World Journal of Urology (2022) 40:849–855
https://doi.org/10.1007/s00345-021-03907-y

ORIGINAL ARTICLE

Prostatic metaplasia of the vagina in transmasculine individuals

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Received: 21 October 2021 / Accepted: 6 December 2021 / Published online: 16 January 2022

Abstract

Purpose To determine the prevalence of prostatic metaplasia in an expanded cohort of transmasculine individuals undergoing gender-affirming resection of vaginal tissue.

Methods Institutional Review Board approval was obtained. Clinical records were reviewed for all transmasculine individuals undergoing vaginal tissue resection at our institution between January 2018 and July 2021. Corresponding pathology specimens were examined grossly and microscopically, including immunohistochemical stains for NKX3.1, prostate-specific antigen (PSA), and androgen receptor (AR). Vaginal specimens from three patients without androgen supplementation were used as controls.

Results Twenty-one patients met inclusion criteria. The median age at surgery was 26.4 years (range 20.6–34.5 years). All patients had been assigned female gender at birth and lacked endocrine or genetic abnormalities. All were on testosterone therapy; median duration of therapy at surgery was 4.4 years (range 1.4–12.1 years). In the transmasculine group, no gross lesions were identified. Microscopically, all specimens demonstrated patchy intraepithelial glandular proliferation along the basement membrane and/or nodular proliferation of prostate-type tissue within the subepithelial stroma. On immunohistochemical staining, performed for a subset of cases, the glandular proliferation was positive for NKX3.1 (16/16 cases; 100%), PSA (12/14 cases; 85.7%), and AR (8/8 cases; 100%). Controls showed no evidence of prostatic metaplasia.

Conclusion One hundred percent of vaginal specimens obtained from transmasculine individuals on testosterone therapy (21/21 cases) demonstrated prostatic metaplasia. Further investigation is warranted to characterize the natural history and clinical significance of these changes. Patients seeking hormone therapy and/or gender-affirming surgery should be counseled on the findings and their yet-undetermined significance.

Keywords Transgender persons · Metaplasia · Androgens · Pathology

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Introduction

Transgender individuals, whose gender identity differs from their assigned sex at birth, represent 0.4–2.7% of the U.S. population [1]. This proportion is growing over time, particularly among younger generations [2]. Desire for, and treatment with, hormone therapy is common: in the 2015 U.S. Transgender Survey, the largest national survey of transgender individuals, 95% of transgender individuals reported a desire for hormone therapy, and 71% reported receiving it [3]. Gender-affirming surgery (GAS) of the genitalia, in contrast, is still fairly uncommon, in large part due to lack of access to such procedures. Among transmasculine individuals – individuals assigned female sex at birth, who identify as male – in the same survey, only 2% underwent metoidioplasty, 3% underwent phalloplasty, and 14% underwent hysterectomy [3]. As a result, the vast majority of transmasculine individuals on testosterone therapy retain their native genital anatomy, including vaginal tissue.

The increasing prevalence of transgenderism and, by extension, gender-affirming treatment presents a growing need to understand the pathological and physiological changes associated with long-term hormone therapy. Some changes, such as male-pattern hair growth, deepening of the voice, and increase in muscle mass are expected and desired components of gender affirmation, while other changes are incidental. Testosterone therapy among transmasculine individuals has been associated, for instance, with increases in blood pressure, triglyceride levels, carotid arterial intimal thickening, and other markers of cardiovascular risk [4]. Identifying and characterizing such changes is important so that any resulting risks can be appropriately managed.

A study that included the first cohort of transmasculine patients to undergo GAS at our institution reported the presence of androgen-associated prostatic metaplasia along the basal epithelium in six of six vaginal tissue specimens [5]. Histologically, this was distinct from other examples of ectopic prostatic tissue, such as tubulosquamous polyps (TSP) of the vagina and masses involving Skene's glands (the female homologue of the prostate), and instead resembled what historically had been termed vaginal adenosis. In the same study, prostatic metaplasia with a similar appearance and distribution was also observed in vaginal tissue from two patients with 46,XX karyotypes and congenital adrenal hyperplasia (CAH), a condition characterized by an endogenous source of androgen excess.

