Introduction
Opposition of the thumb is the most important component of normal hand function. Action of several muscles are required in opposition of thumb, some responsible for positioning of thumb while other provide compressive forces for pinch. Function of median nerve is to mainly provide the positioning of thumb via abductor pollicis brevis, opponenspollicis and superficial head of flexor pollicis brevis. Injury to median nerve either above elbow or below elbow leads to the loss of ability to oppose the thumb to the fingers. There are no postoperative complications. Nine (82%) patients had excellent results, while the remaining 2(18%) had good result.

Conclusion: In patients with isolated traumatic median nerve palsy, Burkhalter opponensplasty yielded excellent and satisfactory results.

Keywords: Extensor Indicis Proprius, Median nerve, Tendon transfer, Opponensplasty, Hand injury.

Material and Methods
The prospective study was conducted at the Mayo Hospital, Lahore, from June 2010 to June 2013, and comprised cases of Burkhalter opponensplasty using the Extensor Indicis Proprius to restore thumb opposition in isolated median nerve palsies. All patients had the condition for 16 to 20 months. The tendon was harvested just proximal to the extensor expansion and the insertion was to the distal attachment of abductor pollicis brevis.

Results: Of the 11 patients in the study, 6(54.5%) were females and 5(45.5%) were males, with overall ages ranging between 19 years and 51 years. There were no postoperative complications. Nine (82%) patients had excellent results, while the remaining 2(18%) had good result.

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Abstract
Objective: To report the outcome of Burkhalter opponensplasty using Extensor Indicis Proprius with isolated traumatic low median nerve palsy.

Methods: The prospective study was conducted at the Mayo Hospital, Lahore, from June 2010 to June 2013, and comprised cases of Burkhalter opponensplasty using the Extensor Indicis Proprius to restore thumb opposition in isolated median nerve palsies. All patients had the condition for 16 to 20 months. The tendon was harvested just proximal to the extensor expansion and the insertion was to the distal attachment of abductor pollicis brevis.

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Extensor Digitorum Communis slip to index. A second incision was made in the fourth compartment and Extensor Indicis Proprius was separated from other tendons and delivered. Then an incision was made on the ulnar side of the wrist. A subcutaneous tunnel was made from the incision to the fourth compartment on the dorsum of hand, and tendon was delivered and passed around on the ulnar side of the wrist. Another subcutaneous tunnel was made to the radio-lateral border of the MCP joint of thumb. Tendon was then passed through the tunnel and woven through the base of abductor pollicis brevis tendon using Pulvertaft technique and was secured with proline 4/0 round body. It was important that the tension was kept be tight with the thumb in full palmar abduction with the wrist in neutral position. Patient was given cast for four weeks postoperatively and then advised physiotherapy.

For the response each patient was examined two weeks after the surgery, and then followed up monthly for six months. Treatment efficacy was assessed at final follow-up using Sundararaj-Mani criteria. As such, the outcome was considered Excellent when opposition to the ring or little finger tip with the interphalangeal joint of the thumb extended; Good when opposition to the index or middle finger tip with the interphalangeal joint of the thumb extended; Fair when the interphalangeal joint of the thumb flexes for opposition; and Poor when there was no opposition.

Testing of opposition was performed with the wrist in 10° of extension to eliminate any element of wrist tenodesis that could aid opposition.

**Results**

Of the 11 patients in the study, 6(54.5%) were females and 5(45.5%) were males, with overall ages ranging between 19 years and 51 years. Functional opposition was initially obtained in 6-8 weeks of postoperative physiotherapy, but continued to improve over some time before hitting a plateau. At final follow-up, 9(82%) patients had Excellent results, while the remaining 2(18%) had Good result. There were no postoperative complications. Six (54.5%) patients experienced pain after the procedure which was cured with analgesics during the hospital stay and oral non-steroidal anti-inflammatory drugs (NSAIDs) at the time of discharge. Pain was relieved in a few days.

