Outcomes following endoscopic-assisted Woodward procedure for Sprengel deformity

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Abstract

Purpose: An endoscopic-assisted approach for Sprengel deformity has been previously reported. Our objective was to assess outcomes of the endoscopic Woodward procedure in a series of patients.

Methods: Retrospective analysis was performed of children with a Sprengel deformity treated between November 2014 and February 2018. Recorded data were demographic, pre- and postoperative active shoulder elevation and deformity severity according to Cavendish.

Results: A total of 12 children (four girls and eight boys, ten right-sided/two left-sided) with a mean age of nine years two months (3 years 5 months to 16 years 1 month) and mean follow-up 19.8 months (10 to 48) were assessed. Nine children were classified as Cavendish Grade III and three as grade IV, respectively. Mean preoperative active shoulder forward elevation was 100.8° (70° to 120°), while postoperatively it increased to 149.2° (100° to 170°). Mean preoperative scapular high difference was 4.5 cm (2.8 to 5.2), while postoperatively it was 1.33 cm (0 to 2.8).

Conclusion: The endoscopic assisted Woodward procedure is an effective technique. Further comparative studies will ascertain advantages in functional and cosmetic results compared to the standard Woodward procedure.

Level of Evidence: Therapeutic study, Level IV

Introduction

Sprengel deformity, first described by Eulenberg in 1863¹ is congenital scapular and periscapular dysplasia. This condition is characterized by a scapula in a higher-than-normal position and rotated inward with rigid periscapular tissues, resulting in limited shoulder girdle movement and an aesthetic defect.²⁻⁴ Several surgical techniques have been proposed to improve function and physical appearance in these patients.²⁻⁷ The Woodward procedure is one of the most universally-used techniques for treating this disorder, owing to its excellent clinical results; but, like other scapular-lowering techniques, it requires extensive surgical exposure to allow descent of the scapula.³⁻⁸⁹ The Woodward procedure, described in 1961, corrects congenital mis-elevation of the scapula by repositioning the origins of the trapezius and rhomboid muscles downward, following resection of the omovertebral bone or anomalous fibrous bands (when present).⁵ The scapula’s dysplastic superior angle is also resected, allowing release of the levator scapulae muscle.

An endoscopically-assisted Woodward procedure has recently been described with promising results.¹⁰ We report the outcomes of this less-invasive technique in a series of children with a Sprengel deformity.

Materials and methods

Children with a Sprengel deformity scheduled for an endoscopically-assisted Woodward technique between November 2014 and February 2018 were included in this study. The procedure was indicated for children with active shoulder forward elevation < 120° (Fig. 1).⁹¹¹ Recorded data were: demographic characteristics, as well as pre- and postoperative active shoulder elevation, scapular high difference, deformity severity according to Cavendish³ and the presence of the omovertebral bone and associated anomalies.
The scapular high difference was measured bilaterally taking as a reference the midpoint of the scapular spine. The distance between two transversal lines at the level of the scapular spine midpoint was considered the scapular high difference.

**Surgical technique**

Most of the surgical steps already described by Soldado et al.\(^\text{10}\) were followed (Fig. 2, supplementary material). The patient was placed in a prone position under general anaesthesia. A 2-cm incision was made at the level of the inferior border of the trapezius muscle midway between the spinal processes and the medial border of the scapula. With blunt dissection, a space was created deep to the trapezius muscle. A second 2-cm incision was made at the level of the scapular spine, medially to the medial border of the scapula, in order to transversely split the trapezius muscle between its upper and middle portion and identify and protect the spinal accessory nerve. With blunt dissection, a space was created deep within the trapezius muscle and connected to the space created through the inferior portal. Then, a long Farabeuf retractor was placed deep into the trapezius muscle, bridging both portals and allowing the assistant to apply upward traction to create a working chamber suitable for dry endoscopy. A 4-mm arthroscope was introduced through the distal portal, allowing visualization of the trapezius and spinal accessory nerve in the superficial layer, as well as the rhomboid muscle in the deep layer.

