IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

DYNAMIC PROGRESSIVE ELBOW ORTHOSIS FOR GRADUAL CORRECTION/PREVENTION OF CONTRACTURES OF ELBOW JOINT BY USING ELBOW LOCK MECHANISM.

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ABSTRACT:
The dynamic progressive orthosis with newly designed elbow joint lock is an attempt to introduce a new concept of the elbow joint for gradual correction/prevention of contractures of elbow joint following trauma, musculoskeletal injuries, congenital contractures, etc.

Currently, there are two types of interventions for elbow contracture:
Operative and non-operative treatment.
The operative treatment involves open or arthroscopic release, arthroplasty, and manipulation under anaesthesia. Although these are efficient treatments, surgery and manipulation under anesthesia are complex and tend to cause neurovascular complications as well as recurrence. The nonoperative treatment mainly involves passive or assistant movement, continuous passive movement, serial bracing, and dynamic and dynamic orthoses. The newly designed dynamic progressive orthosis for gradual correction/prevention of contractures by the use of an elbow joint lock is made such that it locks at different desirable angles to correct or prevent the contracture. It is presented in this report which helps to improve the range of motion of the joint without using serial casting method. The mechanism of dynamic progressive orthoses for contracture is based on creep and stress relaxation.

INTRODUCTION

Elbow Stiffness with loss of function is a common disabling problem that usually arises as a complication of trauma, but may also occur following burns or head injury or in association with degenerative, inflammatory or hemophiliac arthropathy and congenital malformations. The degree of stiffness is related to the severity of the injury and the duration of immobilization at initial treatment.
Elbow contractures can be classified as extrinsic or intrinsic according to the underlying aetiology. Extrinsic contractures involve the peri-articular soft- tissues with a normal or near normal articular surface. Intrinsic factors include disruption of the normal articular surface, osteophytes, intra-articular loose bodies and secondary osteoarthritis. Generally, the functional range of motion for the elbow is between 30 to 130 deg. Flexion contractures greater than 45 deg will significantly limit ADLs. In general, contractures are the result of constriction or stiffness of connective tissues. Aside from joints (such as the elbows), this can also affect the skin, ligaments, muscles, and tendons.

Causes of contractures:
Central nervous diseases including Parkinson's disease, polio, and multiple sclerosis (MS), among others,

- Cerebral palsy,
- Congenital contractures,
- Congenital radial head dislocation,
- Hemophilia-associated hemarthroses,

- Muscular dystrophy,
- Osteoarthritis,
- Post-septic arthritis,
- Rheumatoid arthritis,

Symptoms

The main symptom of the condition is the reduced ability to move the affected arm. This makes even simple activities, such as using a keyboard and getting dressed, extremely difficult.

Some patients also experience pain depending on the cause of the condition.

Conservative treatments are generally recommended in patients suffering from minimal contractures. This often involves physical and occupational therapists who can perform the following procedures:

Mobilizing splinting –

This method involves holding the affected joints at the end of the available range of motion for an extended period. This is proven effective in restoring passive motion to stiff joints and muscles.

Serial casting –

This involves the application and removal of a series of lightweight fiberglass casts to stretch shortened or tight muscles. It is referred to as serial casting because each time a new cast is applied, the position of the body changes. Its goal is to gradually increase the joint's flexibility.

NEED FOR THE STUDY:

As one of the most common musculoskeletal complications following trauma, elbow contracture is a frequent source of disabled daily activities. Conventional interventions are inadequate to provide favorable outcome. The dynamic progressive orthoses are getting popular in the treatment of this problem.

The available design in the market does not provide that much improvement which is required and it requires changing the orthosis every time for improvement of ROM at regular intervals.

Serial casting method is very time consuming and it requires removal and change after sometime to be kept in another angle for correction.

The new concept of elbow joint which locks at every desired angle and helps to improve the range of motion in stiff elbow joint and contractures following trauma is useful for gradual correction/prevention of contractures in elbow joint.

WORKING OF MODEL: The elbow joint with lock is made such that when the patients hand have to be kept in 10 degree of flexion it will be locked in that position and will not change its position until and unless the worm is not moved manually or with allen key of 4mm.