The potential for malignant transformation of androgen-mediated prostatic metaplasia is not yet known. However, among patients with 46,XX karyotypes and CAH, two cases of prostatic adenocarcinoma have been reported [6, 7]. Given that the mechanism for prostatic metaplasia in transmasculine individuals is also hypothesized to be androgen-mediated, the association between endogenous androgen excess and prostatic malignancy in CAH is potentially relevant. Characterizing the association between exogenous hormone therapy and prostatic metaplasia in the transmasculine population is an important first step toward determining how transmasculine individuals should be counseled when considering or receiving gender-affirming treatment.

To further investigate the prevalence of androgen-associated prostatic metaplasia in the vaginal tissue of transmasculine individuals, we performed a retrospective study of the gross and histologic features of vaginal tissue specimens from an expanded cohort of transmasculine patients on testosterone therapy who underwent GAS.

Methods

Following Institutional Review Board approval (protocol IRB-P00029906), clinical records for all patients who underwent gender-affirming resection of vaginal tissue between January 2018 and July 2021 (GAS group) were reviewed for duration of testosterone therapy; history of prior surgeries, including hysterectomy, oophorectomy, and salpingectomy; and type of vaginal resection performed as part of GAS. This included the six patients with results reported in the initial study [5].

Gross pathologic examination included inspection of the unfixed and formalin-fixed specimens in all cases, and of iodine-swabbed unfixed epithelial surfaces in three cases. Light microscopic examination of hematoxylin-and-eosin-stained slides was conducted. In a subset of cases, immunohistochemistry (IHC) was performed using antibodies against NKX3.1 (Athena ES, Baltimore, MD), PSA (DAKO, Carpinteria, CA), and AR (DAKO).

Clinical records were also reviewed for patients without a history of androgen supplementation or gender-affirming therapy, who had vaginal tissue resected for reasons other than GAS (control group). These patients also served as control cases in the initial study [5].

Results

Twenty-one patients met inclusion criteria for the GAS group (Table 1). The median age at GAS was 26.4 years (range 20.6–34.5 years). All patients had been assigned female sex at birth and lacked endocrine or genetic abnormalities. All were on testosterone therapy; the median duration of therapy before GAS was 4.4 years (range 1.4–12.1 years).

Table 1 Clinical and pathological features of transmasculine individuals

Case #	Clinical features			Pathological features[3]			
	Age (yrs)[1]	Testosterone therapy duration (yrs)[1]	Type of vaginal resection[2]	Prostatic metaplasia	IHC staining		
					NKX3.1	PSA	AR
1	26.6	1.4	OV	+	n/a	n/a	n/a
2	22.8	2.0	RC	+	+	+	n/a
3	20.7	2.2	RV	+	+	+	n/a
4*	34.3	3.0	OV	+	+	+	+
5	21.6	3.3	DV	+	n/a	n/a	n/a
6*	26.4	3.3	OV	+	+	−	+
7	34.4	3.4	RV	+	+	n/a	n/a
8	31.2	3.9	DV	+	n/a	n/a	n/a
9*	30.1	4.1	OV	+	+	+	+
10	22.3	4.1	RV	+	+	n/a	n/a
11	22.5	4.4	DV	+	+	+	n/a
12*	23.4	4.5	OV	+	+	+	+
13	24.2	4.7	RV	+	+	+	n/a
14	30.2	5.3	DV	+	n/a	n/a	n/a
15	25.7	6.1	DV	+	n/a	n/a	n/a
16*	25.0	6.7	RV	+	+	+	+
17*	28.0	7.2	OV	+	+	+	+
18	28.2	7.5	RV	+	+	+	n/a
19	25.5	8.2	RV	+	+	+	n/a
20	34.5	9.6	RV	+	+	+	+
21	33.7	12.2	RF	+	+	−	+
Cases involved / cases examined (%)				21/21 (100%)	16/16 (100%)	12/14 (85.7%)	8/8 (100%)

