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FULL PAPER

MR imaging in patients with male-to-female sex reassignment surgery: postoperative anatomy and complications

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Objective: To investigate the role of MRI in the evaluation of both the new female anatomy and complications in male-to-female sex reassignment surgery (MtF-SRS).
Methods: 71 consecutive patients with MtF-SRS had 74 MRI [age range, 21–63 years; mean (±standard deviation) age, 36 ± 10 years; median age, 37 years]. In 47 patients, MRI was performed to rule out early post-operative complications after gender conversion ($n = 40$), vaginoplasty ($n = 6$) or remodelling of the labia majora ($n = 1$). In 27 patients, MRI was performed 1–20 years after MtF-SRS for late post-operative complications, pain or dysuria, inflammatory changes or poor cosmetic outcome. Three patients had MRI both before and after the operation.
Results: MRI allowed investigation of the new female anatomy in all cases. Soon after MtF-SRS, a small amount of blood was identified in all patients around the neoclitoris, urethral plaque and labia. Post-operative complications were clinically significant fluid collections ($n = 5$), labial abscesses ($n = 2$), severe cellulitis ($n = 3$), partial neovaginal prolapse ($n = 3$), focal necrosis and dehiscence of the vaginal wall ($n = 2$) and hypovascularization of the neoclitoris ($n = 1$). After ileal vaginoplasty, three patients developed clinically insignificant haematomas, one a large rectovaginal fistula with dehiscence of the intestinal anastomosis and bowel perforation ($n = 1$). In the 27 patients investigated 1–20 years after MfF-SRS, MRI demonstrated cavernosal remnants ($n = 10$), spared testis ($n = 1$) neovaginal strictures ($n = 8$), fistulas and abscesses ($n = 3$) and prolapse ($n = 2$). Three of these patients also had fibrotic changes. In the remaining three patients, no pathological features were identified.
Conclusion: After genital reconfiguration, MRI allows assessment of the post-operative anatomy and of post-operative complications.
Advances in knowledge: Imaging features of the new anatomy and of surgical complications after SRS are discussed and illustrated.

INTRODUCTION

Male-to-female sex reassignment surgery (MtF-SRS) is the last step of a process involving psychological, endocrinological, aesthetic and legal issues. The procedure is complex and involves multiple processes: at first, orchidectomy, extirpation of the corpora cavernosa and shortening of the urethra, and then creation of a sensitive neoclitoris, of a neovagina suitable for penetration, mons pubis, vulva and labial structures. A variety of surgical techniques have been used, with different functional outcomes. Patients often are not aware of their detailed new anatomy, and in many cases this information is not clearly specified in the surgical report. Then, it is often necessary to re-evaluate the patient anatomy when new pelvic surgery is needed, either related to complications of the gender conversion or not. Furthermore, MtF-SRS is prone to early post-operative complications, the most common being bleeding and inflammation, followed by ischaemic changes and fistula formation.[1,2]

MRI is an excellent modality to evaluate the new female anatomy and its pathologic changes in MtF-SRS.[3–5] Preliminary studies focused on investigation of length and orientation of the neovagina, the presence of cavernosal remnants and thickness of the rectovaginal septum.[3–5] No systematic studies report the detailed post-operative MR anatomy, as well as the findings observed in surgical complications of the procedure.

The aim of this study was to investigate the clinical role of MRI in the assessment of the pelvis after MtF-SRS.

METHODS AND MATERIALS

This study was approved by the institutional review board of the corresponding author. The need for informed consent was waived, given its retrospective nature.

A computer search in the database at our institution was carried out for the clinical and radiological records of the patients who underwent MtF-SRS between March 2002 and August 2016. Only patients having pelvic MR available for retrospective review were considered. This process yielded a total of 71 patients.

Images were retrieved, evaluated retrospectively and correlated with the clinical findings by a radiologist (LED) with 40 years' experience in genitourinary imaging, and by a urologist (SB) with 10 years' experience in MtF-SRS.

The radiologist and the urologist correlated the imaging findings with the clinical history of each patient. They were aware of whether MRI was performed in the early post-operative period or later, and whether post-operative complications were clinically suspected before the imaging procedures. The radiologist and the urologist evaluated the post-operative anatomy, identified pathological features and indicated what sequences were more informative. In particular, they evaluated length and orientation of the neovagina, appearance of the rectoneovaginal septum, the presence of the ischiocavernosus muscle, the presence, morphology and vascularization of the neoclitoris and of the urethral plaque and the presence of cavernosal and/or spongiosal remnants. In the patients investigated early after the operation, they also assessed whether clinically significant fluid collections or other post-operative complications were present, such as fistulas or abscesses.

