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UROLOGY - REVIEW

Organ-sparing procedures in GU cancer: part 2-organ-sparing procedures in testicular and penile tumors

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Abstract

Purpose Organ-sparing surgery (OSS) is recommended in selected patients with testicular tumors and penile cancer (PC). The functional and psychological impacts of organ excision for these genital tumors are profound. In this review, we summarize the indications, techniques and outcomes of OSS for these two tumors.

Methods PubMed® was searched for relevant articles up to December 2018. For Testicular sparing surgery (TSS) search, keywords used were; testicular tumors alone and in combination with "testicular sparing surgery", "partial orchiectomy" and outcomes. For penile conserving surgery (PCS), keywords used were: penile cancer alone and in combination with "penile conserving surgery", "partial penectomy" and outcomes. Because of the low quality of available evidence, a narrative rather that systematic review has been performed.

Results Indications of TSS are tumors ≤ 2 cm in solitary testis or bilateral tumors and no rete testis invasion. Prerequisites include normal testosterone and luteinizing hormone levels and patient compliance with follow-up. Indications for PCS are distal penile lesions with clinical stage ≤ T1. Adequate penile stump (3 cm) is required after surgery to maintain forward urine stream. Frozen section helps to reduce the risk of recurrence. Local recurrence after PCS is not associated with reduced survival and can be managed with another PCS in selected patients. The reported oncological and functional outcomes following TSS and PCS are adequate.

Conclusions In properly selected patient OSS in testicular and penile tumors has a comparable oncological outcome to total organ excision with added advantages of preserving organ function and psychological well-being.

Keywords Organ preservation · Testicular tumors · Penile tumors · Testicular sparing surgery · Partial orchiectomy · Penile conserving surgery

Abbreviations

CIS	Carcinoma in situ
FS	Frozen section
GCT	Germ cell tumor
GL	Glansectomy
GR	Glandular Resurfacing
GTCSG	German Testicular Cancer Study Group
IIEF	International Index of Erectile Function-5
MMS	Mohs micrographic surgery
PC	Penile cancer
PCS	Penile conserving surgery
PP	Partial penectomy
STSG	Split thickness skin graft
TIN	Testicular intraepithelial germ cell neoplasia
TP	Total penectomy
TSS	Testicular sparing surgery

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Testicular sparing surgery

Because of the very successful treatment of testicular cancer (TC), more than 90% of patients are long-term survivors, and consequently quality of life is becoming an important consideration for the young testicular cancer patient [1]. Testicular sparing surgery (TSS) provides obvious endocrinological, functional, cosmetic and psychological advantages over radical orchiectomy [2]. There are several reasons that

led to the resurgence of TSS in the management of testicular masses. The high incidence of benign testicular tumors was first described in 1986 by Haas et al. where it was 31% ($n=72$) of 233 patients with testicular tumors. Of these patients, 70% underwent radical orchiectomy [3]. Several reports showed that between 60 and 77% of tumors less than 2 cm in size and 80% of tumors less than 5 mm were benign, and consequently radical orchiectomy will represent an overtreatment in these patients [4, 5]. Incision the tunica albuginea during partial orchiectomy may not lead to an inevitable tumor seeding as previously thought, if meticulous measures to prevent seeding are adopted [6]. The reported effectiveness of postoperative radiation therapy in eradicating testicular intraepithelial germ cell neoplasia (TIN) in the remaining testicular tissue, which can be present in as high as 95%, has encouraged TSS in testicular cancer [7, 8]. Additionally, bilateral testicular GCT can be present in 2% of patients with metachronous more common than synchronous presentation [9].

Current indications and prerequisites for TSS

TSS is indicated in benign testicular tumors. If a benign testicular tumor is suspected, as Leydig cell tumor, which can be suspected from its symptoms and signs which includes a testicular mass with associated gynecomastia, infertility and endocrine abnormalities, TSS should be attempted [10]. The majority of the incidental small testicular masses detected during infertility work up are benign (75%) and TSS is an acceptable initial management option [11]. Sometimes, the preoperative ultrasound is helpful in identifying the nature of the testicular mass. Pure seminoma and teratoma have characteristic sonographic appearance. Typically, they are well defined and hypoechoic compared with the normal testicular tissue, however, heterogeneity, calcification and cystic changes can also be present. Epidermoid cysts are typically heterogeneous complex cystic masses with a thick rim and the cyst exhibits multilayered hypoechoic or hyperechoic material [12]. Additionally, polar and exophytic lesions are more amenable to TSS than lesions deeply situated in the testicular parenchyma [2].

