Green’s surgical procedure in Sprengel’s deformity: Cosmetic and functional results

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Summary

Introduction: Multiple surgical options are available in the treatment of severe Sprengel’s deformities and vary according to the selected muscle disinsertion site. We report here the functional and cosmetic results of the Green’s operative technique.

Material and methods: We retrospectively reviewed cases of congenital elevation of the scapula operated on, between 1999 and 2007, at Saint-Denis Regional Hospital Center. Clinical and radiographic examinations along with parents questioning were performed.

Results: This study included eight children with a mean follow-up of 4.5 years. Improvement occurred in all cases: the appearance was improved by one grade in three children and two grades in three other children, according to the Rigault’s classification system. Cosmetically, all families were satisfied with the final result of the treatment. A case of complete brachial plexus palsy (BPP) that resolved spontaneously within 7 months was observed.

Discussion: Sprengel’s deformity is an unusual skeletal abnormality. The Green’s operative technique allows both lowering and rotation of the scapula. Muscle attachment is distally, rather than proximally, modified which provides a better biomechanical effect: muscles are reattached higher than the acromiothoracic junction’s rotation center. The Green’s scapuloplasty has been rarely reported in literature, whereas the Woodward procedure remains the reference standard. However, both techniques report similar results. Our choice was based on a better impression in terms of operative approach and improved muscle levers’ distance adjustment to the fulcrum. Finally, resection of the superomedial portion of the scapula which is fixed to the rib cage into a pocket of the latissimus dorsi seems to provide a more efficient correction.

Level of evidence: Level IV, retrospective therapeutic study.

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Introduction

First described in Germany by Eulenberg [1] (1863), and in 1891 by Sprengel [2] about four cases of maldescent of the
scapula, this congenital deformity arises from interruption in the normal caudal migration of the scapula in early fetal development thus resulting in an elevated and hypoplastic scapula. Therefore, the involved scapula appears smaller, lies above the upper thoracic region and is similar in shape, folded at the level of the infraspinous fossa. Numerous surgical treatment options are available in the management of severe Sprengel’s deformities and vary according to the muscular disinsertion site. The purpose of the present study is to report the functional and cosmetic results of the Green’s operative technique.

Material and methods

We conducted a retrospective study on congenital elevations of the scapula managed in Saint-Denis Regional Hospital Center between 1999 and 2007. Age, gender, clinical presentation, the involved shoulder and associated anomalies were noted. All patients were pre- and postoperatively clinically assessed and deformity was graded according to the Cavendish classification (Table 1). Shoulder mobility was evaluated in antepulsion, abduction and rotation. Anteroposterior views in the standing position were obtained for radiographic evaluation and classification according to the Rigault’s grading system (Table 2) [3] preoperatively and at last follow-up. Functional and cosmetic outcome was subjectively assessed by the child’s family. No statistical analysis could be carried out due to the very small sample of patients.

In the Green’s procedure (Fig. 1), muscles are detached from their scapular insertion, the trapezius muscle is then elevated extraperiosteally and reflected medially, thus exposing underlying muscles and the scapula. The supraspinatus muscle is then detached from the scapula along with its periosteum. The omovertebral bone, when present, is excised. The insertions of the levator scapulae muscles on the superior angle of the scapula and of the rhomboid muscles on the medial border of the scapula are dissected. The supraspinous fossa of the scapula is resected, taking care to avoid injury to the suprascapular neurovascular bundle. The scapular attachments of the latissimus dorsi and serratus anterior muscles are detached from the anterior aspect of the scapula. The scapula is then displaced distally down to the level of the normal side using the superomedial angle of the scapula as a landmark rather than its tip because of constant scapular hypoplasia. Once the scapula is in its corrected position, the muscles are reattached to it, the supraspinatus muscle to the base of the scapular spine, rhomboid muscles should be reinserted without compromising the new position of the scapula in the frontal plane by lengthening it if necessary, in order to achieve good orientation of the glenoid and therefore increase in the range of abduction. Some modifications were brought to the initial Green’s procedure: a clavicular osteotomy is performed first to reduce the risk of brachial plexus palsy (BPP); the insertion of the serratus anterior is dissected from the spinal border of the scapula and scapula adherence to the thoracic wall is separated; insertion of the supraspinatus muscle is resected, the inferior pole of the scapula is sutured to the thoracic cage into a pocket of the latissimus dorsi muscle (Figs. 2 and 3).

