

SINGLE LAYERED SMALL INTESTINAL SUBMUCOSA IN THE REPAIR OF SEVERE CHORDEE AND COMPLICATED HYPOSPADIAS

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ABSTRACT

Purpose: Severe ventral chordee often accompanies proximal hypospadias. We describe our experience with single layered small intestinal submucosa (SIS), a commercially available, acellular, collagen based biomaterial, in the repair of severe chordee as part of a multistage approach to the repair of proximal hypospadias.

Materials and Methods: Between 2001 and 2002, 9 boys with proximal hypospadias (penoscrotal to perineal) and severe ventral chordee (greater than 40 degrees) underwent SIS grafting to correct the curvature. In each case the urethral plate was transected at the point of maximal curvature, the defect in the corporal bodies was measured, and the SIS graft was cut 2 mm wider around the perimeter of the defect and sutured into place. Skin resurfacing of the ventral penis was performed in standard fashion using Byars flaps. Recurrence of chordee was assessed by an artificial penile erection test at the time of stage 2 reconstruction.

Results: Of the 9 boys 8 underwent a planned 2-stage repair with subsequent urethroplasty 6 to 12 months after the initial stage 1 chordee repair. Median age at stage 1 repair of the 8 boys was 9 months. Native meatus location was penoscrotal in 6 boys, mid scrotal in 1 and perineal in 1. A 14 month-old boy underwent 1-stage chordee correction with SIS and a transverse preputial island tube graft urethroplasty for penoscrotal hypospadias. There were no perioperative medical or surgical complications related to use of SIS for chordee repair. Median age of the 8 boys at stage 2 repair was 18 months. At stage 2 the graft site was supple and smooth without significant scarring. All chordee correction has remained durable with followup ranging from 16 to 21 months. Postoperative complications occurred in 3 cases, including meatal stenosis requiring meatoplasty, subcoronal fistula requiring repair and complete breakdown of the neourethra in the single stage repair case.

Conclusions: Although this study includes a small population of patients and has limited followup, our favorable experience with single layer SIS suggests that it is a safe and effective, commercially available material for corporal body grafting to correct severe chordee as part of a multistage surgical approach to repair complex hypospadias. A larger series of patients with longer followup is necessary to determine if the chordee correction remains durable. Our experience is insufficient to judge its efficacy in single stage repairs.

KEY WORDS: hypospadias; mucosa, intestinal; grafting; penis

Severe ventral chordee (greater than 40 degrees) is often associated with proximal hypospadias. It appears that the cause of persistent chordee despite degloving of the penis is corporal body disproportion (a discrepancy in dorsal and ventral corporal body length). In these severe cases, especially when the penis is short, 2 of us (IF, EFR) prefer to interpose a dermal graft to correct the chordee.^{1,2} Multiple studies have indicated the efficacy and long-term durability of dermal grafting to correct severe ventral chordee as part of a multistage approach to repair proximal hypospadias.^{1–3} Despite this finding, less successful grafts, including tunica vaginalis, pericardium and vein, have been proposed as alternatives to dermis, each of which carries a higher risk of potential graft shrinkage and recurrent chordee.^{4,5} Although dermis is considered by many to be the gold standard for corporal body reconstruction, most surgeons have sought other more easily obtained materials because dermis is time-consuming to harvest.

Small intestinal submucosa (SIS) is an acellular collagen

based material derived from porcine small intestine. It is commercially available and approved for human use. SIS has been shown to act as a biological scaffold allowing tissue regeneration in the genitourinary system.⁶ We present our experience using SIS for ventral corporal body grafting to correct severe chordee as part of a multistage approach to repair of proximal hypospadias.

MATERIALS AND METHODS

Between 2001 and 2002, 9 boys with proximal hypospadias (penoscrotal to perineal) and severe ventral chordee (greater than 40 degrees) underwent single layer SIS ventral corporal body grafting to correct the chordee. In each case the penis was degloved completely and the urethral plate was transected at the point of maximal curvature. An SIS (SURGISIS, Cook Urological, Inc., Indianapolis, Indiana) graft 2 mm wider around the entire perimeter of the measured corporal defect was then sewn into place with 6-zero polydioxanone or polyglactin. Skin resurfacing of the ventral penis was performed using rotational skin flaps. Intravenous antimicrobials (first generation cephalosporin) were given before

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each procedure. Oral antimicrobials (first generation cephalosporin) were given on an outpatient basis until the urethral stent was removed (7 to 10 days postoperatively). Recurrence of chordee was assessed by an artificial penile erection test at time of stage 2 urethroplasty.

RESULTS

Of the 9 boys 8 underwent a planned 2-stage repair with subsequent urethroplasty 6 to 12 months after chordee correction. Penoscrotal transposition was present in 3 of these 8 cases and was repaired at the stage 1 chordee repair using the Reda penoscrotal transposition technique.⁷ A 14-month-old boy underwent a 1-stage chordee correction with SIS and transverse preputial island tubularized flap urethroplasty for penoscrotal hypospadias. Median age at stage 1 of the 8 boys was 9 months. Preoperative hypospadias location was penoscrotal in 6 boys, mid scrotum in 1 and perineal in 1.

