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Extensor Indicis Proprius Opponensplasty – The Burkhalter Revisited

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Abstract The Extensor Indicis Proprius Opponensplasty although not widely exercised by hand surgeons has previously been shown to produce good results in the restoration of thumb opposition. Over the last 5 years the Extensor Indicis Proprius was selectively used in cases where the Flexor Digitorum Superficialis was unavailable or inappropriate. In a small case series operating on a total of six male patients with an average age of 32 and follow up of 12 months we have been impressed by the functional outcome and lack of donor site morbidity. The Extensor Indicis Proprius is expendable with minimal donor site morbidity, is of sufficient length and has an optimal line of pull to provide a superior mechanical advantage and a favourable torque when compared to Flexor Digitorum Superficialis.

Keywords Extensor Indicis · Tendon transfers · Opponensplasty · Burkhalter · Hand injury

Introduction

Drobnik performed the first tendon transfer in the hand in 1894 on a 4 year old girl whom had suffered from polio [1, 2]. They are commonly indicated in traumatic injuries and peripheral nerve injuries either whilst awaiting nerve repair or

following its failure [3, 4] Opponensplasty developed by Steindler in 1917 [5] currently comprises of a number of methods. Use of the Palmaris Longus popularized by Camitz in 1929, an easy transfer but a static one only returning thumb abduction [2, 3, 6]. The Huber technique popularized by Littler in 1963 uses a short tendon the Abductor Digiti Minimi (ADM), primarily indicated for thumb hypoplasia [7, 8]. The flexor digitorum superficialis (FDS) most commonly used and can be carried out using a variety of techniques including the Royal-Thompson, Bunnell and Fritschi methods [9–11]. Use of the Extensor Indicis Proprius (EIP) was popularised by Burkhalter [12]. He published the results of 65 EIP transfers of which 57 regained excellent thumb function. Anderson et al. also demonstrated good or excellent results in 35 out of 39 patients using the EIP [13]. In a second study by Anderson et al. comparing EIP alongside FDS they found EIP to be superior when carried out in supple hands [14].

It is the experience of the senior author that FDS is more commonly used we hold certain reservations about donor site morbidity and the relative mechanical disadvantage when compared to EIP. EIP Opponensplasty has been shown to produce good results in restoration of hand function by improving opposition and abduction of the thumb yet it has not been widely exercised by hand surgeons [14, 17]. Over the last 5 years the senior author has selectively used EIP in cases where the FDS is unavailable or inappropriate. Having assessed a small series of patients we have been impressed by the functional outcome and would consider selecting the EIP transfer preferentially.

Methods

The operative technique used was based upon that described by Burkhalter [12]. Initially during harvesting of the tendon

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Table 1 Table Demonstrating Degrees of Abduction after 6 and 12 months

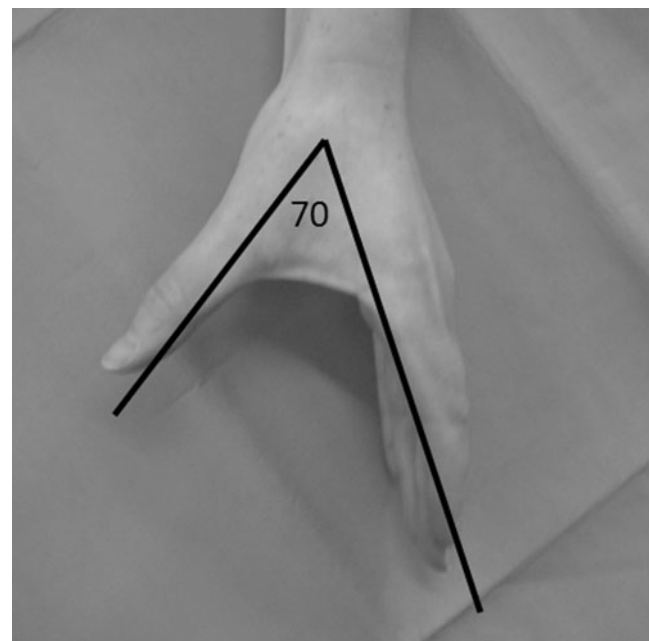
Age	Sex	Injury	Indication for EIP	Degrees of abduction	
				6 months	12 months
32	Male	Assault - Combined Median and Ulnar nerve injury	Forearm flexors repair	60	60
52	Male	Self Harm – Combined Median and Ulnar nerve injury	Previous 2x FDS opponensplasty	60	70
35	Male	Burn contracture of hand palm	FDS tethered – 1 st web release	45	45
22	Male	High median nerve injury	FDS weak	75	90
32	Male	Congenital hypoplasia of thumb	Previous Huber opponensplasty Hypermobile Joints	75	Follow up lost
51	Male	Bilateral severe forarm injuries. Left arm amputated below elbow. Right median nerve intact but weak Thenar muscles.	Skin grafts to volar aspect of forearm	70	70

