The Effects of a Functional Elbow Brace on Medial Joint Stability: A Case Study

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Abstract:

Medial elbow ligament sprains in athletics can be traumatic and disabling. In this case report, we outline the effect of a prototype functional elbow brace on joint stability in a female collegiate javelin thrower with an ulnar collateral ligament sprain. A valgus force to both elbows was applied using graded stress radiography (Telos GA-II /E stress device) at 0, 5, 10, and 15 kiloPascals (kPa) of pressure. The increase in gap width between the coronoid process and the medial epicondyle was measured from anteroposterior radiographs to determine medial displacement. The brace resulted in less displacement in both injured and noninjured ulnar collateral ligament; injured ulnar collateral ligament demonstrated greater displacement regardless of condition. The brace restored medial stability to the elbow joint by 49%, 38%, and 35% at 5, 10, and 15 kPa of pressure, respectively. The application of the brace may be useful in athletes with ulnar collateral ligament injuries.

Article:

Elbow injuries resulting from activities such as baseball and javelin throwing are confounding problems for athletes in these sports.[2] Trauma to the elbow in sports involving violent collisions can also be disabling and problematic for a number of athletes.[3] Although lateral epicondylitis is the most common injury of this joint, tension- induced problems may occur more frequently on the medial aspect of the joint.[2,7] The extent of such an injury may result in compromise of the medial (ulnar) collateral ligament, leading to a significant detriment to function and performance. Numerous studies have implicated the ulnar collateral ligament, primarily the anterior oblique bundle, as being the primary stabilizer of the elbow in various degrees of flexion in response to a valgus stress.[4,5,9-11]

Whether through conservative measures or surgical intervention, postinjury treatment and restoration may take a considerable amount of time. In fact, individuals having undergone operative management have required up to 1 year of functional physical therapy before full

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return to participation.[2,6] However, in sports at the college and professional levels, athletes are often required to return to play before rehabilitation is completed. A question arises as to whether or not an orthotic device applied to the elbow will give this joint functional medial support. In this paper, we examine the effect of a newly developed functional brace on providing valgus support to the elbow of a female collegiate javelin thrower with an ulnar collateral ligament injury. At the present time, there is very little evidence available to validate the use of an orthotic device to add medial stability to the elbow joint.

CASE DETAILS

A 19-year-old white female collegiate javelin thrower (ht = 5'10", wt = 170 lb) sustained an ulnar collateral ligament injury during training 5 months prior to the testing procedure. She had injured her elbow while performing a plyometric box jump in which she accidently landed on an outstretched arm with her elbow in full extension. She was referred by the Hand and Sports Services Section of the Orthopaedic Department to the Radiology Department for further evaluation. Stress radiographs revealed that she had sustained a partial tear of her ulnar collateral ligament. She signed a informed consent form for this study which followed the Human Rights guidelines established by the University of Virginia.

Graded stress radiography was performed with a Telos GA-II/E stress device (Austin & Associates, Fallstone, MD) and an accessory piece of equipment to hold the hand and wrist in supination (patent pending) (Fig 1). This device is equipped with a screw-threaded shaft that permits the gradual application of stress. The pressure is monitored on a light-emitting diode digital readout. Anteroposterior radiographs of the non- injured and injured elbows were taken with 0, 5, 10, and 15 kPa of pressure applied to the lateral aspect of the joint.

The brace used in this case study was a prototype for a newly developed functional elbow brace (Fig 2). The brace consists of two outer shells made of a high temperature plastic (polyethylene) which are fastened to the upper and lower arm with velcro straps. The medial and lateral joint hinges were heat-moulded to allow them to conform to the natural carrying angle of the elbow (15° valgus angle in full elbow extension). The brace was fitted to the subject's elbow with two foam condyle pads placed over the medial and lateral epicondyles through which the axis of rotation of the elbow passes.' By placing the axis of the plastic hinge joints over this portion of the elbow, flexion and extension of this joint was not compromised.

