

# Sigma-lead Male-to-Female Gender Affirmation Surgery: Blending Cosmesis with Functionality

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**Background:** Current male-to-female (MtF) sex-reassignment-surgery techniques have not been fully successful to achieve the ideal objectives. The ordeal of multiple procedures, associated complications, and suboptimal results leads to high rate of dissatisfaction. We have tried to overcome functional inadequacy and address the esthetic issues for outer genitalia and vagina with our innovative “true shape sigma-lead SRS: Kaushik’s technique,” which has now become the technique of choice for MtF genital SRS for our patients.

**Methods:** Between April 2007 and April 2017, authors performed 386 sigma-lead SRS in MtF transsexuals. Results were analyzed based on complications, resurgeries, and esthetic/functional outcomes. Corrective SRS using rectosigmoid constituted 145 cases and is not a part of this study.

**Results:** Maximum follow-up was 7 years (average 34 months). Seventy-eight (20.2%) patients had complications, majority being minor (97.4%). Forty-four (11.4%) required resurgeries, 10 (2.6%) were corrective for introital stricture and mucosal prolapse, whereas 34 (8.8%) opted for optional minor esthetic enhancement. The overall satisfaction rate for cosmetic and functional outcomes was 4.7 out of 5. In addition to review of the literature, innovations in the technique have been explained.

**Conclusions:** Kaushik’s sigma-lead MtF SRS technique is a step short to become the gold standard of genital SRS because it has proven to be safe and reliable. It allows faster healing, minimal dilation, and nearly natural cosmetic results in the form of clitoris/clitoral hood, labia minora, labia majora along with self-lubricating, fully deep, and sensate neovagina with orgasmic capabilities. This is perhaps the largest reported series of rectosigmoid use in transsexuals carried out for primary vaginoplasty. (*Plast Reconstr Surg Glob Open* 2019;7:e2169; doi: 10.1097/GOX.0000000000002169; Published online 2 April 2019.)

## INTRODUCTION

The ultimate goal of male-to-female (MtF) transformation in transenders is not only to achieve external anatomy of the female body through a series of complex

and staged surgeries but also to supplement the completeness by aligning the physical self with the biopsychosocial framework of a female individual, thereby addressing the basic concept of gender identity disorder.<sup>1-3</sup>

MtF gender affirmation surgical techniques span from split-thickness graft, full-thickness graft, penile/penoscrotal inversion, and fasciocutaneous flaps to pedicled intestinal flaps.<sup>4-14</sup> Currently, prevalent techniques have not been fully successful in achieving the ideal objective of reconstructing the genitals that resemble the cis-female genitals in full form and function.<sup>4</sup> The search for new and improved solutions continues because there has been a constant scope of improvement for both functionality and cosmetic outcome.<sup>4</sup> Prolonged hormonal intake leads to penoscrotal hypoplasia making penoscrotal inversion vaginoplasty not feasible.<sup>10,15-19</sup>

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*The technique was introduced and explained during a video workshop and symposium on male-to-female sex reassignment.*

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**Table 1. Questionnaire at 12 Months after Surgery**

Evaluate the Following Aspects and Please Mark on a Scale of 1 to 5, with 1 Being Completely Dissatisfied, 2 Being Dissatisfied, 3 Being Satisfied, 4 Being Very Satisfied, and 5 Being Completely Satisfied

1. Level of satisfaction with perioperative care	1	2	3	4	5
2. Vaginal depth	1	2	3	4	5
3. Cosmetic appearance	1	2	3	4	5
4. Sensations	1	2	3	4	5
5. Orgasmic capabilities	1	2	3	4	5
6. Secretion problem	1	2	3	4	5
7. Overall satisfaction with treatment (feeling like cis-female; quality of life)	1	2	3	4	5

Thus, we aimed to describe in this article our modified technique which has nearly overcome the functional inadequacy of the existing techniques and has addressed the esthetic issues of reconstructed outer genitalia and vagina. It has now become the technique of choice for MtF gender affirmation surgery for our patients.

