Risk of Ventricular Peritoneal Shunt Malfunction In Surgically Treated Early Onset Scoliosis

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Introduction

Early onset scoliosis (EOS) is commonly defined as a deformity of the spine that is present before age 10 with varying etiologies including congenital, neuromuscular, syndromic, and idiopathic[1, 2]. Patients diagnosed with EOS may go on to require surgical treatment aimed at preventing deformity progression and subsequent pulmonary decline[1, 3, 4]. Mainstays of surgical treatments for these patients emphasize growth-friendly strategies and include the vertical expandable prosthetic titanium rib (VEPTR)[5, 6], magnetic expansion control (MAGEC)[7], traditional growing rods[8], and Shilla growth guidance[9] with the goals of treatment being to control scoliosis and allow spinal growth[10].

Many patients, particularly those with neuromuscular or syndromic forms of EOS, may have hydrocephalus and undergo ventriculoperitoneal (VP) shunt placement prior to correction of spinal deformity. These shunts allow diversion of fluid from the ventricles of the brain to the peritoneum for reabsorption. Several case reports and small retrospective reviews have pointed towards the possibility of VP shunt fracture or malfunction following operative correction of scoliosis[11-15], with a potential mechanism being calcification of the shunt leading to fragility in the setting of distraction forces[16]. However, no information is available for patients treated with growth friendly strategies of scoliosis correction.

The purpose of this study was to characterize the risks of scoliosis correction in EOS patients with preexisting neurosurgical shunts and understand if the risk of shunt malfunction is higher in these patients relative to historical standards.

Methods

A retrospective chart review of all patients with ventricular peritoneal shunts who underwent growing instrumentation at a single institution over a 13-year timeframe was performed. Age and diagnosis associated with shunt placement were recorded from the medical record. Shunt related complications and complications requiring reoperation were recorded.

Observations were made between the timing of shunt malfunction and index spine procedure as well as subsequent lengthening surgeries. A minimum of 2 year follow up from the time of initial growing instrumentation insertion was required for inclusion.

Results

Nineteen patients with a VP shunt underwent implantation of Vertical Expandable Prosthetic Titanium Rib (VEPTR) for treatment of scoliosis (Figure 1). The mean age at shunt placement and growing rod instrumentation surgery was 13.7 months (1 day to 13 years old) and 6.1 years (0.5 to 15.1 years), respectively. The diagnoses requiring shunt implantation were: 12 (63.2%) spina bifida, 3 (15.8%) structural defects or obstructions, 2 (10.5%) intraventricular hemorrhage, 1 (5.3%) cerebral palsy, and 1 (5.3%) campomelic dwarfism.

During the first two years following VEPTR implantation, there was a mean of 2.5 VEPTR expansion/revision procedures (0 to 5) without any shunt related complications. The mean length of follow-up in this cohort was 7.0 years (2.6 to 13.2). A total of 3 (15.8%) patients underwent shunt revision following their VEPTR implantation at 2.4, 2.6, and 5.6 years post operatively due to a pressurized shunt, sluggish refill of the shunt, and distal shunt disconnection respectively (Figure 2). Each of these shunt revisions occurred at least 30 days following a VEPTR expansion procedure (1.9, 2.9, and 5.7 months).

Discussion

This is the largest known report of patients with EOS undergoing VEPTR implantation and subsequent lengthening procedures with pre-existing ventricular peritoneal shunts. In this study, we show that in our population there is not an increased risk of shunt malfunction relative to baseline VP shunt risk.

Despite the utility and effectiveness of VP shunts, they are associated with a high degree of complications and may require additional surgical procedures over the course of a patient's treatment. Rates of shunt complication requiring a revision procedure range between