MR was performed with a 1.5-T superconducting imaging system (Intera-Achieva, Philips Medical System, Best, Netherlands) using sagittal and axial planes. Coronal images were obtained when clinically indicated. T_2 weighted and fat-suppressed T_1 weighted images were obtained before and after gadolinium contrast administration (0.1 mmol kg^{-1} body weight gadolinium-tetraazacyclododecanetetraacetic acid (Gd-DOTA). Other sequences were used in selected cases. In particular, a rapid half-Fourier T_2 weighted, balanced steady-state free-precession sequence was used to evaluate the degree of neovaginal prolapse before surgical correction. A vaginal tutor was put in place in 30 patients. The rectum and neovagina were distended with gel in patients who had no vaginal tutor inserted. Exceptions were 10 patients who declined gel insertion, 3 patients with neovaginal closure, 10 patients who were studied for evaluation of cavernosal remnants, 1 patient who was evaluated for localization of a remaining testis and 3 patients in whom a fistula was suspected.

Surgical techniques

Several technical variations have been developed for MtF-SRS. Vaginoplasty using inversion of a combined scrotal and penile skin flap is currently the procedure of choice in many institutions.[6,7] This technique involves removal of the testes, spermatic cords and corpora. The space for the neovagina is created by blunt dissection of tissues between the urethra, prostate and bladder anteriorly and the rectum posteriorly. Scrotal and penile skin is used to create the labia and the wall of the neovagina. The bulbus spongiosum muscle can be preserved and used to reinforce the posterior wall of the neovagina. The neurovascular bundle of the penis is preserved with a little triangular wedge of the dorsal aspect of the glans for the configuration of the neoclitoris. The neurovascular bundle is folded up, positioned and fixed under the pubic skin in order to mimic the mons veneris, and the glans wedge is positioned in the natural anatomical position of the female clitoris. The urethra is sectioned 4–5 cm distally, opened ventrally and incised in a Y fashion. Flaps are sutured around the neoclitoris.[6,7]

In early surgical techniques for MtF-SRS, a neoclitoris was not manufactured, and the crura of the corpora cavernosa and the bulbus of the corpus spongiosum were preserved. In some South American centres, one testis was retained during sex reassignment in the attempt to prevent the loss of libido and orgasmic function secondary to castration.[8] In other surgical variations, the bulbus spongiosum muscle is excised, and the neovagina is manufactured with a variety of techniques including use of the urethra, penile skin only and intestinal segments.[6,9,10]

Several surgical techniques are used for secondary vaginal reconstruction when the primary vaginoplasty yields unsatisfactory functional results, or when neovaginal stenosis develops. Use of intestinal segments is currently preferred.[11] Today, the majority of surgeons use an isolated segment of the sigmoid colon or an ileal loop, the latter being the modality of choice in our institution.[12]

RESULTS

Patient characteristics

In total, 74 MR investigations were performed in 71 patients with MtF-SRS [age range, 21–63 years; mean ± standard deviation (SD) age, 36 ± 10 years; median age, 37 years]. In 47/74 cases, the study was performed within 2 weeks after surgery to rule out early post-operative complications following MtF-SRS ($n = 40$), secondary vaginal reconstruction ($n = 6$) or remodelling of the labia majora ($n = 1$). The reason for early post-operative imaging in each patient is reported in Table 1.

In 27/74 cases MR imaging was performed 1-20 years after SRS. Reason was evaluation of cavernosal and spongiosal remnants in patients presenting with dyspareunia (n=10); strictures or loss of depth on the neovagina (n=8); neovaginal prolapse (n=2), fistulas (n=3); severe chronic pelvic pain (n=2); dysuria (n=1); localization of a testis spared during sex reconfiguration (n=1).

Three patients were evaluated before and after secondary ileal vaginoplasty. Of them, one patient with acute abdomen and one patient with suspected pelvic abscess both had MR and CT studies.

