MOTION FEEDBACK DEVICE TO ASSIST IN IMPROVING JOINT MOTION

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One of the most common sequelae after elbow fracture or dislocation is joint stiffness. 1,2,5,7,10,11,12,16

Elbow stiffness can lead to long-term limitations in basic activities of daily living. 1,2,5,7,10,11,12,16
BACKGROUND

• Approximately 8-10% of the fractures and dislocations in children occur at the distal humerus or proximal radius and ulna.\(^6,8,11\)
DISTAL HUMERUS FRACTURE

Anterior/Posterior View

Lateral View
Elbow dislocation, radial head or neck fracture and coronoid process fracture.
BACKGROUND

• Elbow dislocations are the most common dislocation in the pediatric population. ⁴,⁶,¹³
ELBOW DISLOCATIONS

Posterior Elbow Dislocation

Anterior Elbow Dislocation
Elbow problems are also prevalent in the adult population.

The incidence of fractures in adults is most common in elderly females and young males.\(^4\)

Elbow dislocations are second only to shoulder dislocations in the adult population.\(^3,4,6,13\)

Elbow dislocations are thought to be between 6 and 8 per 100,000 people annually.\(^4,6\)
The elbow is “unforgiving” due to its:

- Anatomy - Superficial joint, numerous muscles, nerves, joint capsule
- Pathology - Spontaneous misbehavior – exaggerated response to insult
- Treatment options - Most treatments are “unreliable” - both operative and non-operative
  - Rehabilitation is unpredictable and frustrating at best
• Superficial (subcutaneous) joint that is prone to infection (2-5%) and problems with wound healing
BACKGROUND

- Following elbow fracture or dislocation, patients are typically immobilized with a sling, posterior elbow orthosis or cast at 90° during the acute phase of healing. \(^7,11,13\)

- All previous studies agree that early active mobilization is the essential component in helping to regain full mobility and preventing stiffness and complications. \(^1-8,10-11,12,13,16,17\)
PROBLEM

- Therapists struggle with the fact that their patients, especially children, “resist” during active assistive range of motion.
- In order to overcome these challenges, a motion feedback device was designed using the latest technology, to encourage active range of motion (AROM) to allow for quicker recovery and restoration of function.
SOLUTION

• The device was conceptualized while working with children that were guarding during their therapy session.

• The therapist wanted a mechanism that would not only allow the patient to relax, but also enjoy their treatment session.

• Music was utilized as the tool to provide motivation and instant positive feedback.

• The ROM device is strapped on the patient with Velcro and via a Bluetooth connection to any smartphone, music is activated once the target ROM is achieved.
MOTION FEEDBACK DEVICE
PURPOSE

- Will a motion sensitive, music activated, feedback device be able to detect changes in elbow position within ±10° through a predetermined arc of motion?
METHODS

• N=60 typically developing children and adults ranging in age from 7 to 70 years.
• All participants were tested bilaterally in both flexion and extension three times.
• A goniometer was used to measure both the initial (90°) and targeted angle (extension 70°, flexion 110°) for music activation.
**RESULTS**

- The ROM device activated 100% of the time providing feedback to the patient.

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RESULTS

Right Elbow Flexion

Left Elbow Flexion
RESULTS

Right Elbow Extension

Left Elbow Extension
DISCUSSION

• Participants in this validation study valued the concept of this device. All the participants, especially the children, enjoyed the ability to select their own songs, the activation of the music, and the instant feedback it provided.
DISCUSSION

• Initially, the device had pre-recorded music and was mounted directly onto a prefabricated hinged elbow brace. Knowing that this setup would be cost prohibitive for patients, the device was modified by removing it from the brace, and a Velcro strap was added. Currently, the device can connect via Bluetooth to any smartphone’s music library, compared to playing pre-recorded music.
DISCUSSION

• In future generations of this device, the researchers hope to have a mobile application that will capture the duration the device was worn, how long the patients were able to maintain the targeted angle and the extent of battery life available. Future research will not only be conducted on patients with traumatic elbow injuries, but also on patients with stiffness of other large joints including the shoulder, wrist, hip, knee, and ankle.
CONCLUSION

• Device can be used for many applications . . .
  • Immediately following injury for controlled ROM
  • Early mobilization for post operative patients
  • Assist with active/passive stretching during the rehab phase
  • Soft tissue tightness
  • Assist with decreasing tone in neurological patients
REFERENCES


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