[1]At the time of GAS. [2]*DV* open distal vaginectomy with cautery ablation of remaining vaginal mucosa, *OV* open total vaginectomy, *RC* robotic completion vaginectomy, *RF* robotic excision of vaginal cuff remnant and fistula, *RV* robotic total vaginectomy. [3]Pathological features from vaginal tissue specimens. + = present or staining positive, − = absent or staining negative, *n/a* not performed. *Cases included in initial study by Anderson et al. [5]

Twenty patients underwent hysterectomy, and at least nine underwent bilateral salpingo-oophorectomy, prior to vaginal tissue resection. One patient (case #3) underwent hysterectomy and bilateral salpingo-oophorectomy at the time of vaginal tissue resection. The types of vaginal resection performed included open total vaginectomy (6/21); open distal vaginectomy with cautery ablation of remaining vaginal mucosa (5/21); robotic total vaginectomy (8/21); robotic completion vaginectomy after prior metoidioplasty (1/21); and robotic excision of vaginal cuff remnant complicated by fistula formation after prior metoidioplasty (1/21).

Gross pathologic examination of vaginal specimens from the GAS group showed no mucosal abnormalities in the fresh or formalin-fixed state. Iodine swabbing of the unfixed gross specimens, performed in three cases, failed to highlight any discrete lesions (Fig. 1). Sampling ranged from 2 to 29 histology cassettes (median 6 cassettes).

Microscopically, 100% of specimens from the GAS group (21/21 specimens) demonstrated prostatic metaplasia. This occurred as a patchy intraepithelial glandular proliferation along the basement membrane (Fig. 2a) in 95% (20/21) of cases. In one case (case #21), the specimen consisted of a postsurgical vaginal fistula site, and squamous mucosa was not represented in the specimen; the prostate-type tissue was present as a nodular proliferation within the subepithelial stroma. The rate of involved blocks demonstrating prostatic metaplasia ranged from 25 to 100%. In all 20 cases in which squamous epithelium was represented, the squamous epithelial layer was thinned and showed a paucity of intracellular glycogen.

IHC staining results are summarized in Table 1. IHC staining for at least one marker was performed in 16 of 21 cases from the GAS group (Fig. 2b–d). Glandular proliferation stained positive for NKX3.1 (16/16 cases; 100%), PSA (12/14 cases; 85.7%), and AR (8/8 cases; 100%); AR staining was also present in unaffected squamous epithelium and stromal cells of the lamina propria.

The control group consisted of three vaginal tissue specimens. These were obtained from two patients who underwent vaginoplasty for obstructed hemivaginas, at age 12 years and