Normal post-operative MR anatomy

Length and inclination of the neovagina was best investigated on T_2 weighted sequences, as well as the straight or angulated

Table 1. Clinical justification for MRI in 47 patients investigated early after the operation

Patient number	Operation	Clinical suspicion
15	SRS	Hyperpyrexia
6	SRS	Rapid anaemization
5	SRS	Excessive pain
5	SRS	Suspected pelvic or labial abscess
4	SRS	Suspected pelvic haematoma
2	SRS	Suspected ischaemic changes
3	SRS	Neovaginal foul-smelling discharge
1	Labia majora reconfiguration	Suspected labial abscess
3	Vaginoplasty	Painful lower abdominal wall
2	Vaginoplasty	Suspected ischaemic changes
1	Vaginoplasty	Acute abdomen

SRS, sex reassignment surgery.

course and integrity of the rectovaginal septum (Figure 1). In the 40 patients investigated within 2 weeks after MtF-SRS, the length of the neovagina ranged from 8 to 15 cm [mean, 11.6 ± 1.5 cm (SD); median, 12.0 cm]. The vagina had a straight course with physiological inclination from front to rear and from low to high in all but two patients, one patient with lateral deviation (Figure 2) and one patient with mild angulation.

When preserved, the bulbus spongiosum muscle was visible as a relatively low-signal intensity tissue between the anal canal and the introitus of the neovaginal entry. On T_2 weighted images, the urethral plaque was identified as a relatively high-signal intensity ribbon with transversal course running anteriorly from the apex of the prostate. The neurovascular bundle presented as a relatively high-signal intensity tubular structure folding into the mons veneris. The urethral plaque, neurovascular bundle, neoclitoris and neovaginal walls were best depicted on fat-suppressed gadolinium-enhanced T_1 weighted images (Figure 1).

In the six patients investigated within 2 weeks after ileum-derived vaginoplasty, the length of the neovagina ranged from 11 cm to 14 cm [mean, 12.3 ± 1.2 cm (SD); median, 12.5 cm]. The vagina had a straight course with physiological inclination.

Early post-operative MRI findings after male-to-female sex reassignment surgery

Small haematomas (≤2 cm thick) surrounding the neoclitoris and the urethral plaque were identified in all the 40 patients investigated within 2 weeks after MtF-SRS. Small fluid collections

Figure 1. Evaluation of the new female anatomy in a 30-year-old male-to-female patient investigated 9 days after sex reassignment surgery: the rectum is distended with gel, and tutor is inserted in the neovagina. (a) Midsagittal T_2 weighted MR image showing the neovagina with the tutor inside (T), urethral plaque (curved arrow), neurovascular bundle folding in the mons veneris (thick arrows), neoclitoris (asterisk), rectovaginal septum (arrowhead). The bulbocavernosus muscle (thin arrow) has been used to reinforce the neovaginal introitus in front of the anal canal (C). A small haematoma (ellipse) is visible near the neoclitoris. (b) The midsagittal fat-suppressed T_1 weighted MR image obtained after gadolinium contrast administration shows the same anatomical features demonstrating vascularization of the neoclitoris (asterisk), urethral plaque (curved arrow) and of the neovaginal wall around the tutor. B, bladder; P, prostate.

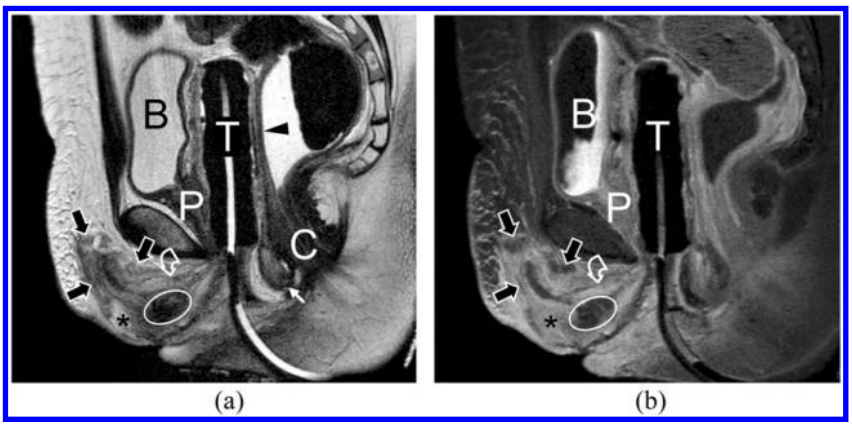
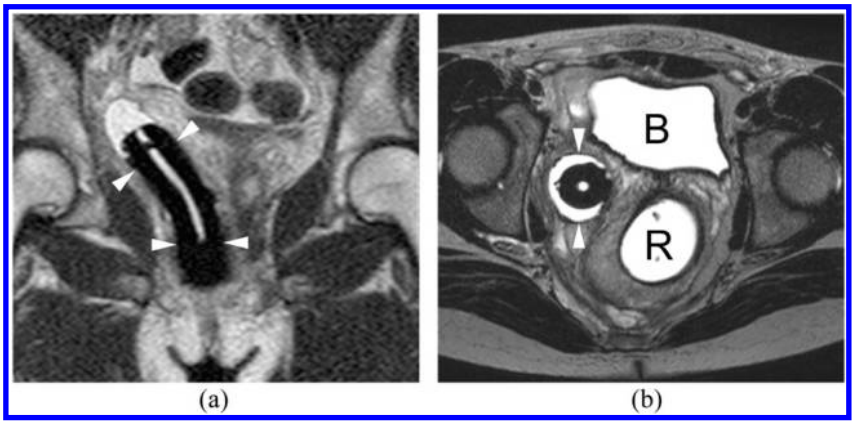