A hooked electrocautery probe (Apollo RF Hook Probe; Arthrex, Munich, Germany) was introduced through the...
proximal portal to release the origins of the trapezius and rhomboid from the spinous processes. Next, the upper trapezius was released. For that purpose, the endoscope was introduced through the proximal portal and the electrocautery probe through the distal portal. When an omovertebral bone was present, the upper portal was prolonged 2 cm to expose and excise it.

In a third step, using the proximal approach in an open fashion, the levator scapulae muscle was detached from the scapula as the dysplastic superior angle of the scapula was excised. Next, the marked, constant adherences between the anterior serratus and thorax were released with blunt digital dissection. Passive scapular rotation and vertical translation were again measured, and the scapula was lowered.

The final step, performed through the distal portal, consisted of fixation of the scapula’s inferior border by suturing it to the ribs with a resorbable #2 suture to equalize the level of the scapular spines. However, in the last seven patients, scapular suture fixation was not performed.

Each patient was discharged the next day after surgery. In all cases the upper limb was placed in a sling for the next two to three weeks, after which non-formal therapy was recommended, and parents were told to encourage their child to perform exercises of shoulder elevation and bar hanging.

Results

Data are summarized in Table 1.

In total, 13 patients were scheduled for the index procedure. However, in a seven-year-old patient with a very severe and rigid deformity (Cavendish IV) associated with scoliosis and a pronounced costal malformation, the procedure was deemed impossible, due to stiffness of the periscapular dysplastic muscles and soft tissues. The procedure was feasible in the remaining 12 children (four girls and eight boys, ten right-sided/two left-sided). Mean age of the patients was nine years two months (3 years 5 months to 16 years 1 month) and mean follow-up 19.8 months (10 to 48).

Nine children were classified as having a Grade III, and three a Grade IV deformity, according to Cavendish. Only case 2 had an omovertebral bone. All Cavendish grade IV deformities were associated with a Klippel-Feil syndrome (cases 2, 7 and 9).

Mean preoperative active shoulder forward elevation was 100.8° (70° to 120°) while mean postoperative active shoulder forward elevation was 149.2° (100° to 170°). Mean shoulder forward elevation improvement was 48.1° (20° to 70°) with a gain of 23.3° (20° to 30°) in the severe deformity group and 57.5° (40° to 70°) in less severe cases (Figs 1, 3 and 4).

Mean preoperative scapular height difference was 4.5 cm (2.8 to 5.2), which decreased postoperatively to 1.33 cm (0 to 2.8).

Discussion

Improved range of movement and cosmesis, except for very severe cases, were obtained using the minimally invasive Woodward procedure described by Soldado, without surgical complications.\textsuperscript{10}

Mean reported shoulder elevation gain following the classical Woodward procedure is 50° (35° to 80°),\textsuperscript{2,8,12,20} which is similar to what we achieved using
the endoscopically-assisted Woodward technique in Cavendish Grade II and III cases. However, only 23.3° gain was obtained within the severe deformity group. This is consistent with the worse results reported by Ahmad in patients with Cavendish Grade IV deformities associated with Klippel-Feil following the classical Woodward technique. Ciaudo et al and Khairouni et al also described the coexistence of high cervical malformations as a predictor of a poor prognosis. On the other hand, other authors have not reported worse results for Sprengel deformity in association with Klippel-Feil syndrome.

Regarding Cavendish Grade IV deformities, although older reports describe limited improvement after surgery, more recent reports claim similar results across all grades of deformity. Worse results in our severe deformity group were related to less scapular rotation and translation gain after surgery, probably because of the more rigid periscapular tissues which are also dysplastic with this malformation. In fact, the extremely stiff periscapular tissues impeded endoscopic surgery in a patient with severe associated costal and vertebral anomalies, not included in this series.

Despite less functional gain and less gain in scapular descent with more severe deformities, these children’s parents were very satisfied with the cosmetic results. This might be explained by the improvement derived by resecting the medial and upper angle of the scapula, thereby removing the suprascapular lump. In fact, some authors believe that surgery is indicated in patients with functional shoulders, owing to this cosmetic improvement.