During the first postoperative month, the shoulder was immobilized in a Velpeau bandage.

Eight children were reviewed over a period of 8 years and six were surgically treated. All patients could be both clinically and radiographically reexamined at a mean follow-up of 4.5 years and a minimum follow-up of 6 months.

Table 1 Cavendish’s classification.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No visible deformity, patient fully dressed</td>
</tr>
<tr>
<td>2</td>
<td>Bumpy aspect of superomedial angle</td>
</tr>
<tr>
<td>3</td>
<td>Shoulders asymmetry, 2 to 5 cm</td>
</tr>
<tr>
<td>4</td>
<td>Shoulder asymmetric elevation &gt; 5 cm</td>
</tr>
</tbody>
</table>

Table 2 Radiographic Rigault’s classification.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Superomedial angle lower than T2 but above T4 transverse process</td>
</tr>
<tr>
<td>2</td>
<td>Superomedial angle located between C5 and T2 transverse process</td>
</tr>
<tr>
<td>3</td>
<td>Superomedial angle above C5 transverse process</td>
</tr>
</tbody>
</table>
Results

The study included six male and two female patients, of mean age two and a half years old at the time of the first visit (range: 6 months to 7 years). Mean age at the time of surgery was 3 years and 8 months (range: 2 years and 1 month to 8 years and 3 months). Five children were right-handed and one ambidextrous. The deformity involved the left shoulder in all six cases.

The associated anomalies included a left pectus carinatum and a non-evolutive 16° thoracic scoliosis in one patient and a T6 hemivertebra responsible for a 15° scoliosis at 5.5 years in another patient. None of the patients displayed renal or cardiac anomaly on systematically performed renal and cardiac scans.

Six patients were operated using the modified Green’s scapuloplasty procedure, three of whom underwent a clavicular osteotomy. Four patients demonstrated radiographic evidence of an omovertebral bone. The mean operative time was 140 min (90 to 200 min). Blood loss averaged 177 ml with significant variations (80 to 300 ml) according to the age of the patient. The mean length of hospital stay was 2.2 days (range: 1 to 3 days).

The only reported complication was complete plexus damage, occurring in a 2.5-year-old child, graded Rigault II and who fully recovered within 7 months. No clavicular osteotomy had been performed in this case.

Five out of six patients had a preoperative restriction of shoulder abduction (over 70°) and limitation of antepulsion (over 35°). The average increase in the range of abduction was 52.5° (35–60°) and 21.6° (10–40°) in antepulsion after surgery (Table 3). The mean difference in scapula height (height of tips) decreased from 4.4 cm (3–6.5) preoperatively to 2.1 cm (0–4) after surgery, that is a mean improvement of 2.3 cm (0.5–4.5). The mean postoperative difference between both supero-internal angles was 1.2 cm (0–2) (Table 4). This significant difference results from an elevated but also smaller and distorted scapula. In five cases, widening of the surgical scar in its proximal section was observed.
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Table 4 Scapular top levels disparities in postoperative improvements (in cm).

<table>
<thead>
<tr>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>+3</td>
</tr>
<tr>
<td>4.5</td>
<td>3</td>
<td>+1.5</td>
</tr>
<tr>
<td>3.5</td>
<td>1.5</td>
<td>+2</td>
</tr>
<tr>
<td>4.5</td>
<td>4</td>
<td>+0.5</td>
</tr>
<tr>
<td>4.5</td>
<td>2</td>
<td>+2.5</td>
</tr>
<tr>
<td>6.5</td>
<td>2</td>
<td>+4.5</td>
</tr>
</tbody>
</table>

Table 5 Status changes according to Rigault’s classification.