The testing procedure was carried out with the subject seated in an up- right position and the elbow flexed 25° to unlock the olecranon from its fossa. The upper arm was held in approximately 65 to 70° of shoulder abduction and external rotation with the forearm fully supinated. The arm was placed within the Telos apparatus with a proximal stabilizing pad just distal to the axilla and a distal stabilizing pad at the hand and wrist. The pressure plate was placed over the lateral joint line and a valgus force was applied at 0, 5, 10, and 15 kPa of

pressure. This graded application of pressure is the standard protocol used by the Department of Radiology with the Telos stress device.

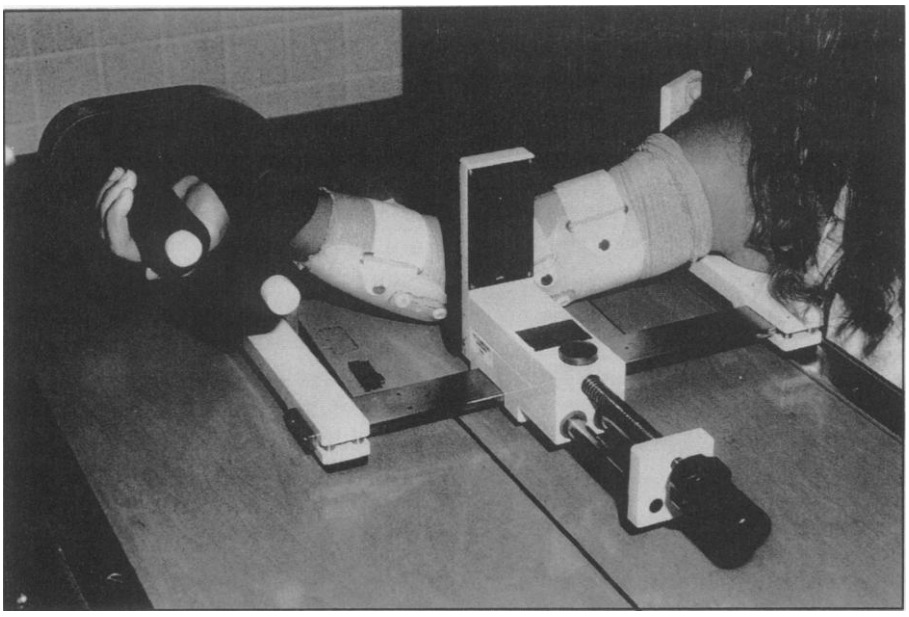

Fig 1:—Patient position for graded stress radiography with a Telos GA-II/E stress device.

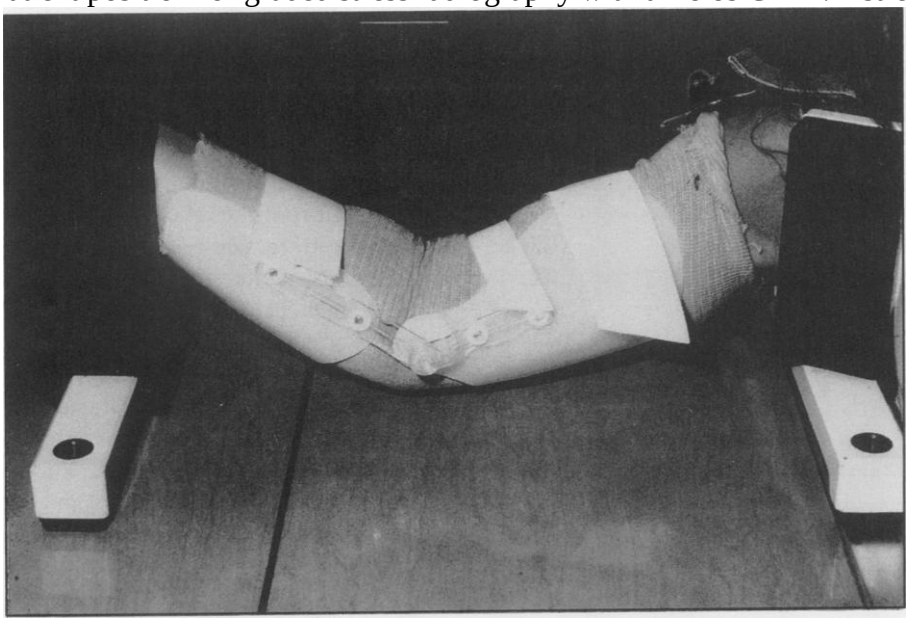

Fig 2:—Prototype for a newly developed functional elbow brace.