There were no perioperative complications encountered associated with use of SIS. On followup examination 1 patient had recurrent ventral chordee secondary to skin tethering and was easily corrected at the stage 2 urethroplasty. Median age of the 8 boys at stage 2 repair was 18 months. Types of stage 2 hypospadias repair included Thiersch-Duplay tube in 6 boys, Koyanagi in 1, and a buccal mucosa interposition tubularized free graft and distal transverse preputial island flap in 1. We did not notice any unusual or excess scarring over the SIS grafting site at stage 2 repair. Tissues were supple with good neovascularity. Complications associated with stage 2 repair included meatal stenosis requiring meatoplasty and a subcoronal fistula that will require repair. At the time of this writing the SIS chordee correction has remained durable with followup ranging from 16 to 21 months.

The 14-month-old boy underwent an attempted 1-stage SIS ventral corporal body grafting and transverse preputial island tubularized flap urethroplasty for a penoscrotal meatus placed directly over the freshly grafted area. This operation was complicated by breakdown of the neourethra to the penoscrotal junction on postoperative day 14. Nevertheless, the chordee was corrected and there was no SIS graft infection. At age 21 months a Thiersch-Duplay urethroplasty was performed, which was complicated by meatal regression to the coronal sulcus. At age 27 months a Thiersch-Duplay distal repair was performed with a successful outcome. Chordee never developed.

DISCUSSION

Corporal body grafting is an important technique for the surgical correction of severe chordee. The most widely used materials are dermis and tunica vaginalis. Multiple reports attest to the efficacy and long-term durability of dermal grafting procedures.^{1-3,5} However, many surgeons believe that dermal graft harvest is time-consuming. Tunica vaginalis free grafts are more readily harvested than dermis but under scrutiny the results of free tunica vaginalis grafts to correct chordee have been poor.^{4,5} Rotational tunica vaginalis flaps have been proposed⁸ and, although they have inherent advantages from native blood supply, use in chordee correction would prevent its pedicle from being a source of vascular tissue to cover a long or complex anastomosis. Therefore, a readily available material that would promote cellular in-growth and neovascularity would be an ideal substance for chordee correction.

SIS may be such a material. It is commercially available and ideally suited for cellular in-growth^{9,10} since it is derived from normal tissue, and it is as conducive a regenerative framework as other autologous materials. Inherent in SIS is collagen, glycoproteins, proteoglycans and growth factors that include fibroblast growth factor, transforming growth

factor- β and vascular endothelial growth factor, which are all known to be important for cellular growth.¹⁰

Other groups have reported their experience with various preparations of small intestinal mucosa for use in the genitourinary system. Kropp et al have successfully used single layer small intestinal submucosa for corporal body grafting in rats and humans, and reported 100% success rates without complications.⁶ All patients had straight erections confirmed by artificial erection at stage 2 repair. Histologically in the rat single layer SIS grafts were fully incorporated into the corporal body identical to control animals that had autologous tunica albuginea grafts.

Knoll reported on 12 patients with Peyronie's disease treated with plaque excision and corporal body grafting with single layer SIS, and 11 were successfully cured of chordee.¹¹ Soergel et al reported complications related to the use of multilayered SIS for corporal body grafting for proximal hypospadias.¹² Of 11 patients 2 had recurrent chordee associated with use of multilayered SIS. In 1 of the 2 cases chordee due to fibrosis at the site of grafting was so severe that the entire graft had to be removed and replaced with a tunica vaginalis flap at stage 2 repair.

Although SIS is available in a single layer (SURGISIS, Cook Urological, Inc.), and a multilayer (STRATISIS, Cook Urological, Inc.) preparation, the successes of the single layer preparations for reconstructive surgery may not be transferable to the multilayer preparations. At the time of this writing it is unclear why there seems to be a difference in surgical outcomes between single and multilayered SIS preparations. Experience with single or multilayered SIS for corporal body grafting is limited. To our knowledge no published animal studies are available examining differences in single versus multilayered SIS preparations for corporal body grafting. Any explanation for this difference based on current literature is speculative and anecdotal. However, several studies indicate that single layered grafts are more stable because the reduced number of graft layers may enable more effective neovascularization and serum imbibition.^{6,13} Although this explanation is unproven at this time, it has some scientific rationale and may ultimately prove to be in controlled animal studies the reason for the favorable results in using single layer rather than multilayer SIS for corporal body grafting in chordee repair.

One of our patients underwent a planned 1-stage operation with SIS ventral body grafting to correct chordee, along with a transverse preputial island tubularized flap repair of penoscrotal hypospadias. This repair resulted in complete breakdown of the neourethra. At this time it is unknown whether the breakdown of the tubularized flap was secondary to it being placed directly over a new SIS corporal patch without any intervening vascularized tissue. Although our experience is too small to judge the overall efficacy of SIS corporal body grafting in planned single stage hypospadias repairs, we no longer perform procedures that allow direct placement of a urethral flap or graft directly overlying a freshly grafted piece of SIS.

CONCLUSIONS

This initial review suggests that single layer SIS is safe and effective for corporal body grafting in a multistaged surgical approach to repair complex hypospadias with severe chordee. Since there is no need to harvest an autologous graft, SIS is an attractive alternative to dermis for the correction of chordee in these complex cases. Although the early experience is highly favorable, long-term followup is needed to determine if chordee correction remains durable.

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DISCUSSION

Dr. Paolo Caione. You reported very good results in 8 children with complex hypospadias. However, in a similar experience from the Indiana group there were a large number of complications. Could you try to explain why you had such good results and they did not?

Dr. A. C. Weiser. We were using the single ply SIS and they did not. Also, we prefer 2-stage repairs which may be another reason.

Dr. Brad Kropp. I believe that the Indiana group was using 4-layer and there is no doubt in my mind that the basic science difference between the 4-layer and 1-layer is the ability of the 1-layer to regenerate or revascularize.