### PATIENTS AND METHODS

Between January 2008 and April 2017, we performed 386 sigma-lead SRS in MtF transgenders who met the World Professional Association for Transgender Health (WPATH) criteria. A total of 145 cases who underwent corrective SRS using rectosigmoid colon were excluded in the study. These patients had been operated before using other techniques and were dissatisfied with outcomes.

Patient records and interviews focused on age, smoking history, surgical time, complications, resurgeries, and cosmetic and functional outcomes were collected and analyzed. Outcomes were assessed according to 7 parameters (Table 1). Informed consent was obtained from each patient.

#### Patient Selection, Surgical Eligibility, and Preoperative Preparation

We excluded patients with body mass index >30. Patients with cardiac diseases, unfit for GA, and sigmoid colon diseases were also excluded. Sigmoid colonoscopy was carried out for those older than 50 years of age or those with a history of bowel problem related to the colon. Estrogen use and smoking were discontinued for at least 2 weeks and 2 months, respectively, before surgery. Over the past 3 years, we have implemented a nonsmoking disclosure to be signed by the patient.

Bowel is prepared using polyethylene glycol with electrolyte solution a day before surgery. Prophylactic antibiotics were administered at the start of surgery. GA with epidural analgesia was used. LMW heparin was administered in patients with a history of DVT. The DVT intermittent pneumatic pumping system was used intraoperatively and for 2 days postsurgery. The patient was placed in lithotomy position during the procedure.

#### Surgical Technique

We developed this surgical procedure as a modular concept. Module 1 is the creation of vulva, and module

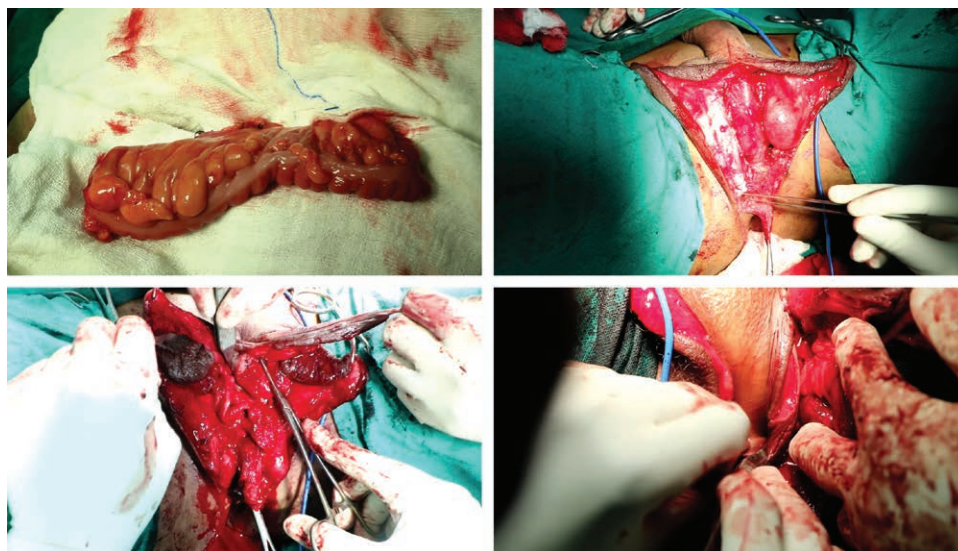


**Video Graphic 1.** See video, Supplemental Digital Content 1, which displays sigma-lead MtF gender affirmation surgery demonstrating surgical technique and postoperative results, <http://links.lww.com/PRSGO/B24>.

2 is the creation of vagina using penile skin and rectosigmoid colon segment. Both modules are preferably done together as a single stage, although they can be carried out in 2 stages (see video, Supplemental Digital Content 1, which demonstrates surgical technique of sigma-lead gender affirmation surgery and postoperative results, <http://links.lww.com/PRSGO/B24>).

