognosis. Joint contracture management depends on its etiology, and early intervention should modify its outcome.[1-3]

Intrinsic or extrinsic elbow lesions should be considered (Table 1), which appear frequently combined with factors such as: patient age, inflammatory, infectious or degenerative diseases, hemophilic diseases, trauma, burns, immobilization duration, heterotopic ossification, tumors, neurological and congenital diseases.[1]

All authors declare no potential conflict of interest related to this article.

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Article received on 07/16/2021, approved on 10/07/2021.

Table 1. Joint stiffness intrinsic and extrinsic components.

Intrinsic components	Extrinsic components
Intraarticular adhesions	Capsular or ligament contracture
Poor joint alignment	Heterotopic ossification
Loss of joint cartilage	Extra-articular vicious consolidation
Combination of the above	Soft tissue contractures by burns

Source: Charalambous and Morrey.[2]

Prevention and treatment of joint contracture depend on the cause of stiffness, and early intervention should improve prognosis. The methods used can be conservative or surgical, alone or in combination.[4]

Postoperative use of articulated orthosis helps with stretching and maintaining soft tissue joint range-of-motion gain (capsular, ligament, tendon and muscle structures) throughout the therapeutic process.[5]

Static or dynamic orthosis (depending on the protocol used) in association with continuous passive motion (CPM), of variable duration, is recommended for the inflammatory phase, which lasts about two weeks and includes the immediate postoperative phase. In the next phase, lasting two to six weeks, when scar tissue maturation occurs, collagen can still be elongated, and any movement lost due to CPM discontinuation can be regained. During remodeling (six weeks to six months), the priority is to achieve active range of motion along the same passive arc. At this stage, muscles and tendons should be at their maximum range of motion, but may lack strength at its extremes, which may regress if not maintained by the orthosis. If the patient fails to strengthen the joint to its maximum flexion and extension, contracture will recur.

The immobilization program should be continued, with gradual removal of the daytime orthosis, but keeping the nighttime orthosis for six months or more. Immobilization will last proportionally to the contracture.

In clinical practice, plasters and non-articulated orthotics are commonly used in the postoperative phase of orthopedic surgeries, for a variable period, to protect the surgical procedure performed. But this immobilization method goes against the principle of early mobility that every joint should have, since absolute rest of the limb is not indicated. Experts are often faced with complex joint lesions and observe the need for additional extrinsic protection after surgical fixation, or even after a lesion that does not require an invasive approach.[6]

Among the orthotics indicated for elbow injury rehabilitation, articulated orthoses are preferred over non-articulated ones, since the former allow joint movement. Articulated orthotics are divided into static and dynamic:

- Static orthoses: allow the maximum tolerated elongation (maximum flexion or maximum extension), in a constant position.[7]
- Dynamic orthoses: are adjustable and scaled securely to avoid pain or instability, allowing constant stretch load.[2]
- Static-progressive orthoses: static orthotics that allows adjustment in joint position in small increments, adding force.[7]

Needing faster and better results, health professionals encourage the use of articulated orthotics as an important instrument to assist in injury rehabilitation, aiming at joint protection and mobility, generating safety for the surgeon and the rehabilitation team, and positive effects for the patient, both in pain control and early member functionality.

Objective

Review articles on articulated joint orthosis for joint stiffness rehabilitation.

METHODS

A literature search, without time and language restrictions, was conducted on the PubMed, MEDLINE and LILACS databases, using the following Health Sciences Descriptors (DeCS): "printing, three-dimensional," "orthotic devices," "braces," "elbow," "elbow joint," "contracture" and "articulation disorders."

Our review sought to retrieve and analyze studies with the highest level of evidence that have already been conducted on elbow joint orthoses for joint stiffness rehabilitation.

Table 2 summarizes the strategy used. We found 299 articles in PubMed, 321 in Medline, and 5 in LILACS.

Table 2. Search strategy.

PubMed	(*Elbow) OR Elbow[MeSH Terms]) AND Capsular Contracture) OR Capsular Contracture[MeSH Terms]) AND Orthoses) OR Orthoses[MeSH Terms]) AND Orthosis) OR Orthosis[MeSH Terms]) AND Brace) OR Brace[MeSH Terms]) AND Orthotic Devices) OR Orthotic Devices[MeSH Terms]) AND Splints) OR Splints[MeSH Terms]) AND Static Splints) OR Static Splints[MeSH Terms]) AND Dynamic Splints) OR Dynamic Splints[MeSH Terms]) AND Elbow Splint) OR Elbow Splint[MeSH Terms*])
LILACS	(*Orthoses OR Orthosis OR Brace OR Elbow Splint OR Orthotic Devices OR Static Splints OR Dynamic Splints AND Elbow OR Capsular Contracture OR Printing, Three-Dimensional*)

Inclusion criteria

- Clinical trial;
- Randomized clinical trial;
- Systematic review;
- Meta-analysis;
- Human beings;
- Articles published in the last 20 years.