Figure 2. A 37-year-old patient with male-to-female sex reassignment surgery before 10 days: coronal (a) and axial (b) T_2 weighted images showing right deviation of the neovagina (arrowheads). B, bladder; R, rectum.



were also visible along the neurovascular bundle (in 9/40 patients), labia (in 3/40 patients), neovagina (in 2/40 patients) and inguinal canal (in 4/40 patients). They were all considered as clinically non-significant. Larger fluid collections were identified in 5/40 patients around the neoclitoris, neurovascular bundle and urethral plaque and were regarded as clinically significant. Two patients had abscess in the labia majora (Figure 3). Of them, one patient took antibiotics until clinical resolution; the other patient had surgical drainage of the abscess. Three patients had MR confirmation of clinically obvious severe cellulitis of the labia, but no fluid collections requiring drainage were found (Figure 4).

Partial prolapse of the scrotal flap forming the posterior neovaginal wall was identified in 3/40 patients (Figure 5). It was treated with reposition of the sutures in the midpart of the penoscrotal skin flap.[13] One patient had a small dehiscence of the neovaginal wall which closed spontaneously (Figure 6). Hypovascularization of the neoclitoris was identified in a patient in whom the neurovascular bundle was incidentally damaged during the operation. The neoclitoris, however, was considered viable and proved sensitive at the medical follow-up examinations. A focal necrosis of the vaginal wall healed spontaneously through secondary epithelization.

Early post-operative MR findings after ileal vaginoplasty

Regarding the six patients investigated early after ileal vaginoplasty, one patient had no pathological findings, three patients had clinically insignificant haematomas ($\leq$2 cm thick) of the anterior abdominal wall and one patient had residual stenosis of the neovaginal entry. One patient presented with acute abdomen 4 days after the operation. MR identified a large rectovaginal fistula. Acute peritonitis due to associated dehiscence of the intestinal anastomosis with bowel perforation was best identified on an abdominal contrast-enhanced CT study performed immediately after the pelvic MR investigation (Figure 7).

Late post-operative MR findings after sex reassignment surgery with different techniques

MRI allowed an excellent evaluation of the length and girth of the cavernosal and spongiosal remnants (Figure 8), length and morphology of the neovagina (which was inadequate for penetration in eight patients) (Figure 9) and the presence of fibrotic

Figure 3. Abscess formation in the labia majora of a 22-year-old male-to-female patient investigated 9 days after sex reassignment surgery: axial (a) and coronal (b) fat-suppressed T_1 weighted MR images obtained after gadolinium contrast administration show fluid collections within the labia (arrowheads) and peripheral rim of enhancement consistent with abscesses. The patient was treated with systemic antibiotics and subsequently underwent successful percutaneous drainage on the right side.