The German testicular cancer study group (GTCSG) pioneered the research on TSS and issued useful recommendations to be fulfilled for TSS in malignant testicular tumors. These include patient and tumor factors. Regarding patient factors, patients should be compliant with follow-up and should have normal preoperative serum Luteinizing hormone and testosterone levels. Regarding tumor factors, the tumor is present in a solitary testis or bilateral testicular tumors whether synchronous or metachronous. The tumor should be less than 2 cm in size and with no rete testis invasion, multiple frozen sections (FS) should be taken from the tumor bed after enucleation and adjuvant radiation therapy is administered to the remaining testicular tissue to eradicate any TIN [13]. In addition to these prerequisites the European Association of Urology guidelines added that the tumor volume should be less than 30% of the testicular volume [14].

The role of frozen section in TSS

Understanding the role and limitations of FS in TSS is important. FS is an integral part of TSS. The main role of FS is to diagnose GCT and to confirm a negative margin. The mean limitations of FS are; First, it samples only a portion of the mass consequently there is a possibility of false negative results for malignancy. Second, it cannot diagnose TIN. TIN requires placental alkaline phosphatase (PLAP) which requires excellent tissue preservation which is difficult to achieve with FS. Also skip lesions of TIN are possible [15]. The reliability of intraoperative excision and FS diagnosis was described by Tokuc et al. in 26 patients where FS correctly identified 24 malignant and two benign testicular masses [16]. Elert et al. compared the FS results to the final pathology in 354 patients with testicular masses and reported 100% concordance rate. The pathological diagnoses correctly identified by FS in this report: 317 tumors (89.5%) were malignant [(100 seminomas (38.5%), 217 nonseminomas (61.5%)] and 37 tumors (10.5%) were benign (17 epidermoid cysts, 14 Leydig cell tumors, two cystadenomas, two simple cysts, two hemangiomas). There was a failure rate of 10% and 8% to differentiate seminomatous from nonseminomatous tumors and vice versa; however, this did not have clinical implication [17].

There are few possibilities for the FS report during TSS. (1) The FS reports the excised tissue is benign. In this scenario TSS is justified. (2) The FS reports there is TIN. This patient group should undergo local irradiation to the remaining testicular tissue in the dose of 18–20 Gy. This helps to eliminate the risk of recurrence. Patients who did not receive irradiation experienced at least a 25% local recurrence rate [2]. Patients with TIN and desiring fertility, can have radiation postponed for 2–3 years, provided no other risk factor is present and the tumor is small, until they father children [8]. Alternatively, preoperative/pre-irradiation sperm banking is a viable option. (3) The FS reports the excised testicular tissue is malignant. This is controversial. In the report by Shilo et al., these patients ($n=5$) underwent immediate completion orchiectomy and with no evidence of recurrence at a mean follow-up of 48 months [18]. However, in a larger report ($n=73$) from the GTCSG, these patients did not undergo immediate completion orchiectomy, and received the regular standard of care for testicular cancer based on tumor histology. The group reported 98.6% of the patients are alive and free of disease at a median follow-up of 91 months (range 3–191) [2]. (4) The FS report is inconclusive. Most would recommend completion orchiectomy [18]. 5) The FS report

shows mature teratoma. In this case, further excision of testicular tissue is warranted until negative margin is achieved since teratoma is a radio and chemo resistant tumor [2].

Surgical technique of TSS

The testicle is delivered through inguinal incision. The testicular mass is identified by palpation or by intraoperative ultrasound if the mass is impalpable and a needle can be placed next to it. A soft tourniquet is placed around spermatic cord. Ice slush is placed around the testicle for 10 min and dissection is started. A direct incision to the tunica at the mass site is performed avoiding blood vessels. This step can be added by the use of magnifying loops or microscope. Parenchymal tissue is dissected gently off the mass and the mass is enucleated. Multiple frozen sections are taken from the four corners of the tumor bed. Additional biopsy is taken from the periphery for permanent pathological exam to diagnose TIN. Hemostasis is maintained. The tunica albuginea is closed using a running absorbable suture and the vascular clamp is removed [2].