Through left lateral Pfannenstiel approach, the rectosigmoid colon was freed. Preferably, the proximal pedicle, a sigmoidal branch of the inferior mesenteric artery, is chosen to get the antegrade segment. If the proximal pedicle was not reliable, a distal pedicle was identified, preferably having 2 vessels consisting of branches of the superior rectal artery. The mesentery was sequentially ligated and divided in between ligatures throughout the length of the selected segment. Bowel was washed through the colotomy incisions at proximal and distal division sites to avoid spillage of colon contents. The colon segment was divided at the proximal and distal sites (Fig. 1A). The proximal end of the graft was closed (distal end in cases of distal pedicle), making it the dome of the neovagina. About 1 cm from the anus, a posteriorly based triangular scrotal flap (4 cm base width × 6 cm length) was raised, and a cavity was created between the bladder and rectum. The colon segment was delivered gently in the created cavity. The distal end of the segment was sutured with the invaginated scrotal flap completing the posterior vaginal wall. The dome of neovagina was fixed with sacral promontory to minimize the incidence of prolapse.

The midline scrotal incision was extended until the penile base ventrally. After orchiectomy, the preserved cord along with fat was fixed until the lower end to enhance labia majora bulk (Fig. 1B). About 3 inches of the proximal urethra was separated off the corpora. Penile skin was degloved superficial to the Buck's fascia all the way, except for a small flap (4 cm × 2 cm) of inner preputial skin, which was left attached to the glans (Fig. 1C). The dorso-lateral part of glans with attached preputial skin flap and dorsal tunica albuginea containing neurovascular bundle were dissected off, until the base of the penis (Fig. 1D, E). Corpora were excised.



**Fig. 1.** A, Harvested pedicled colon segment. B, Right orchiectomy showing fixation of cord structures until the lower end. This is done bilaterally to achieve bulk of labia majora. C, The penile skin is degloved superficial to the Buck's fascia, leaving one-third of preputial skin attached to the glans. D and E, Dorsolateral part of glans is elevated along with dorsal tunica vaginalis containing neurovascular bundle. F, Penile skin is slit into 2 flaps except for proximal 1 inch. Clitoral shaft is made. Bilateral triangular back cut flaps to create the clitoral hood. G, Bilateral triangular flaps tucked under the tubed clitoral shaft to achieve a 1-cm hood, and glans is reshaped in the form of clitoris and fed under the hood. H, Distal two-thirds of the preputial flap attached to slit penile flap is lifted up to meet the upper third of the preputial flap attached to glans. The anchor suture being applied to define the groove between the labia majora and minora, and the labia minora are sculptured.

Penile skin flap was slit into 2 halves barring a proximal 1 inch. Tube-like clitoral base/shaft was constructed by enfolding the central unslit proximal portion and was anchored to the suspensory ligament with 3-point nylon 4-0 suture. Some amount of pubic fat is incorporated in the tube to avoid flattening. Small (1 cm × 1 cm) triangular flaps raised akin back cuts on medial aspects of either penile hemiflaps and were stitched under a clitoral tube to create an approximately 1-cm roof, achieving a clitoral hood. The trimmed reshaped clitoris was anchored under this hood (Fig. 1F, G). The side wings of small preputial flaps were sutured to the medial edge of penile skin in a “Namaste” position forming the upper one-third of labium minus.

In the center of distal third of the penile flap, an anchor suture was taken and fixed to the crural base deep in the vaginal cavity. This key suture provided a downward pull and defined the groove between the labia majora and minora creating an inner layer of majora and outer layer of minora. The lower two-thirds of the attached preputial skin were lifted up in “Namaste” position and attached to the upper third of labium, thereby achieving full-length labia minora (Figs. 1H and 2A). The rest of the penile skin was anastomosed to the colon segment in a zig-zag, tension-free manner to complete the anterior and lateral vaginal walls. The mucocutaneous junction was typically placed beyond 2 inches (Fig. 2B).

Extra scrotal skin was deepithelialized preserving the dartos tissue to achieve the bulk of labia majora (Fig. 2C). The edges of this scrotal skin were medialized and anchored to the crural stump (Fig. 2D). The labia majora were constructed with stitching of medialized scrotal skin

with outer half of slit penile flap. The urethra was slit transversely and spatulated, and corpus spongiosum was trimmed. Urethra was placed caudal to the clitoris.