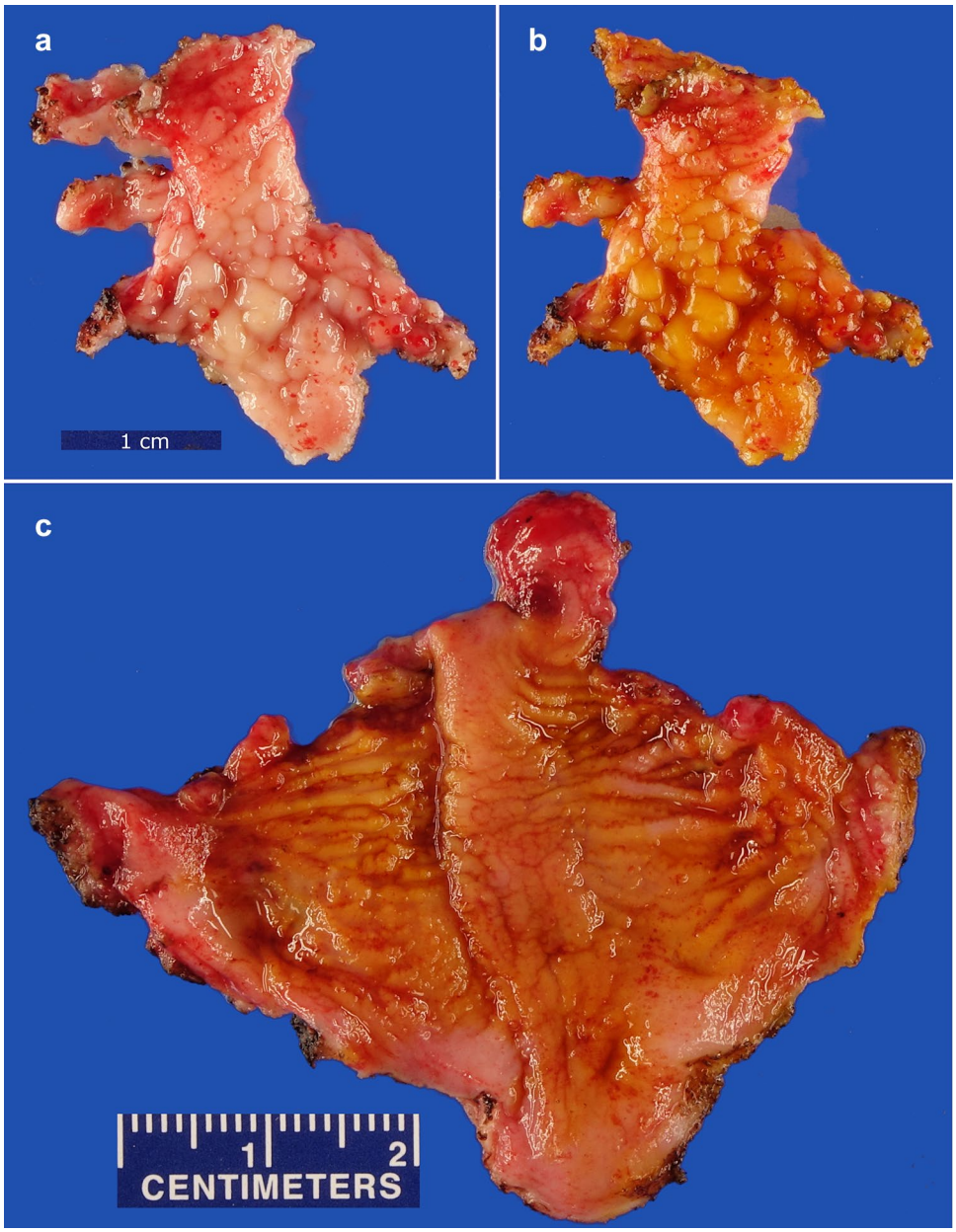

Fig. 1 **a**, **b** Vagina specimen from a 21-year-old transmasculine individual (case #5), fragmented during excision. The largest fragment (**a**, unfixed) shows a bosselated pale tan-pink surface and no grossly identifiable lesions; iodine-wash (**b**) shows an even light brown hue, without appreciable variegation from glycogen-poor (pale) or glycogen-rich (dark brown) areas. **c** Intact vagina specimen (unfixed and iodine-treated) from a 30-year-old transmasculine individual (case #14). Grossly, the mucosa is rugated and evenly colored light tan, without appreciable lesions

13 years respectively, and one patient who underwent radical vaginectomy for yolk sac tumor at age 1.5 years. For the third case, a section of benign vaginal tissue was examined. In all three control cases, vaginal tissue showed squamous epithelium without evidence of transitional metaplasia or prostatic glands. IHC was negative for both NKX3.1 and PSA in all three cases. AR showed multifocal weak staining in stromal fibroblasts and squamous cells of the basal layer.