Non-inclusion criteria

- Population under 18 years old;
- Expert opinion;
- Animal research;
- Articles published over 20 years ago

Exclusion criteria

- Studies with children;
- Dental braces;
- Orthotics for lateral epicondylitis;
- Absence of joint stiffness or diseases that do not result in loss of range of motion (ROM);
- Neurological diseases;
- Peripheral nerve diseases;
- Wrist and hand diseases.

RESULTS

After applying the inclusion, non-inclusion and exclusion criteria, we were left with four articles from PubMed and no paper from LILACS. Of the four PubMed articles, two were systematic reviews and two randomized clinical trials.

In a systematic review, Chen et al.[8] evaluated the use of static-progressive orthotics for elbow contracture. The authors searched for articles in English published during January 1, 1997, and January 31, 2017, in the Web of Science, Cochrane Library, PubMed and EBSCOhost databases. Two evaluators assessed the quality of the articles. After summarizing each paper in evidence tables, the authors performed a narrative synthesis. The final sample included ten clinical trials,

of which only two were controlled clinical trials. By way of conclusion, the researchers suggest that these orthotics could improve ROM for patients with elbow contracture. Some studies selected patients shortly after surgical treatment, while others recruited patients who failed standard physiotherapy from 4 to 11 weeks or had elbow contracture between 52 days and 16.7 months. Despite the positive outcomes reported in all papers analyzed, the contribution of static-progressive orthotics to improvement in interventions performed after surgery can be questioned, as it is difficult to exclude the effects of another concomitant treatment. In short, evidence suggests that progressive-static orthotics help in elbow contracture by improving range of motion.

Veltman et al.[9] analyzed eight studies evaluating progressive-static and dynamic splints for non-surgical treatment of post-traumatic elbow stiffness, including one randomized clinical trial and seven retrospective cohort studies. For analysis, patients were divided into two groups: (1) patients treated with progressive-static immobilization and (2) patients treated with dynamic immobilization. The first group included 160 patients (160 elbows) with elbow stiffness described in six studies. Mean range of motion before immobilization for all elbows was 72° (range 54°–89°) with an average of 112° flexion (range 101°–118°) and an average of 39° extension deficit (range 23°–59°). Mean improvement was 36° for an average post-immobilization ROM of 108° (range 100°–112°) with 128° flexion (range 125°–130°) and 22° extension deficit (range 17°–28°). The second group included 72 patients (72 elbows) with elbow stiffness analyzed in three studies. Mean time between trauma and the start of static or dynamic immobilization was 9 months. Mean range of motion before immobilization for all elbows was 63° (range 52°–68°) with an average of 111° flexion (range 100°–124°) and an average of 48° flexion contracture (range 41°–58°). Mean improvement was 37° for an average post-immobilization ROM of 100° (range 92°–105°) with 127° flexion (range 126°–129°) and 28° extension deficit (range 21°–37°). In conclusion, both dynamic and progressive-static splints present good outcomes in elbow stiffness treatment. Choice of one orthotics over the other is up to the surgeon and the patient. According to the authors, treatment with dynamic orthotics or progressive-static immobilization have similar outcomes.

In a randomized clinical trial, Merolla et al.[10] evaluated the efficacy, usability, and tolerability of a dynamic elbow orthosis compared to standard plaster following medial or lateral collateral ligament reconstruction. The study included 26 individuals, 23 with medial collateral ligament (MCL) injury and three with lateral collateral ligament (LCL) injury, randomized into two groups of 13 patients: group A received dynamic orthotics and group B was treated with plaster splint. Outcome measures included visual analog pain scale pain score, arm circumference, grip strength, Oxford Elbow Score (OES), and ROM. Patients were evaluated at the beginning of the study and at 2, 6, 12, and 24 weeks. All patients reported a significant pain reduction at 6, 12, and 24 weeks ($p < 0.05$). Mean circumference was significantly higher in group A at all times (all $p < 0.05$). Mean grip strength was higher in group A at 2 and 6 weeks ($p < 0.05$), whereas the difference found at 12 and 24 weeks was not significant. The OES and passive ROM values of both groups were not significantly different at any time. The authors concluded that both the dynamic orthosis and the plaster splint provided effective and safe elbow immobilization after MCL or LCL reconstruction. Dynamic orthosis provided greater pain reduction, faster recovery of muscle trophism and grip strength, and was better tolerated.

In a prospective randomized clinical trial, Lindenhovius et al.[11] evaluated the difference between immobilization with progressive-static and dynamic elbow splints in flexion-extension and pronation. The study included 66 patients with post-traumatic elbow stiffness: 35 received progressive-static immobilization and 31 dynamic orthosis. Patients answered the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire at enrollment and at the six- and twelve-month evaluation. Results showed no significant differences in ROM gain over time between the orthotics. Improvement in arch flexion (dynamic versus static) averaged 29° versus 28° at three months ($p = 0.87$), 40° versus 39° at six months ($p = 0.72$) and 47° versus 49° at twelve months after immobilization was started ($p = 0.71$). Mean DASH score (dynamic versus static) was 50 against 45 points at enrollment ($p = 0.52$), 32 against 25 points at six months ($p < 0.05$) and 28 against 26 points at twelve months after enrollment ($p = 0.61$). The authors found no significant differences in motion improvement between the progressive-static and dynamic immobilization protocols. Choice of the immobilization method can be determined by patients and their physicians. Three patients who were prescribed a dynamic splint requested a change to a progressive-static splint due to pain and discomfort.