<table>
<thead>
<tr>
<th>Rigault</th>
<th>Rigault</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>Postoperative</td>
</tr>
<tr>
<td>III</td>
<td>I</td>
</tr>
<tr>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td>III</td>
<td>II</td>
</tr>
<tr>
<td>III</td>
<td>II</td>
</tr>
<tr>
<td>III</td>
<td>II</td>
</tr>
</tbody>
</table>

The appearance of each patient was improved, by one grade in three children and by two grades in three other children, according to Rigault’s classification (Table 5).

Subjectively: all parents were satisfied with the cosmetic appearance of the achieved scapular lowering. Five mothers were satisfied with the cosmetic appearance of the scar whereas one deplored a thick aspect. Functionally, a loss of strength on the operated side was observed in three cases and one child had an sub-optimal active elevation (even if reported identical to the contralateral side, at 130°). Two of these patients felt discomfort when dressing.

Discussion

Characteristics of the study population are similar to those reported in the literature. Sprengel’s deformity remains an unusual condition. Apart from the study conducted by Cavendish, which included 110 patients, studies published in the literature are usually based on a very small sample of patients. Numerous authors refer to the Cavendish classification, which includes 110 patients, in their series. In our series, the left side is more commonly affected (eight cases out of eight) whereas it generally involves the right side in other studies. The condition may sometimes be bilateral.

The deformity is usually noticed at birth and progresses with growth. Therefore, diagnosis is often delayed (mean age at the time of the first visit 32.8 months in our series). This condition is often identified when occurrence of gleno-humeral instability is not correlated with Sprengel’s deformity. Mean age at surgery (3.8 years) correlates that reported in the literature.

Jeanopoulos advocates surgery for children between 2 and 5 years of age whereas Carson et al. underline the complexity of such procedure when attempted in children under 2 or 3 years of age and recommend isolated resection of the superomedial portion of the scapula in patients aged over 6 years old. We did not encounter such difficulty in our series.

Robinson et al. recommend clavicular osteotomy in older children, however considering a case of brachial plexus injury occurring in a 2.5-year-old child in our series, we believe it should be performed systematically when intraoperative monitoring is not available.

Numerous authors refer to the Cavendish classification prior to surgical indication. Surgery appears best indicated in patients graded 2 and 3 with mild deformity. However, this classification remains subjective and inaccurate since it is based on morphologic and aesthetic criteria. Moreover, it is difficult to use in case of bilateral deformity. As for Khaireouni et al., we believe the radiographic Rigault’s classification is by far the most objective for surgical indication.

According to Farsetti et al., surgery should be indicated in stage III but also in stage II when the superomedial angle of the scapula is above C6. On the other hand, according to these authors, final outcome should only be judged according to functional and cosmetic results rather than radiographic ones, since postoperative radiographic modification of Rigault’s classification does not appear significant.

Most authors agree to say that a concomitant local or regional anomaly is a pejorative predictive factor. Surgically-treated patients with associated Klippel-Feil syndrome reported a poor outcome in Farsetti et al. series. According to Khaireouni et al., the presence of associated severe spinal deformities has a significant pejorative impact.

There is a small number of series which report the use of the Green’s procedure since the largest ones resort to various surgical treatments. Only Leibovic et al. in 1990 report 17 cases of congenital scapular elevations in 15 children of mean age 3 years and 9 months and surgically treated by a modified Green’s procedure between 1972 and 1986. These authors usually report satisfactory cosmetic results. Functionally, the range of abduction increases by 30 to 40° and achieves best results in patients younger than 5 years old. In our series, mean abduction improvement was 52.5° and mean antepulsion improvement was 21.6°. Radiographically, Leibovic et al. do not report major changes in scapular positioning in the frontal plane which contradicts our findings, whereas they report a mean lowering of the scapular inferior pole of 1.5 vertebrae, which correlates our results (2.3 cm).