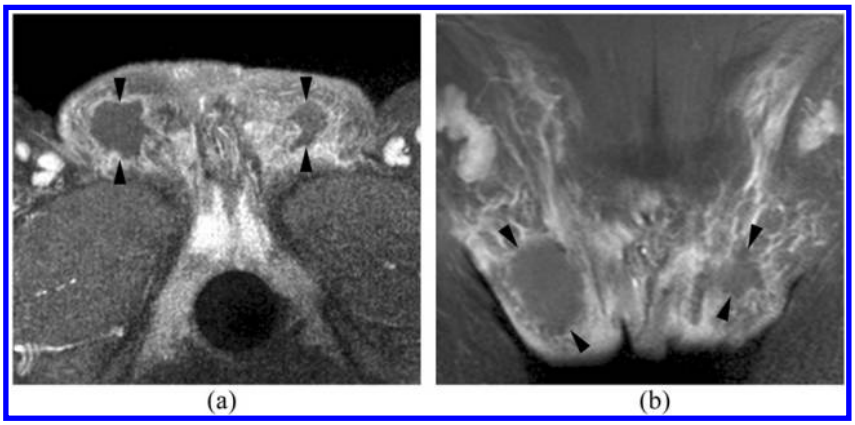
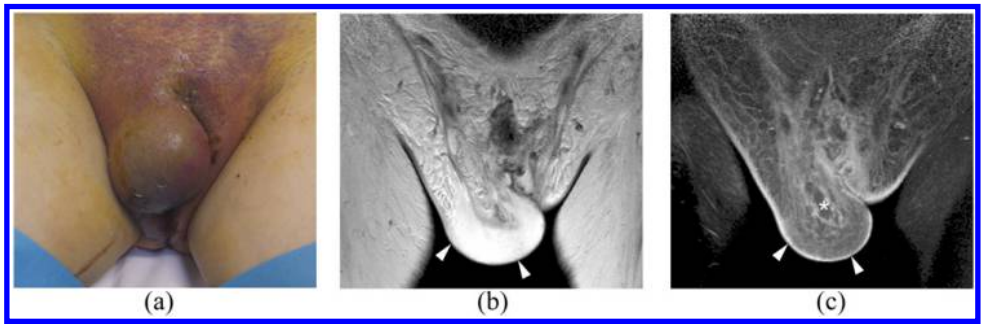


Figure 4. Cellulitis of the right labium in a 35-year-old male-to-female patient investigated 9 days after sex reassignment surgery presenting with fever and marked swelling and redness of the right labium: (a) Photograph showing a clinically obvious cellulitis. (b, c) Coronal T_2 weighted (b) and fat-suppressed T_1 weighted images obtained after gadolinium contrast administration (c) show thickening with oedema and hyperaemia of the right labium (arrowheads) and a small fluid collection (asterisk) not requiring drainage. The patient healed with a course of antibiotics within 1 week.



changes of the surrounding tissues. Perineal fibrosis was identified in two patients with neovaginal strictures, and in the patient with dysuria, presenting as low-signal intensity tissue in the vestibulum, around the urethra and around the neovagina opening.

In three patients, MRI was able to evaluate the presence of fistulas and abscesses and to follow the course of the fistulas (Figure 10). A total neovaginal prolapse was identified in two patients with sigmoid vaginoplasty investigated with static and dynamic pelvic floor MRI (Figure 11). In the patient with non-palpable spared testis during sex reconfiguration, MRI identified the testis in the root of the left thigh, with spermatic cord running within the left labium major (Figure 12). In the remaining three patients, one patient with dysuria and two patients with severe chronic pelvic pain, no pathological features were found.

DISCUSSION

MtF-SRS requires significant remodelling of the pelvic tissues. Bleeding is common, particularly when manufacturing the neoclitoris. In our series, small haematomas surrounding the neoclitoris, urethral plaque, labia and adjacent tissues were identified in all patients soon after the operation. They should be considered normal post-operative findings not requiring treatment or surgical revision. Clinically significant post-operative complications were relatively common in our series, accounting globally for 30–37%. In most of the cases, however, they were managed conservatively.

Figure 5. Partial prolapse in a 50-year-old male-to-female patient investigated 5 days after sex reassignment surgery: the midsagittal fat-suppressed T_1 weighted MR image obtained after gadolinium contrast agent shows the prolapsed, well-vascularized posterior neovaginal wall (curved arrow).

Figure 6. Dehiscence in the anterior neovaginal wall of a 25-year-old patient who had male-to-female sex reassignment surgery 9 days before: the neovagina (arrowheads) and the rectum were distended with gel. The midsagittal T_2 weighted image is showing extravasation of gel from the anterior wall of the neovagina (curved arrow).