Classically, authors have recommended surgery at an early age (before a child is five or six years old) owing to enhanced surgical outcomes as a result of more supple tissues found at this age. Since then, many authors have adopted this recommendation. However, except for Klisić et al, who reported that 80% of children older than ten years exhibited residual scapular elevation after surgery, no other studies have shown poorer results for older patients undergoing a Woodward procedure.

In our two older children (15 and 16 years old, cases 9 and 10), operated upon because of cervical pain, excellent functional and cosmetic results and resolution of pain were obtained. Doita et al reported cervical pain control and function improvement in 20- and 26-year-old patients undergoing upper-medial scapular angle...
and omovertebral bone resection. Thus, in older children, cervical pain might be an indication for surgery.

The standard Woodward procedure uses an open approach, with a long skin incision that extends from the occiput to the T12 spinous process. A less invasive procedure could offer the advantages of reduced postoperative pain, shortened hospital stay, lowered infection rate, fewer wound complications and reduced recovery time, as well as superior cosmetic results. Unfortunately, most such data are unavailable in the literature and any comparison between open and endoscopic Woodward procedures requires a prospective comparative study.

Scapular deformity might be another advantage of our minimally invasive procedure, as an unsightly scar due to keloid formation or widening is one of the more commonly reported complications, ranging in prevalence from 20% to 30%. Carson et al reported a 60% rate of unsightly scarring if a subcuticular suture is not used. We did not observe scar-related cosmetic problems in our patients. Furthermore, the length of the sum of both incisions used with our minimally invasive procedure might only be approximately 20% the length of the scar generated during the classical procedure.

Several other complications have been described following the classic Woodward procedure. Winging of the scapula has been reported by several authors. Carson et al and Ahmad attributed this to inadvertent injury of the serratus anterior while detaching adherences or due to extra-periosteal detachment of the serratus anterior during resection of the superomedial angle of the scapula. Mild preoperative scapular winging is a risk factor for postoperative winging of the scapula and might be a contraindication for this procedure. Case 8 of our study, belonging to the severe group, developed a marked scapula alata. We believe that, since periscapular muscles, including the trapezius and upper portion of serratus anterior, can be absent, hypoplastastic or atrophic, its deficit might become evident after releasing the adherences between the thorax and the serratus anterior.

Brachial plexus palsy following the Woodward procedure is another complication described by several authors, with a higher risk in older patients. Prevention of this injury by clavicle osteotomy has been recommended. Although we did not perform an osteotomy, according to literature, it might be advisable. In patients we operated on later, which even included the older ones, we did not fix the scapula to the ribs, which might be a risk factor for plexus injury. It might also have contributed to the absence of plexus complications in our series. We believe that the scapula is kept in the new position by gravity. This study has several limitations. Firstly, the number of patients included is limited. However, most reports on Sprengel deformities are limited in patient number, due to the rarity of this deformity. Our follow-up also was relatively short at a mean 20.6 months; but no reports describe relapses beyond 12 months after surgery. Validated upper extremity functional tests were not performed. Finally, a comparative study would have allowed a comparison of data related to invasiveness and functional outcomes.

In spite of the promising results obtained, a comparative prospective study remains necessary to compare this technique’s clinical and aesthetic outcomes, complications and cost-effectiveness against those of the traditional open Woodward approach.

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COMPLIANCE WITH ETHICAL STANDARDS

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ETHICAL STATEMENT

Ethical approval: This research involving human participants was performed in compliance with Helsinki declaration and was approved by our ethics committee. Informed consent: Informed consent was obtained from all individual participants included in the study.

ICMJE CONFLICT OF INTEREST STATEMENT

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AUTHOR CONTRIBUTIONS

All authors participated in the design, data acquisition, analysis and interpretation of data, were actively involved in the drafting and critical revision of the manuscript and provided final approval of the submitted version.

SUPPLEMENTAL MATERIAL

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