**Discussion**

Though the current study had its weakness like not assessing the power of opposition and the working with a

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Age</th>
<th>Sex</th>
<th>Mode of Trauma</th>
<th>Time passed since injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>35</td>
<td>Male</td>
<td>Road Traffic Injury at elbow</td>
<td>16 months</td>
</tr>
<tr>
<td>ii</td>
<td>46</td>
<td>Female</td>
<td>Knife injury at wrist</td>
<td>18 months</td>
</tr>
<tr>
<td>iii</td>
<td>29</td>
<td>Female</td>
<td>Road traffic injury at forearm</td>
<td>16 months</td>
</tr>
<tr>
<td>iv</td>
<td>48</td>
<td>Male</td>
<td>Machine injury</td>
<td>17 months</td>
</tr>
<tr>
<td>v</td>
<td>26</td>
<td>Male</td>
<td>Road traffic accident</td>
<td>19 months</td>
</tr>
<tr>
<td>vi</td>
<td>44</td>
<td>Female</td>
<td>Road traffic accident</td>
<td>16 months</td>
</tr>
<tr>
<td>vii</td>
<td>31</td>
<td>Female</td>
<td>Self-harm</td>
<td>20 months</td>
</tr>
<tr>
<td>viii</td>
<td>19</td>
<td>Female</td>
<td>Glass injury</td>
<td>19 months</td>
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<tr>
<td>ix</td>
<td>22</td>
<td>Male</td>
<td>Toka injury</td>
<td>16 months</td>
</tr>
<tr>
<td>x</td>
<td>51</td>
<td>Male</td>
<td>Assault</td>
<td>19 months</td>
</tr>
<tr>
<td>xi</td>
<td>26</td>
<td>Female</td>
<td>Fire arm injury wrist</td>
<td>20 months</td>
</tr>
</tbody>
</table>

Figure: A: Pre-op picture of 46-year-old female with median nerve injury and unable to abduct the thumb. B and C: 4 weeks post-op picture showing abduction. D and E: 6 months post-op showing full opposition of thumb.
small sample, it had two strengths: uniform aetiology and technique having been performed by a single surgeon. As for the power of opposition, the intact ulnar nerve, which in some patients anomalously innervates the ulnar muscle, means many patients with traumatic median nerve injury do not lose opposition, as noted in literature.\\(^{15}\)

One study used a modified Bunnell opponensplasty on 86 patients with leprous neuritis resulting in paralysis of intrinsic muscles of hand. It reported 18 Good results, 63 Fair, and 5 Poor results.\\(^{16}\) A series of 24 cases showed 15 patients with Excellent results, 6 with Good and 3 with Fair result.\\(^{14}\) A case series of 23 patients reported 13 Excellent results, 6 Good, 3 Fair, and 1 Poor. Another grading was used to assess the power of pinch which was Good in 14 hands, Fair in 7 hands and Poor in 2.\\(^{17}\)

We applied Burkhalter opponensplasty using Extensor Indicis Proprius, and Excellent and Good results were obtained. However, we did not assess the degree of abduction, opposition and power of pinch.

The basic physics underlying the system needs to be assessed in order to optimise the force exerted by a pulley system to increase the function of tendon. The length of the lever and the angle at the fulcrum are the two variable quantities upon which the torque which is produced by the motor is dependent. Also when the angle of the fulcrum is closer to a straight line, less force is required to overcome friction at pulley. In opponensplasty using Flexor Fugitorum Superficialis, tendon performs more work to produce the same force at its insertion compared to Extensor Indicis Proprius because of the fact that Flexor Digitorum Superficialis has smaller angle and potentially greater distance than Extensor Indicis Proprius having larger angle and shorter distance. Maximum abduction is seen in Extensor Indicis Proprius because Extensor Indicis Proprius has direct line of action to pisiform than that of Flexor Digitorum Superficialis.\\(^{18,19}\) Hence, the circumduction achieved with Extensor Indicis Proprius is greater than Flexor Digitorum Superficialis.

Burkhalter Opponensplasty shows good functional results with minimal donor-site morbidity and limited increase to index extension. Not only is Extensor Indicis Proprius largely expendable, it is of sufficient length and line of pull provides a favourable torque and superior mechanical advantage.

### Conclusion

Burkhalter opponensplasty using Extensor Indicis Proprius gave excellent results in median nerve injury.

### Acknowledgment

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### References