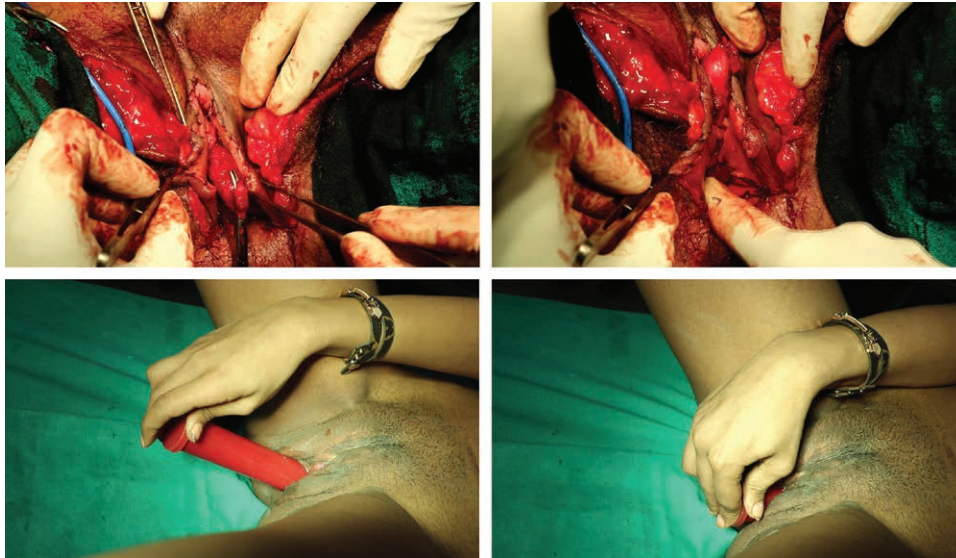
#### *Postoperative Period*

Pain relief was achieved with intravenous and epidural analgesia. Intravenous antibiotics were administered for 3–5 days. Use of electrolyte solutions (potassium, calcium, and magnesium) has dramatically improved the recovery and reduced paralytic ileus incidence. Patient passed flatus within 48 hours and was allowed liquids orally. Foley's catheter was removed after 6 days and ambulation resumed. Daily vaginal wash was done from third day onward. Hospital stay duration was 7 (5–10) days. Dilation schedule was extremely simple, which was started 7–14 days postsurgery. Dilation was performed twice daily with soft deflatable mold for 5 minutes followed by 5–10 minutes using a rigid dilator and continued for 8–16 weeks, as necessary. The patients were advised to maintain hygiene by washing the genitalia with 5% betadine solution for about 3 weeks. Sexual activity can be resumed at 6–8 weeks. Penetrative sex is counted as dilation.

## RESULTS

The total number of patients was 386. Average age was 39 (22–63) years. Eighty-two patients (21.2%) had a history of smoking. Average surgical time was 5.2 (4–7) hours. None required emergency reoperation. Average follow-up was 34 (12–84) months.





**Fig. 2.** A, Sculptured labia minora with well-defined clitoris and hood. B, Vaginal introitus, zig-zag mucocutaneous junction is placed at or beyond 2 inches. C, Scrotal skin is degloved preserving dartos to achieve additional bulk to labia majora. D, Medialization of labia majora, and margin of scrotal skin is medialized and anchored to crura to place the scar medially. E, Immediate postoperative. F, Two-week postoperative. G and H, One-year postoperative.

Seventy-eight patients (20.2%) developed complications, with the majority (97.4%) having minor complications (Table 2). Minor healing issues were seen in 21 (5.4%) patients and were managed conservatively. Mucorrhea was reported by 24 (6.2%), which resolved after 9 months. Mucosal prolapse was seen in 6 (1.5%), especially those older than 50 years of age (n = 5). Other minor complications include introital stricture, dyspareunia, urinary retention (managed with prolonged catheter and cholinergics), wound infection, paralytic ileus, and clitoral necrosis. Major complications in the form of colon segment vascularity loss were noticed intraoperatively in 2 patients (0.5%), who had a smoking history.

Touch-up surgeries were performed in 44 (11.4%) patients; of these, 10 (2.6%) were corrective and 34 (8.8%)

were for esthetic enhancement of genitals in combination with other surgeries at a later date (Table 3). Out of the 10 who had corrective touch-ups, 6 (1.5%) were for introital strictures and 4 (1%) for mucosal prolapse.

