Brachial plexus palsy secondary to birth injuries

LONG-TERM RESULTS OF ANTERIOR RELEASE AND TENDON TRANSFERS AROUND THE SHOULDER

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We describe the long-term results in ten patients with obstetric brachial plexus palsy of anterior shoulder release combined with transfer of teres major and latissimus dorsi posteriorly and laterally to allow them to act as external rotators. Eight patients had a lesion of the superior trunk and two some involvement of the entire brachial plexus. The mean age at operation was six years, and the mean follow-up was 30 years.

Before operation, the patients were unable actively to rotate the arm externally beyond neutral, although this movement was passively normal. All showed decreased strength of the external rotator, but had normal strength of the internal rotator muscles. Radiologically, no severe bony changes were seen in the glenohumeral joint.

No clinically detectable improvement of active abduction was noted in any patient. The mean active external rotation after operation was 36.5°. This was maintained for a mean of ten years, and then deteriorated in eight patients. At the latest follow-up the mean active external rotation was 10.5°.

The early satisfactory results of the procedure were not maintained. In the long term there was loss of active external rotation, possibly because of gradual degeneration of the transferred muscles, contracture of the surrounding soft tissues and degenerative changes in the glenohumeral joint.

Obstetric brachial plexus palsy is a complication in a small number of live births, 0.4 to 2.5 per 1000, and 75% to 95% of patients recover completely during the first year of life.

The remaining patients have some permanent damage, and in most the main problem is in the shoulder. All children with obstetric brachial plexus palsy have damage to the fifth and the sixth cervical nerves and in about 48%, the lesion is confined to these two nerves. The most common deformity of the arm is internal rotation and adduction because of loss of muscle balance around the glenohumeral joint. In these cases treatment should be carried out on the shoulder since limited shoulder movement affects the function of the whole limb.

After the age of four years when muscle weakness has stabilised, or fixed contractures intervene, a series of operations may be performed in children with a residual shoulder palsy. Several soft-tissue procedures have been described to release the internal rotation deformity such as anterior shoulder release, as well as to improve active external rotation and abduction of the arm by tendon transfers. The tendons which are usually transferred to strengthen external rotation are those of latissimus dorsi and teres major because of their length.

We have reviewed, in ten patients with internal rotation and adduction deformity of the arm, the long-term results of anterior shoulder release combined with tendon transfer of latissimus dorsi and teres major (Table I). The mean age of the patients at the time of operation was six years (5 to 9). Eight had a lesion of the superior trunk of the brachial plexus, the fifth and sixth cervical nerve roots, and two (cases 4 and 5) had some degree of involvement of the whole plexus. The right arm was affected in eight patients and the left in two. Four had previously received some form of physiotherapy for one to two years and the remaining patients had received inter-
Operative technique. This is according to the technique of Merle d’Aubigné.\textsuperscript{12}

With the patient supine under general anaesthesia, the involved upper limb and shoulder are prepared and draped. An anterior approach to the shoulder is made through the deltopectoral groove. The insertion of pectoralis major is defined and divided in half. Subscapularis is sectioned near its insertion and the contracted anterior capsule released. The tendinous insertions of the latissimus dorsi and teres major are identified, tagged with a suture and released near the bone. Two strong sutures are passed through the ends of the tendons. Holding the arm in full external rotation through the same incision and using a curved needle the tendons of latissimus dorsi and teres major are withdrawn and passed posteriorly and laterally close to the humerus, but not subperiosteally, and sutured to the humeral stump of the divided tendon of pectoralis major.

After irrigation and wound closure, the upper limb is immobilised for six weeks with a shoulder spica in 45° to 90° of abduction and full external rotation, 90° of flexion at the elbow, and with the forearm in supination. The portion of the cast encircling the chest should be applied the day before the operation, and the remainder of the cast in the operating room. The cast is removed after six weeks and progressive strengthening, stretching and passive range-of-motion exercises begun.

midtern physiotherapy before the initial operation. One (case 4) of the two patients with involvement of the whole plexus had previously had a transfer of flexor carpi ulnaris to the extensor tendons of the fingers and thumb; the other (case 5) had little limitation of hand function.