Testosterone levels following TSS

The GTCSG studied testosterone levels following TSS and reported 85% of their patients ($n=73$) did not develop hypogonadism nor required testosterone replacement therapy [2]. Bojanic et al. studied the testosterone levels before and after TSS performed in 24 patients and reported no change in testosterone levels as well [19].

Fertility following TSS

There are several considerations to be accounted for when assessing fertility following TSS for testicular masses. Many patients with GCT are already azospermic. Local irradiation following TSS invariably damages spermatogenesis as well as chemotherapy can have detrimental effects on spermatogenesis. Many TSS are performed on patients with incidental diagnosis of small testicular masses during infertility workup. However, in patients with preoperative normal semen analysis and did not receive postoperative radiation, fertility is preserved in a large number of patients [19].

Oncological outcomes following TSS

In the appropriately selected patients, and with the use of adjuvant radiation therapy or chemotherapy as per treatment guidelines, and meticulous follow-up, the reported patient survival from high volume centers is comparable to radical orchiectomy. We have compiled select studies reporting on TSS outcomes, and with a minimum of 10 patients or more in Table 1.

Follow-up protocols following TSS

The follow-up of patients underwent TSS will depend on the pathology of the excised testicular mass and whether chemotherapy, radiation therapy or retroperitoneal lymph node dissection was offered to the patient as per standard testicular cancer guidelines. It is safe to say that patients with benign histology following TSS do not require further follow-up. Regardless of the follow-up protocol chosen, it is wise to teach the patient to do regular self-exam and to report any suspicious new finding to his physician.

Conclusions

The role and indications of TSS are expanding. This is likely to the increase in detection of asymptomatic impalpable testicular masses secondary to the increased use of scrotal ultrasound. TSS is an appropriate option in benign testicular masses suspected or confirmed with FS.

Currently the main indication of TSS is the testicular mass in a solitary testis or bilateral synchronous or metachronous testicular GCT. Normal preoperative serum testosterone and LH levels, and patient compliance with follow-up protocols are prerequisites. Administration of postoperative testicular radiation to eliminate TIN is required in patients with GCT. Functional and oncological outcomes in the properly selected patients are adequate.

Penile conserving surgery

Penile cancer (PC), though a rare malignancy, its traditional treatment of total penectomy (TP) with perineal urethrostomy results in a significant impact on the patient psychological, urinary and sexual functions [25]. Fortunately, the majority of PC at initial presentation is distally located; rarely exhibits skip lesions, and usually low or intermediate grade making penile conserving surgery (PCS) an appealing option [26].

Indications and prerequisites to PCS

Typically, PCS is offered to the compliant PC patient who has a distally located tumor with a low clinical stage of Ta/TIS or T1. A remaining penile stump sufficient for forward directed urine stream is a prerequisite for PCS; otherwise TP should be performed. Such penile length is suggested to be at least 3 cm [27].

Contraindications to PCS

Patients presenting with high grade disease (G3) or with corporal invasion (≥ T2) are better managed with the more

Table 1 Select studies reporting on testicular sparing surgery

Study	*N*	Size (cm)	P or NP	F/U (months)	Concordance of FS with FP	FP	Management of malignancy at FS	RR/survival
Heidenriech et al.[a] [2]	73	Mean: 1.5 cm (range: 0.5–3)	N/A	Median: 91 (range: 3–191)	N/A	M: 62 B: 11	TIN[b]: Postoperative testicular radiation (18–20 Gy) Testicular Cancer[c]: completion orchiectomy was not performed.	98.6% survival at the median follow-up of 91 months.
Passarella et al.[d] [20]	11	Mean 1.17 (range: 0.6–2	P: 11	N/A	9/11 (81.8%)	M: 2 B: 9	Completion orchiectomy[e] ($n=4$)	N/A
Leroy et al. [21]	15	Range 0.4–1.6	NP:15	N/A	13/15 (86.6%)	M: 4 B: 11	Completion orchiectomy[f] ($n=6$)	N/A
Carmignani et al. [22]	10	Range: 0.4–1.6	NP:10	Mean: 1 (range 9–19)	10/10 (100%)	B: 10	Completion orchiectomy[g] ($n=3$)	All alive at end of F/U
Muller et al.[h] [23]	20	≤ 0.5	NP: 20	All group: 34.9 (5.4–63.8) Malignant group: 32.6 (28.8–36.5)	19/20	M:4 B:16	Completion orchiectomy ($n=4$) 2 Cycles of Carboplatin for Seminoma	All alive at end of F/U
Shilo et al.[i] [18]	16	0.8–2.5	NP:4 P: 12	M[j]: 48 B: 28	16/16 (100%)	M: 5 B:11	Completion orchiectomy ($n=5$)	No recurrence
Galosi et al.[k] [24]	28	Mean: 0.9 Range: 0.2–1.5	NP: 28/28	N/A	No false + result	M: 6 B: 22	Delayed orchiectomy ($n=11$)	N/A
Bojanic et al.[l] [19]	24	All ≤ 2	N/A	Mean: 51 Range (7–178)	No FS performed	M: 25 B: 1	No FS performed	All alive at end of F/U