The level of satisfaction was assessed using a questionnaire at 12 months postoperatively. Response was received from 329 patients. Average overall satisfaction level was 4.7/5 (Tables 1 and 4).

### DISCUSSION

MtF vaginoplasty techniques span from split-thickness graft, full-thickness graft, penile/penoscrotal inversion, and fasciocutaneous flaps to pedicled intestinal flaps.<sup>4-14</sup> Currently, penile inversion is the most commonly performed sex reassignment surgery (SRS) technique worldwide.<sup>11-13,20-22</sup> This technique was pioneered by Burou,<sup>23</sup> Gillies and Millard,<sup>24</sup> Edgerton and Bill,<sup>25</sup> and Pandya and Stuteville.<sup>8</sup> In this technique, the pedicled sensitive penile skin is used, but it results in inadequate vaginal depth, disfigured outer vulva, constant and unpleasant discharge, possible vaginal vault prolapse, and painful postoperative care.<sup>7,9,26</sup>

Prolonged hormonal intake leads to penoscrotal hypoplasia making penoscrotal inversion vaginoplasty not feasible.<sup>10,15-19</sup> To overcome the limitation of inadequate vaginal depth in transsexuals, the use of skin graft was introduced by Abraham.<sup>27</sup> The use of full-thickness skin graft from penile skin was first reported by Fogh-Anderson<sup>28</sup> and refined by Preecha<sup>11</sup> and Motta et al.<sup>29</sup>

Limitations of skin graft split skin graft (SSG)/full thickness graft (FTG) vaginoplasty are inadequate graft take up, contraction of vagina due to scarring and graft shrinkage, long and painful postoperative aftercare and long-term dilation (even lifetime), introducing skin into a

**Table 2. Complications and Patient Follow-up**

Characteristics	No. Patients (%)
Total no. of patients	386
Smoking history	82 (21.2)
Emergency reoperations	0 (0.0)
Complications	78 (20.2)
Major complications*	2 (0.5)
Colon graft loss	2 (0.5)
Recto vaginal fistula	0 (0.0)
Urethro vaginal fistula	0 (0.0)
Anastomotic failure	0 (0.0)
Minor complications†	76 (19.7)
Mucorrhea	24 (6.2)
Minor healing issues	21 (5.4)
Mucosal prolapse	6 (1.5)
Dyspareunia	6 (1.5)
Stricture introitus	6 (1.5)
Urinary retention	5 (1.3)
Paralytic ileus	3 (0.8)
Wound infection	3 (0.8)
Clitoral necrosis	2 (0.5)

\*2.6% of the 78 patients with complications.

†97.4% of the 78 patients with complications.

**Table 3. Description of Corrective/Touch-up Surgeries**

Characteristics	No. Patients (%)
Total no. patients	386
Touch-up surgeries	44 (11.4)
For complications	10 (2.6)
Stricture	6 (1.5)
Prolapse	4 (1.0)
For cosmetic reasons	34 (8.8)
Cosmetic procedures*	
Labia majora skin removal	9 (2.3)
Fat grafting labia majora	27 (7.0)
Labia minora reshaping	9 (2.3)
Clitoris reshaping	4 (1.0)
Posterior commissure correction	6 (1.5)
Protruding corpus spongiosum correction	9 (2.3)

\*Many patients opted for combination of procedures.

nonphysiological location, a vagina with poor erogenous sensations, no self-lubricating/self-cleaning properties, dyspareunia, neovaginal prolapse, donor area scarring, condylomatosis, intraepithelial neoplasia associated with human papilloma virus, and carcinoma.<sup>4,7,9,26,30,31</sup>

Forceful dilations lead to vicious cycle of breakdown and healing of patchy scars causing further stenosis necessitating lifelong painful dilation to keep the vagina patent. Should the patient leave dilation, patchy healing results in pockets with entrapped skin grafts, leading to repeated bouts of infection with purulent discharging sinuses? We have noticed these findings during corrective SRS. In corrective SRS, detaking this entrapped skin graft is challenging and poses risks to adjacent structures.