As in dynamic progressive therapy of patient of elbow contracture gradually correction is provided by increase in degree of motion of elbow flexion.

Using dynamic progressive orthoses, the tissue is stretched and held at a constant length. The amount of force is decreased over time. It is a periodic application of stress relaxation that is experienced. Dynamic progressive orthoses are typically worn in 30 minutes 2-3 times a day. In each 30minute session the force that is being applied is increased every 5-10 minutes by the patient in an effort to increase ROM during the time the brace is being worn. This treatment usually lasts about 2-4 months.

The uprights which contain the gear and worm mechanism is attached to arm shell at two points.

The uprights which is movable is attached to forearm shell and moves throughout the range of motion and locks at desirable angle.

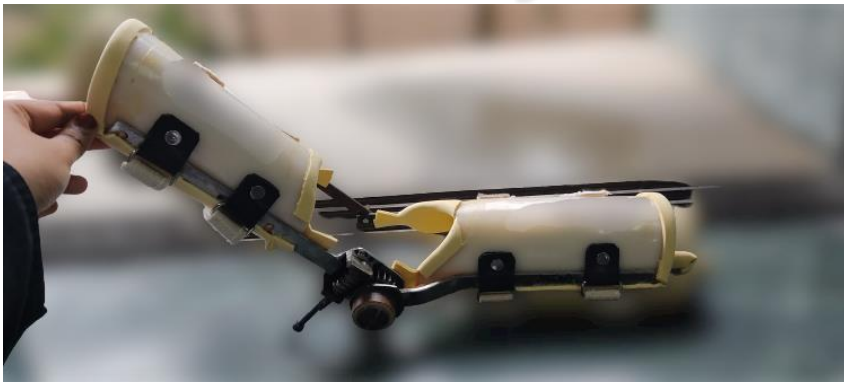

Figure 1 Prototype

In stress relaxation, the displacement is constant and the applied force varies. This is the principle of dynamic progressive orthoses, in which patients are instructed to constantly adjust and readjust the tension on their stiff joints. The tissue reaches the plastic deformation state more quickly and the effects will last longer.

1. Non-elastic component places tension on stiff joint/tissue to hold at its maximum tolerable length.
2. Adjustments to the tension on each joint can be made by the client.
3. The orthotic design maintains the shortened tissue at its maximal tolerable length and does not stress beyond it. It is very important not to exceed the maximal tolerable stress level, which could lead to tissue failure.
4. The longer the tissues remain at its maximum tolerable length, the more it increases in length. This concept is known as total end range time (TERT).
5. Success can be measured by small gains of perhaps 5–10 degrees a week.

Figure 2 Final Design

The Benefits:

1. Improved range of motion without pain; high tolerance for orthotic use because the patient can control the force of the tension; higher compliance and higher patient satisfaction result.
2. The patient is able to adjust the tension force gradually, as this type of orthotic intervention takes advantage of small incremental changes in tissue length.
3. The optimum orthotic design allows for small changes in joint motion without remolding of the orthosis each time gains in range of motion are accomplished

Figure 3 Changing of angle at regular intervals

Comparison between the new design and the available options

1] The new design does not need to be changed everytime for correction as in available designs it needs to be change for gradual correction of contracture.

2] Serial casting method is ruled out as the new design provides desired flexion and extension angle with locking mechanism.

3] Dynamic progressive braces include those equipped with tuners that produce distraction forces on the humeroulnar joint in the final degrees of extension and compression forces in the final degrees of flexion.

CONCLUSION:

As this design is conceptual and no trials are yet been done, it becomes premature to comment upon the actual success of the design. But as the design is the result of detailed study of human elbow joint and mechanics, and stimulates the same.

The desired advantages as well as the listed drawbacks are expected in the working model of the dynamic progressive orthosis with elbow joint lock for gradual correction/prevention of elbow contractures by improving the range of motion.

The newly designed dynamic progressive orthosis with elbow joint lock is useful in increasing the range of motion of stiff elbow joint by gradually increasing the desired flexion – extension angle and locking at that desired angle.

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