Discussion

Androgen-associated prostatic metaplasia of vaginal tissue in transmasculine individuals is a phenomenon that has been recently described, with a prevalence and clinical significance that remain to be determined [5]. In this study, we report the histopathological findings of vaginal

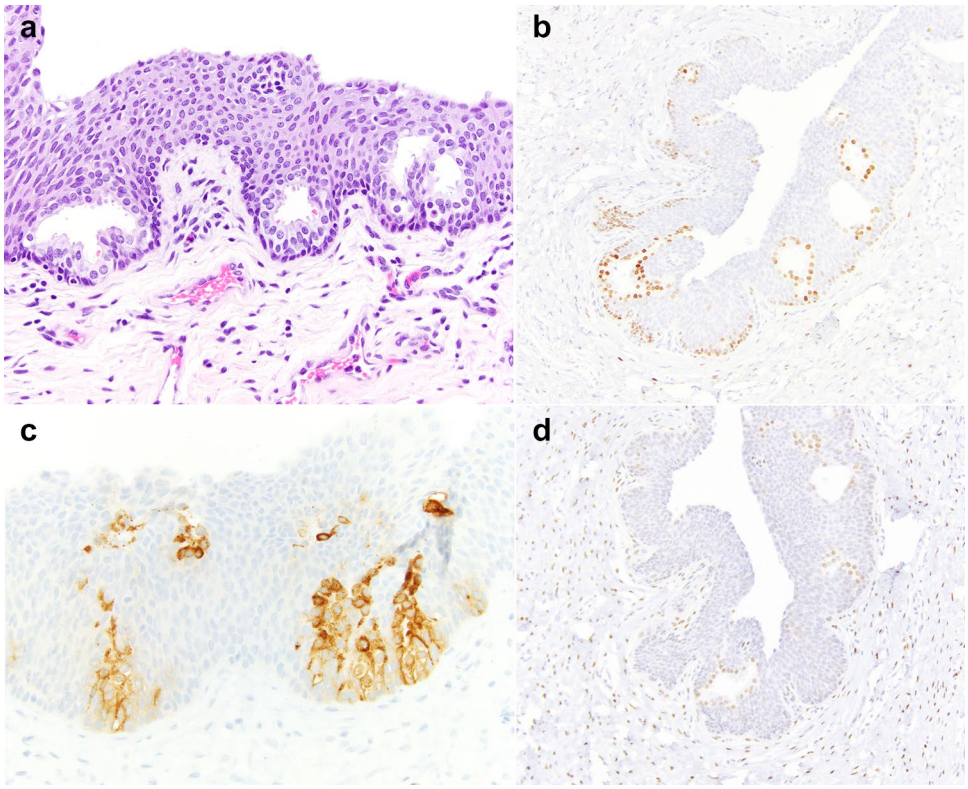

Fig. 2 **a** Prostatic metaplasia is characterized by patchy glandular proliferation along the basal aspect of the squamous epithelium (case #16, hematoxylin and eosin, original magnification, 400x). Immunohistochemical staining for **b** NKX3.1 highlights nuclei of intraepithelial glands and vicinal basal cells (case #20, original magnification, 200x); **c** PSA marks cytoplasm of variably well-formed glands (case #16, original magnification, 400x); and **d** androgen receptor highlights nuclei of prostatic-type glands as well as stromal fibroblasts (case #20, original magnification, 200x)

specimens from 21 transmasculine individuals on testosterone therapy who underwent GAS. Prostatic metaplasia was present in 100% of specimens in the GAS group, as compared to 0% of specimens in the control group.

These findings suggest that the phenomenon of prostatic metaplasia is highly prevalent in the vaginal tissue of transmasculine individuals. In our initial report, 6 of 6 (100%) vaginal tissue specimens from transmasculine individuals showed prostatic metaplasia, while a more recent study by Lin et al. reported prostatic metaplasia in 10 of 15 (67%) vaginal tissue specimens from transmasculine individuals [5, 8]. The present study represents the largest series reported to date of prostatic metaplasia in vaginal tissue of transmasculine individuals and demonstrates that prostatic metaplasia of the vagina is very common, if not ubiquitous, among transmasculine individuals on androgen therapy. Our findings also suggest prostatic metaplasia may be far more prevalent in the vagina than in the cervix of transmasculine individuals [8–12].