The noninjured extremity was tested first without application of the brace, then with the brace. The same procedure was repeated with the injured extremity.

Anteroposterior radiographs were taken at each of the corresponding pressures to detect any changes in medial elbow displacement. Medial elbow displacement was measured by the distance in millimeters between the coronoid process of the ulna and the nearest point on the

curved contour of the medial epicondyle. The measurement was performed using a loupe (7 x) provided with a calibrated scale with 10 divisions to the millimeter (Bausch & Lomb, Inc, Rochester, NY).

To correlate pressure with the amount of medial displacement representative to the extent of ulnar collateral ligament stretching, a relative displacement ratio was calculated for the various pressures applied (*d/dO*). The displacement (millimeters) at zero pressure is represented by *dO*, and the displacement at the various pressures are represented by *d*. The relative displacement values in each of the four different conditions were entered into the following equation to calculate the percentage restoration to medial elbow stability in the injured arm as a result of brace application: % restoration = injured w/o brace — injured w/ brace/(injured w/o brace — noninjured w/o brace).

Elbow Instability

The difference in medial joint laxity between the noninjured and injured extremities are presented in Fig 3, illustrating greater joint laxity in the injured arm than the noninjured extremity at all pressures. The table indicates higher displacement values in millimeters as well as higher relative displacement values at 5, 10, and 15 kPa of pressure in the injured extremity when compared to the noninjured extremity.

Brace Support

There was a reduction in relative displacement in the noninjured arm after brace application (.01 to .04 difference). However, there was a greater reduction in relative displacement in the injured arm after brace application (.19 to .21 difference) than the noninjured arm. With respect to the restorative effects of the brace, greater medial stability was restored to the elbow at lower pressures (49% at 5 kPa) than at the higher pressures (35% at 15 kPa). At 10 kPa of pressure, the brace restored 38% support to medial stability (Fig 3).

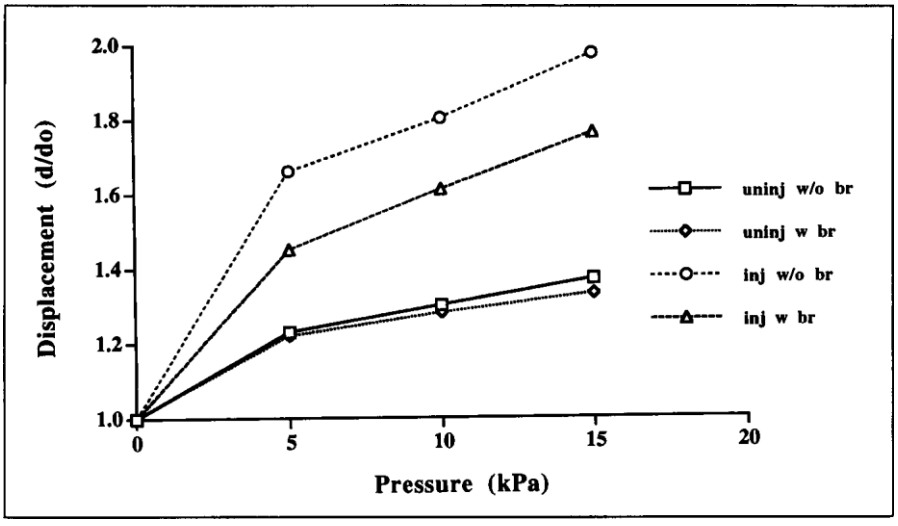

Fig 3:-Relative displacement values of the medial elbow joint plotted against pressure (kiloPascals) in the noninjured and injured extremities with and without application of the brace.