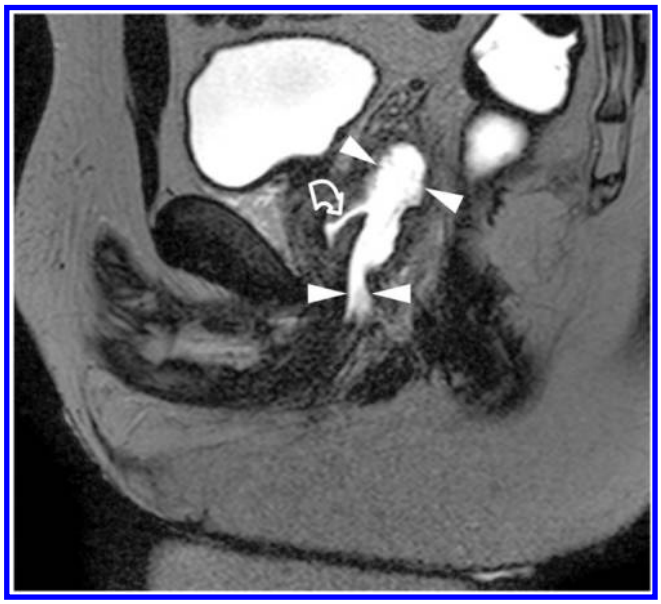
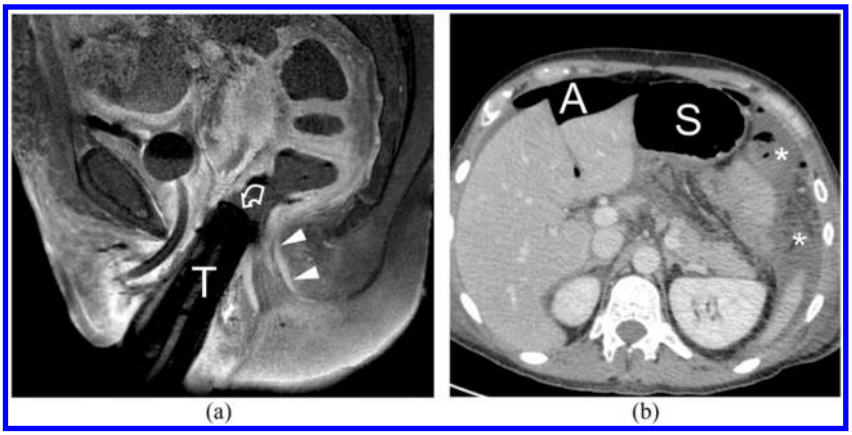


Figure 7. A 43-year-old patient who had male-to-female sex reassignment surgery 11 years before: the patient developed acute abdomen 4 days after secondary ileal vaginoplasty. (a) The midsagittal fat-suppressed T_1 weighted image is showing protrusion in the rectum (curved arrow) of the tutor inserted in the neovagina (T), immediately above the anal canal (arrowheads). (b) The CT image obtained after i.v. iodinated contrast injection shows extraluminal air (A) and intraperitoneal fluid containing air bubbles (asterisks), consistent with peritonitis. Direct visualization of the discontinuity of the bowel wall was not obtained. An emergency laparotomy was performed, which identified a 3-cm rectovaginal fistula and dehiscence of the ileal anastomosis. S, stomach.



Secondary ileal vaginoplasty was performed in six patients. A severe complication (dehiscence of the suturing stitches, peritonitis and a large rectovaginal fistula) was observed in one of them. MRI identified the fistula, but contrast-enhanced CT was necessary for a complete evaluation of the abdomen before reoperation.

Previous MRI studies of patients after MtF-SRS report an average length of about 9.3 cm (range: 6–11 cm) for the neovagina manufactured with the penoscrotal skin flap.[3–5] In our series of patients operated with the same approach, we found a longer average neovaginal length of 11.6 ± 1.5 cm (SD), which is in keeping with the depth reported in a recent systematic review of 10–13.5 cm.[9] Changes in the surgical technique in the most recent operations can explain this discrepancy. In our institution, surgeons prefer not to close the apex of the neovaginal cylinder. The dome of the cavity is covered through secondary epithelialization, and a deeper neovagina is obtained.

Figure 8. Evaluation of the new female anatomy in a 28-year-old male-to-female patient operated before 10 years complaining of discomfort and dyspareunia during penetration: the T_2 weighted axial image obtained after ultrasound-guided intracavernosal Prostaglandin E1 injection showing large cavernosal stumps (asterisks). The clitoris was not manufactured.