Our present study has important near- and long-term clinical implications. In the near term, it suggests a need for modified patient counseling. Transgender patients who seek androgen therapy and/or GAS should be counseled on the likelihood of developing androgen-mediated prostatic metaplasia. They should be informed that, although prostatic metaplasia appears benign, its long-term clinical ramifications are not yet completely understood. Furthermore, they should be informed that surveillance regimens, while not in place today, may prove necessary in the future pending the results of further investigation, so continued follow-up is important.

In the longer term, our findings underscore the need for prospective studies of transgender individuals on prolonged exogenous androgen therapy. Among genotypically female patients with CAH, who are exposed to endogenous androgen excess, prostatic development is a well-established phenomenon; notably, at least two cases of prostate adenocarcinoma have been reported in this population [13]. Winters et al. described a case of metastatic prostate cancer in a 62-year-old genotypic female with CAH [7]. The patient's PSA was 13 ng/ml at diagnosis and decreased to < 0.1 ng/ml after external beam radiation therapy (EBRT) but rose to 10 ng/ml with development of bony metastases. In the second case, reported by Wesselius et al., a phenotypically male patient with a 46,XX karyotype and CAH was started at age 12 years on testosterone therapy [6]. At age 62 years, after PSA rose to 4.6 ng/mL, he was diagnosed on prostate biopsy with Gleason 4 + 3 prostate adenocarcinoma. PSA decreased to 0.4 ng/ml after treatment with EBRT.

In our present study, the cellular characteristics of the prostatic-type epithelial cells support a benign process, further suggesting that it is best viewed as a type of metaplasia. Given that the longest duration of testosterone therapy in our cohort was 12 years, however, these findings

should be interpreted accordingly. Long-term follow-up studies have not yet been reported in the transgender population but will be important in the future.

Prostatic metaplasia was not associated with gross lesions in this or prior studies. Furthermore, iodine staining of gross unfixed specimens in the present study did not reveal lesions. We know of no other study that has explored the use of iodine in gross evaluation, mimicking clinical evaluation with Lugol's iodine. These findings represent a unique contribution to the literature and further suggest that physical examination is unlikely to be an effective means of clinical monitoring. Moreover, colposcopy may cause distress for transmasculine patients: in studies of cervical cancer screening perceptions among transmasculine individuals, provider-administered Pap smears have been described as emotionally invasive and a source of vulnerability and gender discordance [14]. PSA testing may be a more useful and acceptable approach to monitoring. To assess this, prospective studies of PSA levels in transgender patients on prolonged androgen therapy could be considered.

Further investigations are also warranted to elucidate the biological mechanism for androgen-associated prostatic metaplasia. As has been noted previously, this phenomenon is morphologically and histologically distinct from other forms of vaginal ectopic prostatic tissue, such as TSP, which are thought to arise from misplaced Skene's glands and are not associated with androgen excess [15, 16]. In TSP, prostatic changes are localized to discrete polyps, mostly in the upper vagina of postmenopausal women, and microscopically are observed within the stroma. In the present study, in contrast, no gross lesions were observed, and glandular differentiation occurred widely throughout the squamous epithelium.

These differences suggest that in transmasculine individuals, prostatic metaplasia arises via a distinct pathway. A more likely mechanism entails androgen-mediated plasticity of vaginal tissue. Xenograft studies have demonstrated that human female fetal proximal urethra can undergo prostatic development when grown in dihydrotestosterone (DHT)-treated mouse hosts [17]. Other studies, meanwhile, have identified hormone-responsive vaginal epithelial stem cells [18]. A recent study from our institution of mastectomy specimens from transmasculine individuals identified prostatic metaplasia in breast epithelium, which has been shown previously to express AR [19, 20]. In the present study, AR expression was consistently observed in vaginal tissue specimens from the control group as well as the GAS group. This further supports the biological feasibility of hormone-mediated changes in vaginal tissue composition. Future animal and in vitro human tissue studies will be helpful to elucidate the biological basis of androgen-mediated transformation of vaginal tissue and to determine whether there is a dose effect of androgen exposure. Such studies may also be useful for predicting the potential for malignant transformation.