Displacement (mm), Relative Displacement (d/d0) and Difference Values of the Noninjured and Injured Extremities With and Without the Application of the Brace in Response to a Valgus Stress at 0, 5, 10, and 15 kPa of Pressure.

	Pressure (kPa)	Noninjured		Injured		Difference
		mm	*d/dO*	mm	*d/dO*	
Nonbraced	**0**	**3.0**	**1.00**	**3.0**	**1.00**	
	5	**3.7**	**1.23**	**3.65**	**1.22**	**.01**
	10	**3.9**	**1.30**	**3.85**	**1.28**	**.02**
	15	**4.1**	**1.37**	**4.0**	**1.33**	**.04**
Braced	**0**	**3.0**	**1.00**	**3.3**	**1.00**	
	5	**5.0**	**1.66**	**4.8**	**1.45**	**.21**
	10	**5.4**	**1.80**	**5.3**	**1.61**	**.19**
	15	**5.8**	**1.97**	**5.8**	**1.76**	**.21**

DISCUSSION

The objective diagnostic technique used in this study is of prime value. Manual measurement of joint laxity as performed by the elbow valgus stress test is virtually dependent upon the skill and technique of the tester. In addition, being objectively aware of the patient's joint laxity allows the practitioner to make more informed decisions concerning appropriate treatment.

The importance of the ulnar collateral ligament as the primary stabilizing structure to the elbow in response to a valgus stress has been investigated.[4] The anterior bundle of the ulnar collateral ligament, referred to as the epitrochlear-coronoid fasciculi, is the strongest portion of this ligamentous complex. .[4] More recent investigators reported that the anterior band of the ulnar collateral ligament is a taut structure throughout the full range of motion and provides the primary restraint to a valgus stress.[8,9] With respect to other elbow stresses, Sojbjerg and associates[10] applied a 1.5-Nm valgus and internal rotary force to 12 cadaveric elbow specimens. They found that isolated transection of the anterior bundle of the ulnar collateral ligament resulted in significant joint instability that was not reproducible with isolated transection of the posterior oblique bundle or the joint capsule. A study of 30 cadaveric elbow specimens yielded similar results.[5] These authors.[5] reported that isolated transection of the anterior portion of the ulnar collateral ligament resulted in significant and gross instability in response to a valgus stress at 0, 45, and 90° of elbow flexion. These studies not only indicate the importance of the ulnar collateral ligament to medial stability of the elbow, but also provide an assumption that can be made in studies such as these. It can be assumed that medial elbow instability, as measured in this study, is a result of damage to the ulnar collateral ligament.

The effect of the brace in this study appeared to reduce relative joint displacement of the elbow in response to a valgus stress (Fig 3). We could find no previous studies in the litera-

ture that examined the effect of a brace on medial elbow stability. Since the brace did have the ability to restore medial stability to the elbow by at least 35%, this poses a major question: "Would this brace offer similar support to the elbow in sport- specific patterns?" Although the results from this study cannot answer this question, they do indicate the need for further research. This is based on the fact that by reducing medial elbow displacement, the degree of stress on the ulnar collateral ligament is decreased. .[5]

Research involving a large sample size subjected to these procedures would allow for between-groups measures, and the overall consistency of results may yield more definite conclusions with respect to the effectiveness of the brace.

Another factor to be considered is the brace design. The brace used in this study was a custom-moulded prototype in which one of the authors served as the model. A brace designed to accommodate varying elbow widths or a number of different brace sizes would have to be used for future study.

A longitudinal study examining the effects of the brace with use is a third factor that should be considered in future studies. Examining medial elbow laxity after an athlete returns to activity would provide information on brace effectiveness during sport- specific participation.

In this case, the brace had a more pronounced effect on the injured extremity than the noninjured extremity. The use of the brace on extremities with varying injury severities would give a better indication for use in those individuals demonstrating ulnar collateral ligament injuries to the elbow.

In conclusion, the brace tested in this case may be useful for athletes with ulnar, collateral ligament injuries who are planning to return to competition prematurely. Further modifications to the prototype will be required before it can be used in an athletic setting. However, the preliminary results demonstrate a positive trend towards the restoration of medial elbow stability.

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