The criteria for selection for surgery were the age of the patient, the radiological state of the glenohumeral joint, the range of passive movements at the shoulder, and the strength of latissimus dorsi and teres major.

All the patients were beyond the age at which any spontaneous recovery could be expected. The radiological appearance of the glenohumeral joint showed minor osseous changes only with no flattening or deformity of the humeral head and no evidence of subluxation or dislocation.

For the surgical technique to be successful, the shoulder must have a satisfactory range of passive external rotation clinically confirming the absence of significant bony change in the joint. The muscle power of latissimus dorsi and teres major must be 4+ or 5 on the Medical Research Council scale.\textsuperscript{17}

Before operation, we assessed the patients’ ability to perform activities of daily living such as feeding, washing, and grooming using the affected limb. The active and passive range of movement of the entire upper limb, as well as, muscle strength were also recorded. All the patients had difficulty placing the affected hand over the mouth and behind the head, neck and back. None of the affected arms could be actively externally rotated beyond neutral.

Pectoralis major and subscapularis were normal in strength. Latissimus dorsi and teres major had a power of 4+ or 5, but the strength of the external rotator muscles was reduced.

Before operation, seven patients were grade I and three grade II according to the classification of shoulder function of Kirkos and Papadopoulos.\textsuperscript{18}

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This technique has the following advantages. The stump of the partially divided tendon of pectoralis major gives secure fixation for the transferred tendons of latissimus dorsi and teres major unlike the osteoperiosteal flaps which have been described in other similar surgical techniques. In addition, the stump increases the functional length of the transferred tendons making suture easier. The portion of pectoralis major which remains intact allows some active internal rotation of the humerus to be preserved.

**Results**

The patients were followed up for a mean of 30 years (25 to 42). At each follow-up they were assessed clinically and radiologically. The results were graded using the classification system of Kirkos and Papadopoulos.\(^{18}\) The patients were also asked their subjective opinion of the final result.

The mean active external rotation was \(-2.5^\circ\) (-10 to 0), but the mean passive external rotation was \(47^\circ\) (30 to 60). The mean active internal rotation was \(44^\circ\) (20 to 65) and the mean passive internal rotation \(68.5^\circ\), \(10^\circ\) to \(40^\circ\) greater than active internal rotation. There was no clinically detectable difference between the pre- and post-operative active abduction of the arm (Figs 1a to 1c).

Before operation, the mean pre-operative active abduction of the arm was \(75^\circ\) (30 to 110) and the mean passive abduction \(93^\circ\) which was \(10^\circ\) to \(50^\circ\) greater than the active range, especially if the arm was held in the coronal plane. In all patients, the pre- and post-operative measurement of

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Fig. 1

Photographs (case 2) showing the function of the shoulder with superior trunk palsy before operation a) at the age of five years, with decreased abduction and limited external rotation of the arm and after operation at b) 22 years, c) 40 years with limited active abduction, d) at 22 years with active external rotation decreased to \(15^\circ\) and e) at 40 years with further decrease of active external rotation to \(0^\circ\).
rotation of the shoulder was performed with the humerus held alongside the body.

After the tenth post-operative year there was a gradual decrease in active external rotation compared with that achieved initially (Figs 1d and 1e) in eight patients (cases 1, 2, 3, 4, 6, 7, 9, and 10), while only two shoulders (cases 5 and 8) retained their initial post-operative active external rotation at the final follow-up (Table II).

The post-operative mean active rotational movement was initially 87.5˚ reducing to 49.5˚ at the final follow-up (Table II). The mean active internal rotation immediately after operation was 51˚ reducing to 39˚ at the final follow-up (Table III). The mean post-operative passive internal rotation was 65˚ reducing with time to 54˚, while there was no clinically detectable difference between active and passive rotational movements of the arm at the final follow-up.

At the time of the latest follow-up, three shoulders were grade I and seven grade II, while radiographs of the shoulder revealed deformity of the humeral head in eight patients (cases 1, 2, 3, 4, 6, 7, 9, and 10) and osteoarthritis in five (cases 1, 2, 3, 4, and 7). All patients were satisfied with the result of the operation for the first ten years. Eight had observed a gradually increasing limitation of active external rotation after ten years.