Our study is limited by its single-institution, retrospective design and small cohort size, reflecting a nascent field of study. While many questions remain, the findings of this study strongly suggest that prostatic metaplasia is very common among transmasculine individuals and, as such, warrants further investigation.

Conclusion

One hundred percent of vaginal tissue specimens (21/21) obtained from transmasculine individuals on testosterone therapy demonstrated prostatic metaplasia. Future studies are needed to characterize the natural history and clinical significance of these pathological changes. In the meantime, transmasculine individuals pursuing testosterone therapy and/or surgery for gender affirmation should be counseled on these findings and informed that their clinical implications are yet to be determined.

Author contributions RX: protocol/project development, data collection or management, data analysis, manuscript writing/editing. DD: protocol/project development, data collection or management, manuscript editing. JB: protocol/project development, data collection or management, manuscript editing. CE: protocol/project development, data collection or management, manuscript editing. RY: protocol/project development, data collection or management, manuscript editing. WA: protocol/project development, data collection or management, manuscript editing. SV: protocol/project development, data collection or management, manuscript writing/editing.

Funding No funds, grants, or other support was received.

Declarations

Conflict of interests The authors have no relevant financial or non-financial interests to disclose.

Ethics approval This retrospective chart review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Human Investigation Committee (IRB) of Boston Children's Hospital approved this study.

Informed consent Patients signed informed consent regarding publishing their data and photographs.

References

1. Nolan IT, Kuhner CJ, Dy GW (2019) Demographic and temporal trends in transgender identities and gender confirming surgery. Transl Androl Urol 3:184–190. https://doi.org/10.21037/tau.2019.04.09