DISCUSSION

We found little relevant literature on specific therapeutic management for elbow stiffness. Most studies on the topic incur in methodological deficiencies when comparing between types of articulated elbow orthotics. Data often refers to global rehabilitation concepts rather than specific evaluation and treatment. Hence, elbow stiffness after injury is challenging dilemma for surgeons, therapists and patients.[12]

Joint contracture is a common complication after trauma and can lead to surgical treatment in up to 12% of cases. Pain and swelling after trauma or surgery play an essential role in promoting stiffness. Research points to capsular retraction and soft tissue contracture as major contributors of elbow stiffness after bone and ligament restoration and alignment.[12]

Overall, orthotics use have two purposes: protection and recovery of movement. Protective immobilization is fixed and non-articulated, maintained at a 90° comfort position, and initiated after trauma; whereas immobilization for regaining motion is usually articulated, initiated after some tissue healing and subsequent application of a low prolonged stretching load, used to increase ROM.[13]

Dynamic orthotics tend to cause greater soft tissue lesions and inflammation under a constant load on the joint, resulting in low compliance. Progressive-static orthotics can achieve greater stretching via stress relaxation. Progressive-static orthotics have many advantages: force and ROM adjustment to maximum tolerable intensity; tolerable load controlled by patient according to subjective sensation; greater tolerance and compliance; mobility, patient could do active exercises after easily removing the orthotics; effective, efficient, economical, requires less time and money.[12]

Although ROM gain occurs mostly in the first six months of orthotics use, a randomized controlled clinical trial conducted with patients using progressive-static or dynamic orthosis for joint stiffness, observed a group gain in between six and twelve months, showing that persistence and patience during non-surgical treatment are important and necessary.[11]

After conducting a meta-analysis and systematic review of 13 studies on the efficacy of orthotics in treating non-bone mobility restriction of the elbow, a study analyzed progressive-static, dynamic or static devices for treatment of soft tissue injuries after trauma or surgery that caused joint stiffness. Mean duration from incident to the start of treatment with the device was 6.9 ± 5.1 months. ROM improvement was 38.4 ± 8.9 (95% confidence interval, 39.5° to 41.8°). Comparison between dynamic, static or static-progressive orthotics found no significant difference, but the authors recommended using progressive-static orthotics three times for thirty minutes a day in each direction as the first-line treatment for elbow stiffness without evidence of restriction or heterotopic ossification.[14]

Early joint mobility should be prioritized for a satisfactory final clinical outcome. Extrinsic stabilization using orthotics effectively ensures the safety of the procedure performed, providing immobilization and favorable environment to capsule-ligament and bone healing.

This method, such as a cast or plaster splint, provides stability and reduces force transmission at the fracture site or soft tissue injury to allow healing of the bony and ligament structures around the joint, but when used excessively, can cause secondary stiffness and contracture.[13] Besides hindering early gain of motion, it hampers grooming and hygiene, requires changes, interferes in the quality of radiological exams, can have allergic effects, requires time for the procedure, presents constant loosening, can lead to adverse circulatory effects, joint stiffness, loss of muscle mass, skin necrosis, or even compartment syndrome.[12]

The articulated orthosis enables early mobility and protection of the procedure performed, since it blocks varus and valgus movements, enabling healing of acute ligament injuries or reconstruction of chronic injuries, preservation of fractures, chondral procedures, arthroplasties, etc. It provides protection with joint mobility, briefly recovering functionality, reducing pain, providing comfort of use, benefiting limb blood circulation, and avoiding joint stiffness.

CONCLUSION

Joint elbow orthotics may be beneficial for treating joint stiffness, since they improve ROM and pain, including superiority effect on non-articulated gelding orthosis. Progressive and dynamic static orthotics showed similar outcomes, differing only in the greater discomfort when wearing dynamic orthotics.

ACKNOWLEDGEMENTS

I thank the fellow authors and project collaborators; Professor Renato Santos for his advice during the various writing stages; Professor Heitor Carvalho for the grammatical and organizational corrections; Amanda Martins for her help in the bibliographic research and summary; Professor Elvio Garcia for categorical coordination of the graduate course, and Professor Lydia Masako for her technical-scientific influence, knowledge and assistance during the academic journey.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. AMGC: literature review, bibliographic search; RSOF: project design, organization; HCG: manuscript writing and data analysis; ABSM: summary of articles; EBG: manuscript review; LMF: intellectual conceptualization and methodology.

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