1 cm of the dorsum of the hood is taken and both the sagittal band and the extensor digitorum comunis (EDC) is reconstituted to the index. The fourth compartment is opened and EIP is freed from the other extensors. Subsequently two incisions are made an ulnar incision to deliver the EIP and and a small incision over the pisiform to accommodate the EIP, the tendon is to be passed around the ulnar side of the wrist. A subcutaneous tunnel is then made to the radio-lateral border of the Meta-carpo-phalangeal Joint of the thumb. In previously described methods the points of insertion vary [13, 14]. We weaved the EIP through the abductor pollicis brevis tendon (APB) and then performed a dorso ventral sling around the Extensor Pollicis Longus (EPL). The tendon Tension was balanced with position and the transfer secured with a 4/0 ethibond. It is recommended that the tension be tight with the thumb in full palmar abduction with the wrist in neutral position. Post operatively the patient requires immobilization and physiotherapy.

We operated on a total of six male patients with an average age of 32 using the Burkhalter Opponensplasty. All six patients had both varying indications for tendon transfer and varying contraindications preventing the use of FDS as demonstrated in Table 1. The minimum follow up was 12 months, of the six one patient was lost and only followed up at 6 months.

Pre-operatively we measured thumb abduction using our department's current technique which is a simplification of previous techniques. Due to the multiplaner movement of the thumb the measurement of abduction per-se is difficult. Subjective methods previously outlined by Anderson et al. are influenced by the relative position of the thumb interphalangeal joint as well as the ranges of movement of the adjacent fingers and therefore do not measure the true faze of thumb abduction [13]. Objective methods of post operative evaluation have been previously described, notably by Mehta et al. and Fritschi, such methods can take into account the position of the resting thumb, range of abduction, degree of flexion of the

terminal phalanx, the pinch pattern and the strength of pinch [10, 17]. Although such methods are comprehensive we felt that they may be complex and not efficient in a busy teaching hospital to reconcile these potential pitfalls we use a simpler technique of measurement. We found our current method to be simple, reliable and reproducible. The patient is asked to place the hand ulnar side down perpendicular to the table, at which point the position of the trapio-metacarpel joint is marked. The patient is then asked to abduct his thumb in a plane parallel to the table and a line is drawn from the marked point to the ulnar side of the thumb nail and the angle between this line and the axis of the second ray is measured using a goniometer as demonstrated in Fig. 1. Although by abducting the thumb

**Fig. 1** Showing method of measuring thumb abduction using goniometer

in the transverse plane parallel to the table the extensor activity is minimised, this can bias the assessment.

Results

The overall results are presented in Table 1; the average abduction at 6 months was 64 ° and 67 ° at 12 months. There was no donor site morbidity.

Discussion

When looking to optimize the force exerted by a pulley system and hence increase the function of the tendon the basic physics underlying the system needs to be assessed. In a pulley system, the torque which is produced by the motor is dependent upon two variable quantities; the length of the lever and the angle at the fulcrum. Furthermore the closer the angle at the fulcrum is to a straight line the less force is expended to overcome friction at the pulley. The smaller angle and the potentially greater distance in an FDS transfer means that the transferred tendon has to perform more work to produce the same force at its point of insertion than the EIP which has a larger angle and shorter distance. The line of action of the EIP to the Pisiform is more direct than FDS, this has been shown to maximise abduction [15, 16]. Clinically applied the angle of abduction and therefore circumduction achieved with an EIP is greater than with an FDS.

As far as rehabilitation for the EIP is concerned in our institutions experience the period of cortical reconditioning and achievement of optimal function is prolonged although it is of note that this is not a universal experience. We have been selectively using the EIP transfer when FDS has been unavailable. EIP opponensplasty shows impressive functional results and donor site morbidity is minimal and largely limited to some loss of independence of index extension. Not only is EIP largely expendable, it is of sufficient length and has an optimal line of pull to perhaps provide a superior mechanical advantage and a favourable torque.

Declaration of Conflicting Interests All named authors hereby declare that they have no conflicts of interest to disclose.

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