First mention of intestinal vaginoplasty in MtF transsexuals dates 1974, when Markland and Hastings used cecum and sigmoid transplants.<sup>32</sup> Ileal, ascending colon, and transverse colon segments have also been used without extra advantage, but added excessive discharge problem.<sup>12,14,29,33</sup>

The promising benefits of sigmoid colon vaginoplasty were large lumen, integral strong walls resistant to trauma, mucosal lining with self-lubricating and self-cleaning properties, excellent vaginal sensations, rapid healing, and minimal postoperative care with shorter dilation regimen.<sup>4,5,7,34,35</sup> Studies have shown that use of pedicled sigmoid colon flap for vaginoplasty mitigates many of the issues seen with penoscrotal flap.<sup>7,36–38</sup> Most of the studies relegate rectosigmoid transfer to MRKH syndrome, previously failed skin vaginoplasty, or in patients with previous penectomy and orchiectomy (secondary vaginoplasty).<sup>9,39</sup> Many studies have pointed out the following complications in rectosigmoid vaginoplasty: mucorrhea, mucocele, introital stricture, unnatural reddish appearance due to the visible mucosa at the opening, neuroma formation, increased risk of bacteria entering the abdomen, postoperative ileus, and constipation.<sup>4,5,9,22,40</sup>

**Table 4. Questionnaire Results (n = 329 Patients)**

Satisfaction Index	Points	No. Patients (%)
Completely dissatisfied	1	3 (0.91)
Dissatisfied	2	3 (0.91)
Satisfied	3	32 (9.72)
Very satisfied	4	63 (19.14)
Completely satisfied	5	228 (69.30)

These limitations were minimal to nonexistent in our patients. Complications were seen in 78 patients (20.2%), with the majority (97.4%) having minor complications. Only 10 (2.6%) needed corrective surgeries mainly for introital stricture (causing dyspareunia) and mucosal prolapse. In this technique, distal 2–3 inches of penile skin is anastomosed to sensate rectosigmoid in a zig-zag, tension-free manner placing mucocutaneous junction at or beyond 2 inches, thus avoiding the unnatural red appearance and minimizing introital stricture and mucosal prolapse. Minor abdominal wound infection was noted in 3 (0.8%), which were earlier cases. Addition of intraoperative bowel wash dramatically led to practically zero wound infection rate. Incidence of mucorrhea was quite low, which was reported only in 24 patients (6.2%) and resolved within 9 months in all patients. A *shorter rectosigmoid*, with most parts having dehydrating properties, lessens mucorrhea, but maintains natural self-cleaning and self-lubricating properties. Studies in the literature have reported higher incidence of prolonged mucorrhea.<sup>5,9,22</sup>

Intraoperative colon graft vascularity loss was considered a major complication and was observed in 2 patients (0.5%) who had a history of smoking and claimed quitting for 2 months before surgery. In one case, the ileum was successfully used as an alternative. In another case, the ileal segment was discolored and bowel vaginoplasty was not suitable. Rectovaginal or urethrovaginal fistula in other techniques has been reported in previous studies,<sup>5,13,26,42–45</sup> but none of our patients had these.

The primary focus in most of the genital reconstructive surgery has been to develop an optimal method of creating a neovagina that would facilitate sexual intercourse. Clitoris/clitoral hood and labia minora remain among the most difficult structures to reconstruct. Despite increasing concerns for esthetic results of vulva and clitoro-labial creation with erogenous sensations, the ideal clitoro-labiaplasty, which would yield results resembling a biological female in every aspect, has not yet been achieved.<sup>4,17,45,46</sup>

Brown used a reduced glans attached to its dorsal neurovascular pedicle. The incidence of clitoral necrosis was very high necessitating modification of techniques and secondary corrective surgeries.<sup>47–50</sup> Maintaining the viability of full-length preputial skin necessitates preserving the bulky glans tissue, which results in bulky clitoris leading to hindrance in hood creation. This large clitoris is esthetically unacceptable and is taken as a residual penis by the patient. Additional incisions and corrections in pursuit of the perfect outcome would lead to vascular compromise to the labial minora and occasionally clitoris and hypertrophic scarring,<sup>4</sup> which we experienced in our earlier cases.