2. Meerwijk EL, Sevelius JM (2017) Transgender population size in the United States: a meta-regression of population-based probability samples. Am J Public Health 2:e1–e8. https://doi.org/10.2105/AJPH.2016.303578
3. James SE, Herman JL, Rankin S, Keisling M, Mottet L, Anafi M (2016) The Report of the 2015 U.S. Transgender Survey. National Center for Transgender Equality, Washington, DC
4. Dutra E, Lee J, Torbati T, Garcia M, Merz CNB, Shufelt C (2019) Cardiovascular implications of gender-affirming hormone treatment in the transgender population. Maturitas. https://doi.org/10.1016/j.maturitas.2019.08.010
5. Anderson WJ, Kolin DL, Neville G, Diamond DA, Crum CP, Hirsch MS, Vargas SO (2020) Prostatic metaplasia of the vagina and uterine cervix: an androgen-associated glandular lesion of surface squamous epithelium. Am J Surg Pathol 8:1040–1049. https://doi.org/10.1097/PAS.0000000000001486
6. Wesselius R, Schotman M, Schotman M, Pereira AM (2017) A patient (46XX) with congenital adrenal hyperplasia and prostate cancer: a case report. J Endocr Soc 9:1213–1216. https://doi.org/10.1210/js.2017-00281
7. Winters JL, Chapman PH, Powell DE, Banks ER, Allen WR, Wood DP Jr (1996) Female pseudohermaphroditism due to congenital adrenal hyperplasia complicated by adenocarcinoma of the prostate and clear cell carcinoma of the endometrium. Am J Clin Pathol 5:660–664. https://doi.org/10.1093/ajcp/106.5.660
8. Lin LH, Hernandez A, Marcus A, Deng FM, Adler E (2021) Histologic findings in gynecologic tissue from transmasculine individuals undergoing gender-affirming surgery. Arch Pathol Lab Med. https://doi.org/10.5858/arpa.2021-0199-OA
9. Khalifa MA, Toyama A, Klein ME, Santiago V (2019) Histologic features of hysterectomy specimens from female-male transgender individuals. Int J Gynecol Pathol 6:520–527. https://doi.org/10.1097/PGP.0000000000000548
10. Miller N, Bedard YC, Cooter NB, Shaul DL (1986) Histological changes in the genital tract in transsexual women following androgen therapy. Histopathology 7:661–669. https://doi.org/10.1111/j.1365-2559.1986.tb02520.x
11. Singh K, Sung CJ, Lawrence WD, Quddus MR (2017) Testosterone-induced "Virilization" of mesonephric duct remnants and cervical squamous epithelium in female-to-male transgenders: a report of 3 cases. Int J Gynecol Pathol 4:328–333. https://doi.org/10.1097/PGP.0000000000000333
12. McMullen-Tabry ER, Sciallis AP, Skala SL (2021) Surface prostatic metaplasia, transitional cell metaplasia, and superficial clusters of small basophilic cells in the uterine cervix: prevalence in gender-affirming hysterectomies and comparison to benign hysterectomies from cisgender women. Histopathology. https://doi.org/10.1111/his.14587
13. Elfekih H, Ben Abdelkrim A, Marzouk H, Saad G, Gasmi A, Gribaa M, Zaghouani H, Hasni Y, Maaroufi A (2021) Prostatic tissue in 46XX congenital adrenal hyperplasia: case report and literature review. Clin Case Rep 3:1655–1662. https://doi.org/10.1002/ccr3.3868
14. McDowell M, Pardee DJ, Peitzmeier S, Reisner SL, Agenor M, Alizaga N, Bernstein I, Potter J (2017) Cervical cancer screening preferences among trans-masculine individuals: patient-collected Human Papillomavirus vaginal swabs versus provider-administered pap tests. LGBT Health 4:252–259. https://doi.org/10.1089/lgbt.2016.0187
15. McCluggage WG, Ganesan R, Hirschowitz L, Miller K, Rollason TP (2006) Ectopic prostatic tissue in the uterine cervix and vagina: report of a series with a detailed immunohistochemical analysis. Am J Surg Pathol 2:209–215. https://doi.org/10.1097/01.pas.0000180446.17517.b8
16. McCluggage WG, Young RH (2007) Tubulo-squamous polyp: a report of ten cases of a distinctive hitherto uncharacterized vaginal polyp. Am J Surg Pathol 7:1013–1019. https://doi.org/10.1097/PAS.0b013e31802bdd72
17. Cunha GR, Cao M, Franco O, Baskin LS (2020) A comparison of prostatic development in xenografts of human fetal prostate and human female fetal proximal urethra grown in dihydrotestosterone-treated hosts. Differentiation. https://doi.org/10.1016/j.diff.2020.06.001
18. Ali A, Syed SM, Jamaluddin MFB, Colino-Sanguino Y, Gallego-Ortega D, Tanwar PS (2020) Cell lineage tracing identifies hormone-regulated and Wnt-responsive vaginal epithelial stem cells. Cell Rep 5:1463-1477 e1467. https://doi.org/10.1016/j.celrep.2020.01.003
19. Kensler KH, Beca F, Baker GM, Heng YJ, Beck AH, Schnitt SJ, Hazra A, Rosner BA, Eliassen AH, Hankinson SE, Brown M, Tamimi RM (2018) Androgen receptor expression in normal breast tissue and subsequent breast cancer risk. NPJ Breast Cancer. https://doi.org/10.1038/s41523-018-0085-3
20. Kim CF, Jou D, Ganor O, Boskey E, Kozakewich HPW, Vargas SO (2021) Prostatic metaplasia and pilar differentiation in gender-affirming mastectomy specimens. Modern Pathol. https://doi.org/10.1038/s41379-021-00951-2