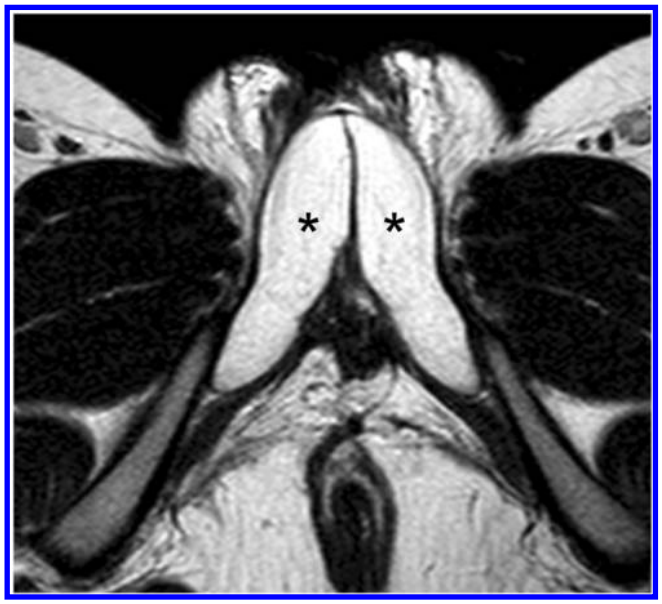
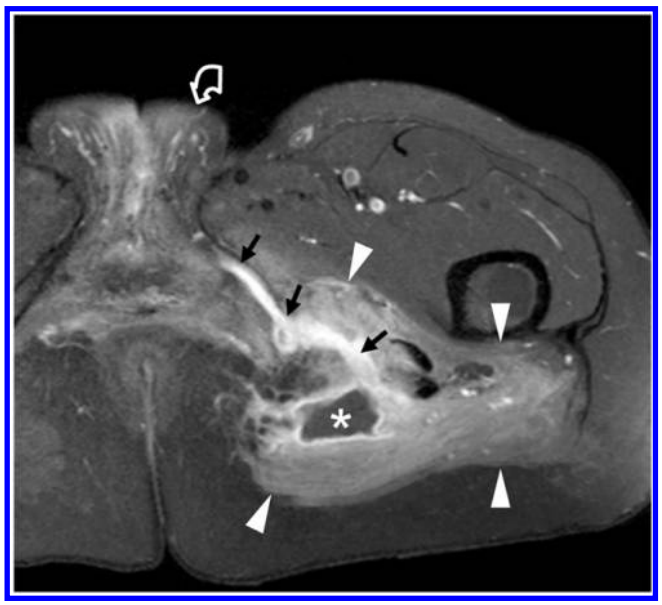


Figure 9. A 51-year-old male-to-female patient operated 13 years before, who developed neovaginal stenosis: the T_2 weighted midsagittal image obtained after distension with gel shows a short, funnel-like neovagina (arrowheads).

Figure 10. A 33-year-old male-to-female patient operated 6 months before presenting with clinically suspicious abscess in the left gluteal region: the patient complained of pus discharge from a fistula between the left majus and minus labium. The axial fat-saturated T_1 weighted image obtained after gadolinium contrast injection shows left gluteus abscess (asterisk) with markedly hyperaemic gluteus maximus and adductor magnus muscles arrowheads. A fistula (small arrows) spreads from the abscess towards the labia (curved arrow).



Loss of neovaginal depth and strictures hampering penetration is commonly encountered even years after the operation.[1] In our series, six patients were investigated early after secondary ileum-derived vaginoplasty. An average neovaginal length of 12.3 cm was obtained, in keeping with the length reported in a recent study.[14]

Besides evaluating the neovaginal length and course, and demonstrating the presence of post-operative complications, MRI was useful in planning new operations in patients who had previously undergone MtF-SRS and complained of unsatisfactory results, neovaginal strictures, pain or dysuria, inflammatory changes or poor cosmetic outcome. In particular, the extension of fibrotic changes which may hamper the surgical procedures, especially in post-inflammatory neovaginal strictures, could be assessed.

This study has several limitations, with the principal one being its retrospective nature. Since MRI was performed when clinically indicated, we are not able, with the present study, to evaluate the incidence of early post-operative complications in the general population of patients undergoing MtF-SRS. Owing to case selection bias, some patients with mild complications may not have been evaluated with MRI, or may not have been recorded for inclusion. Furthermore, some patients were referred to our institution after MtF-SRS surgery performed in other centres, using a variety of techniques. Often, the detailed surgical technique was not described in the surgical report, and the surgical approach used was deducted by analysis of the changes shown at MR and not from the patient charts.