Table II. Mean active movements of the shoulder pre- and post-operatively (˚)

<table>
<thead>
<tr>
<th></th>
<th>Pre-operatively</th>
<th>Early results</th>
<th>Late results</th>
<th>Final results</th>
</tr>
</thead>
<tbody>
<tr>
<td>External rotation</td>
<td>-2.5</td>
<td>36.5</td>
<td>16</td>
<td>10.5</td>
</tr>
<tr>
<td>Abduction</td>
<td>75</td>
<td>79</td>
<td>77.5</td>
<td>77</td>
</tr>
<tr>
<td>Rotational motion</td>
<td>41.5</td>
<td>67.5</td>
<td>57.5</td>
<td>49.5</td>
</tr>
</tbody>
</table>

Table III. Mean active and passive internal rotation of the shoulder pre- and post-operatively (˚)

<table>
<thead>
<tr>
<th></th>
<th>Pre-operatively</th>
<th>Post-operatively</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active</td>
<td>Passive</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>44</td>
<td>68.5</td>
</tr>
</tbody>
</table>

Fig. 2
Anteroposterior radiographs of both shoulders of the patient seen in Figure 1 a) pre-operatively at the age of five years without evidence of subluxation, or bony changes of the humeral head, b) at 22 years after operation showing flattening and deformity of the humeral head and c) 40 years after operation with further deformity and degenerative changes of the right shoulder.
Axillary nerve palsy, which is a complication of the Sever-L’Episcopo procedure\(^1\) observed by Strecker et al.,\(^{19}\) was not seen in our series. The only complication which we observed in one patient (case 7) was hypoesthesia in the area of the superficial radial nerve.

**Discussion**

The most common functional disability after obstetric brachial plexus palsy is limitation of external rotation of the shoulder with weakness of abduction.

Several operative procedures for this disabling deformity have been described. Fairbank\(^8\) described an operation to correct the internal rotation deformity and Sever\(^7\) published a modification of this operation using an anterior shoulder release. Release of the soft tissues improves the cosmetic appearance, but recurrence of the deformity, weakness of external rotation or both were frequently noted at follow-up.\(^{19}\)

L’Episcopo\(^{11}\) described transfer of the tendons of latissimus dorsi and teres major to a more lateral position on the humeral shaft to act as external rotators. Several modifications of this surgical technique have been described.\(^{12-16}\)

That described by Merle d’Aubigné\(^{12}\) which we used in our patients was the most up-to-date at the time at which our patients were operated upon. The approach is solely anterior and the restoration of muscle balance seems to be better because the transferred tendons are sutured to the humeral stump of the partially divided tendon of pectoralis major.

Our study has the advantage of a much longer follow-up than previous reports.\(^{6,13,16,19-24}\) It is well-known that tendon transfer does not increase active abduction of the shoulder. In eight of our ten patients, there was a characteristic gradual loss of the active external rotation which had been achieved by the operation and maintained for ten years. This may be the result of degeneration of the transferred latissimus dorsi and teres major because of the tension under which they were sutured and compression in their new position from the surrounding muscles and the bone. The gradual decrease in all rotational movement of the shoulder during follow-up was probably due to the shrinking of the surrounding soft tissues, deformity and degenerative change affecting the humeral head (Fig. 2). These changes may have been caused by biomechanical alterations in the joint after operation, especially the division of the subscapularis tendon which may affect the stability of the joint.

The ideal age for this type of secondary reconstructive procedure is debatable. Gilbert et al.\(^{20}\) reported that palliative operations are possible from two years of age. On the other hand Hoffer and Phipps,\(^{21}\) stated that function of the muscles returns gradually in an unpredictable fashion in children with obstetric brachial plexus palsy, and it is difficult to anticipate the final strength of the muscles. For this reason, we delayed tendon transfers until the patient was at least four years of age, by which time recovery of muscle strength had reached a plateau. Waters,\(^{25}\) reported that transfer can be successfully performed between the ages of two and seven years, depending on the severity of glenohumeral deformity. Also the older patient is usually more cooperative in regard to the essential post-operative physiotherapy.\(^{16}\)

There are only minor differences between the various modifications of the L’Episcopo procedure. We, therefore, believe that the long-term results of the surgical technique described in our study are likely to be applicable to the other techniques.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

**References**