The Green’s technique provides a good visualization of the superomedial scapular angle, generally hook-shaped and lying on the thorax. It particularly provides a better access to the acromiothoracic vasculonervous pedicle which must be carefully protected prior to bony resection, an essential stage of the procedure to achieve good scapular mobilization. One of the main advantages of this technique is intraoperative exposition of the scapula which allows muscular reinsertion at a different site on the scapula and
theoretically enhances the lever arm relative to the scapular center of rotation. Actually, the scapula should rotate freely in order to achieve 90° of abduction. Scapular tilt reduces the abduction angle to less than 100° in 40% of patients with Sprengle’s deformity.

There is a correlation between the results of the different studies currently available [4,18,21,22]. According to Carson et al. [7], the Woodward procedure seems the most physiological and the best biomechanically adapted since it displaces more distally the origin of muscle insertion. It combines glenoid varus correction with scapular lowering, both enhancing shoulder function. Actually, Khairouni et al. [12] and Crha and Gal [11] believe deformity does not only concern scapula but its whole region. In the Green’s operative technique, the scapula is both lowered and rotated in the frontal plane. Muscle insertion is modified distally rather than proximally which provides better biomechanical outcome since muscles are re-attached higher relative to the acromiothoracic centre of rotation.

In fact, the outcomes of both operative techniques are comparable since they are based on the same principle: to combine muscular with bony gesture and modify scapular height but above all its orientation in order to achieve both cosmetic and functional improvement. According to Khairouni et al. [12], it seems that shoulder abduction is limited by scapulothoracic stiffness and inferior orientation of glenoid cavity but not by the presence of an omovertebral bone. Cho et al. [23] outline the great interest of three-dimensional ultrasound imaging in the description of skeletal anomalies and preoperative planning. Their systematically performed preoperative scanographic study thus revealed the existence of an omovertebral bone in more than 50% of cases whereas previous series only report a rate of 19 to 40% of cases [4,13,21,22]. Among our six surgically-treated patients, four omovertebral bones were intraoperatively discovered, none of which had been seen on preoperative radiographs. CT scans play a great role in the detection of an omovertebral bone but do not appear sufficient in analyzing a non-bony formation such as fibrous band. In any case, the surgical approach used in the Green’s procedure provides thorough exploration of the whole superomedial region and allows detachment of potential scapular fixation to the dorsal spine, whether they were preoperatively identified or not. Complications are rarely reported in the literature, no infection is mentioned but the scar is often widened or even cheloid aspect. We did not find any scapular detachment from the thoracic plane even if commonly reported with the Woodward operative technique.

No recurrence of deformity was noted in our study.

Conclusion

The Sprengel’s deformity is an unusual and unknown condition whose diagnosis is often delayed. Surgical management should be considered both for cosmetic and functional reasons. Green’s procedure provides good results with satisfactory abduction and antepulsion improvement and a mean scapular lowering of 2.5 cm. A case of complete BPP that resolved spontaneously within 7 months was observed. A clavicular osteotomy should be systematically performed, whatever the age of the patient. Lowering but also rotation of the scapula, to achieve proper glenoid reorientation, is one of the main objectives. Once corrected, the scapula should be sutured to the thoracic rib cage with bioabsorbable material, thus allowing postoperative immobilization in a Velpeau bandage.

The Green’s scapuloplasty has been rarely described in the literature, whereas the Woodward procedure remains the most popular technique. However, both procedures report similar results and our choice was based on a better operative visualization and an improvement in muscular lever arms.

Resection of the superomedial scapula and its fixation to the thoracic rib cage into a pocket in the latissimus dorsi seem to provide better outcome into a pocket in the latissimus dorsi.

References