An additional limitation of our study concerns the inability to determine retrospectively how much the imaging results had an impact on the functional outcome and quality of life of these patients, as most of them were lost at follow-up. Further studies on prospective series are necessary to clarify these points.

In conclusion, MtF-SRS is the final step of a long and complex route which requires a multidisciplinary approach to the patient. Surgery is performed in a limited number of specialized centres, and peculiarities of the new female anatomy and of possible complications are usually not known by the general radiologists. Also, in these centres, the patient is often managed on clinical basis only. Urologists are not aware of the potential of imaging investigations in these patients, and radiologists are not confident with the pelvic anatomy after genital reconfiguration and with early and late post-operative complications.

Figure 11. Neovaginal prolapse in a 39-year-old patient who had male-to-female sex reassignment surgery and sigmoid neovagina 16 years before; the midsagittal balanced Fast Field Echo image obtained during pelvic squeeze (a) and strain (b). Neovaginal protrusion is already present during pelvic squeeze (arrowheads) and increases during pelvic strain.

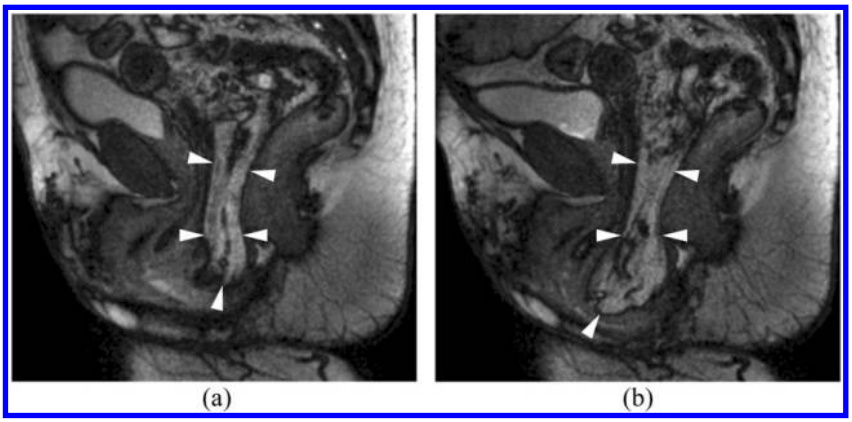
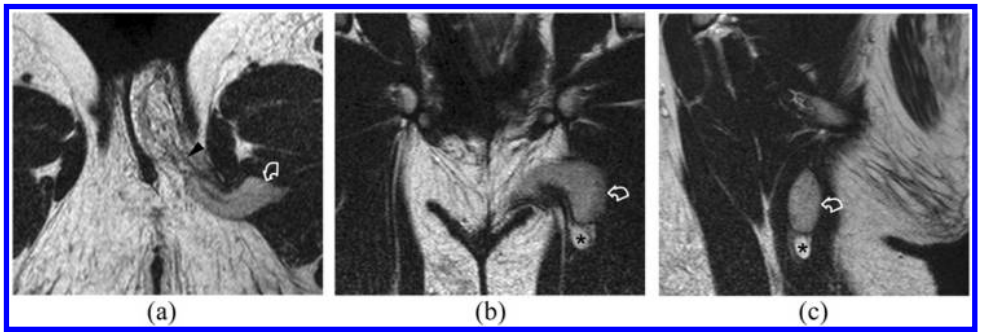


Figure 12. A 41-year-old male-to-female patient operated in South America 22 years before: during sex reassignment, the left testis was spared. The patient complained of a large left labium majus and of experiencing severe left perineal pain during vigorous intercourse. On medical examination, the testis was not palpable. T_2 weighted MR images on axial (a), coronal (b) and sagittal planes (c) show the testis (curved arrows) buried in the musculature of the left upper leg. The spermatic cord [arrowhead in (a)] runs front–rear within the left labium majus. The asterisks indicate an epididymal cyst.



Our study shows that many transsexual patients would benefit from imaging investigation, whose peculiarities should be known at least by radiologists working in centres in which SRS is performed. Although we were not able to assess in retrospect the role of imaging in the clinical management of each patient, we believe that imaging, at least, increases the confidence in the diagnosis obtained on clinical basis.

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