In this technique, 3–4 inches of penile and preputial skin is utilized to create cosmetically appealing vulva parts: clitoris shaft, clitoral hooding, natural size sensate clitoris, full-length labia minora, bulky youthful full-length labia majora, and natural appearing introitus. The unsplit proximal central part of penile flap is enfolded (entubed) with a 3-point anchor stitch giving a natural clitoral shaft. The incorporated fat avoids flattening of the shaft.

We developed the innovative idea of using bitriangular flaps, achieving about 1 cm hood/roof over the clitoris as

in a cis-female. Clitoral hood gradually transits into the labia minora. *Inclusion of dorsal tunica albuginea* ensures viability of island neurovascular flap and enables the making of a small anatomical-sized clitoris and larger glanular flaps for the upper part of labia minora. The pedicle is robust and kink resistant with minimal incidence of necrosis and revision surgeries. Moreover, erogeneity is quite high owing to more nerve endings being incorporated. The whole of the preputial skin remains viable as it is used in *2 separate flaps for labia minora creation*. Small flap remains attached to the clitoris in the form of glanulo-preputial flap and a larger preputial skin flap remains attached to the penile skin. The groove between the labia minora and majora was defined with an anchor stitch to penile flap, as described previously. We preserved viable fat, cord structure, and dartos tissue to achieve bulky labia majora until the lower end. Medialization of labia majora is a unique modification to achieve more esthetic natural look of the vulva in the form of apposed labia majora, deep commissure, and medially placed scar which becomes inconspicuous over the time.

Minor clitoral and labial necrosis was noticed only in 2 patients (0.5%), which is extremely low as compared to other studies.<sup>47–49</sup> Minor healing issues with minor necrosis were noticed in 21 (5.4%) patients with smoking history, which were treated conservatively. The incidence is low as compared with that reported in the literature.<sup>11,42,44,52</sup> Cosmetic enhancement was carried out in 34 patients (8.8%), which is quite low as compared with a previous report.<sup>13</sup> Moreover, these touch-ups were optional rather than required, as these were opted in combination with other surgical procedures during revisits for possible esthetic enhancement of otherwise acceptable genitals. The protrusion of corpus spongiosum was seen in 9 (2.3%) patients in earlier part of our series. Later, we adopted trimming of the corpus spongiosum as described by Preecha.<sup>11</sup> Incidence of protrusion in our study is quite low as compared with other studies.<sup>5</sup>

Few studies have focused on functional outcome in the form of sexual outcome after male to female (MtF) SRS.<sup>52,53</sup> The latest articles emphasize the need of developing new instruments for evaluating gender confirmation surgery outcome as there are no valid instruments available yet.<sup>54,55</sup> In our series, the outcome was assessed in terms of esthetic and functional outcomes, including orgasmic capabilities. Out of 329 patients who responded to the questionnaire, 323 (98.2%) were satisfied with the outcome. Overall average satisfaction level was 4.7/5. The satisfaction rate is much higher than that reported by other studies involving a lesser volume of patients.<sup>5,7,13,56–60</sup>

There are some limitations of the study. First, even though the plastic surgeon was the same for all patients, the general surgeon involved varied. This could have contributed to some variations in the outcome. Second, even though we have collected subjective data from the patients, we do feel that objective data from physical examinations are lacking. Third, even though the technique has a long learning curve, this study with a long follow-up is evidence that this technique is safe and effective.

## CONCLUSIONS

The sigma-lead MtF gender affirmation surgery is a safe and reliable technique. It allows faster healing and very minimal postoperative aftercare while delivering very natural cosmetic results in all major aspects of cis-genitals, namely, the sensate clitoris, clitoral hooding, full-length stand-out labia minora, and appealing apposed youthful labia majora with minimum scarring. It also provides a self-lubricating, fully sensate deep neovagina, allowing for clitoral and vaginal sexual arousal and climaxes with minimal dilation requirement. Complications, though present, can be treated successfully with revision surgery. Moreover, this is perhaps the largest reported series of rectosigmoid transfer in MtF transsexuals performed for primary vaginoplasty.

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