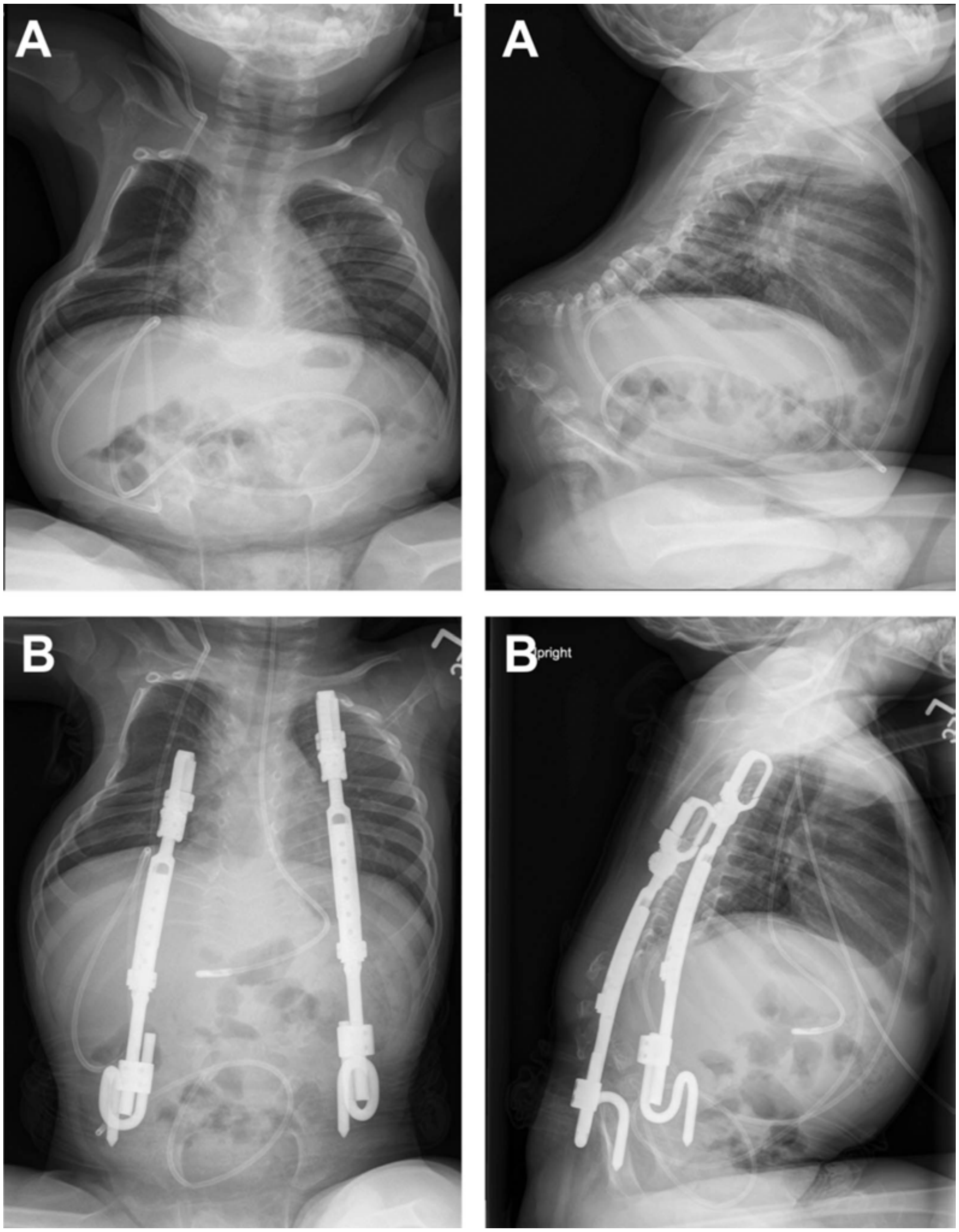

Figure 1. AP and Lateral Scoliosis Radiographs **(A)** Pre-VEPTR Insertion; **(B)** Post-VEPTR insertion in a child with a ventricular peritoneal shunt

20%-40%[17-19], with one report of 64 patients with 15 years of follow up by Stone et al[20] indicating that 84.5% of patients will require at least one VP shunt revision.

While a single center retrospective review of 35 patients with VP shunts undergoing posterior spinal fusion demonstrated a low risk of shunt complication[12], Lai et al[11] reported a series of three neuromuscular scoliosis patients with long term VP shunts experiencing shunt related complications following correction of curves by posterior spinal fusion. Additionally, Blakeney et al[21] reported a case of a 10-year-old female undergoing halo-gravity traction leading to a shunt fracture prior to planned scoliosis correction. Patel et al[22] reported a case of a 12-year-old male undergoing kyphosis deformity correction leading to shunt malfunction. However, there has been no documented cases of shunt complication following growth-friendly methods of scoliosis correction. Given the amount of distraction forces placed on the spine and the need for continued expansion of growth friendly implants[23], this poses a continued theoretical risk given the reported cases of shunt malfunction. While three patients in our cohort experienced a shunt complication during their follow up, none of these events occurred within two years of the index procedure or 30 days of a VEPTR lengthening. Additionally, none of these were a result of a broken shunt, which is the common reported complication in previous case reports[11, 21].

Potential explanations of these findings include that the population studied here, with an average age of 6 years, is

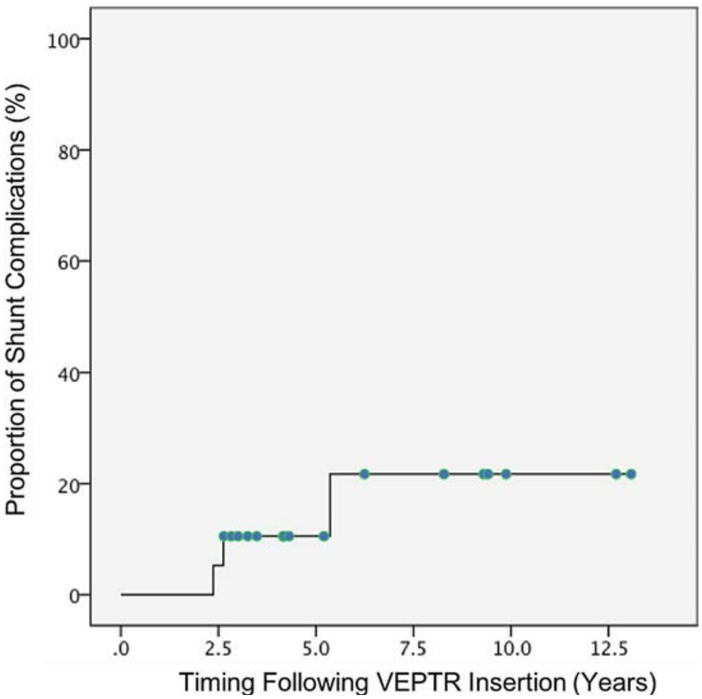

Figure 2. Burden of shunt-related complications following initial VEPTR implantation procedure

younger than the age of reported VP shunt complications and may have a lower likelihood of shunt calcification and fragility[11]. Additionally, the distraction force placed on the spine by growth friendly strategies is likely less than experienced in traditional posterior fusion techniques. Limitations of this study include its single center nature and relatively small sample size, making it difficult to detect potentially rare shunt related complications. Further multicenter analysis should be performed to determine the exact risk of ventriculoperitoneal shunt malfunction in patients with EOS.

Conclusions

EOS patients with pre-existing VP shunts undergoing deformity correction with growth friendly constructs do not have a higher risk of shunt related complication. Growing constructs can safely be employed by pediatric spine surgeons in these patients without fear of inducing immediate or short-term shunt complications. Compared to the literature, EOS patients with VP shunts are at no greater risk for long-term shunt related complications.

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