B Benign pathology (fibrosis/adenomatoid tumor/leydig or sertoli cell tumor), *FS* frozen section, *FP* final pathology, *F/U* follow-up, *M* malignant (seminoma or non-seminoma), *N* number of patients, *N/A* not available, *P/NP* palpable mass on clinical exam/non-palpable mass on clinical exam, *RR* recurrence rate, *TIN* testicular Intraepithelial germ cell neoplasia, *TSS* testicular sparing surgery

[a]German Study Group for Testicular Cancer. All patients had bilateral testicular tumors or tumors in a solitary testis

[b]18–20 Gy were administered. Patient received repeat biopsy after 6 months to confirm no TIN and Sertoli-cell-only syndrome is present

[c]Completion orchiectomy was not performed and further management as per testicular cancer management guidelines with chemotherapy/radiation therapy as appropriate

[d]In 2 patients, FS was inconclusive so; patients underwent radical orchiectomy and final pathology was benign

[e]Completion orchiectomy in 4. In 2/4 the FS was malignant and in 2/4 it was inconclusive

[f]The six patients underwent completion orchiectomy had FS showing malignancy in 4/6 and inconclusive FS in2/6

[g]The 3 patients underwent completion orchiectomy had the FP diagnosis of adenomatoid tumor with abscess in 1 and Leydig cell tumor in 2

[h]The contralateral testis was normal in all patients (20/20)

[i]Testicular Sparing surgery attempted in 16. Five had completion orchiectomy because of malignant FS

[j]F/U was 48 months for malignant cases and 28 months for benign cases

[k]All patients had NP, ≤ 15 mm mass and all had initial TSS with delayed orchiectomy for malignancy confirmed in FP or for other benign reason

[l]26 TSS were performed on 24 patients

aggressive of the PCS; partial penectomy (PP) rather than less aggressive PCS options [28]. The non-compliant PC patient with insufficient penile stump for forward directed urine stream represents a contraindication to PCS.

Margin controversy in PCS

The traditional 2 cm safety margin following PCS is no longer required. Currently a 5 mm safety margin is

sufficient which has led to increase in PCS utilization in recent years [28].

Role of frozen section in PCS

Frozen section (FS) from both the corporal and urethral margins following PCS helps to reduce the risk of recurrence and may also aid in increasing penile length. Studies in which FS was routinely performed reported 4–10% recurrence rate versus 29% if FS was not routinely performed [29–31].

Surgical techniques of PCS

Laser surgery

Laser ablation is considered an option for in situ disease and low grade T1 tumors. It is not recommended in lesions with > 6 mm depth invasion and T2 tumors. Either the CO2 laser or the neodymium–yttrium-aluminum-garnet (Nd:YAG) laser can be used. Nd:YAG laser has a higher penetration power than CO2 laser, and can be alternative to topical chemotherapy in PC presenting as carcinoma-in situ (CIS). It is imperative when treating PC using laser to ablate the surrounding area of the tumor bed with a margin of 5 mm and 3 mm when using CO_2 laser and Nd:YAG laser, respectively [32–34]. The reported recurrence rate after CO_2 and Nd:YAG laser are 10–26% and 3.1–48%, respectively [32, 33, 35].

Mohs micrographic surgery (MMS)

Small (< 1 cm) low stage, low grade lesions are amenable to MMS which aims at sequential excision of the tumor in layers with pathological exam until a negative margin is achieved. An study of 35 patients performed MMS for PC demonstrated a 5-year local control rate of 94% and a 5-year overall cure rate of 74% [36]. However, more contemporary literature shows that local recurrence rate is 32% [37]. MMS requires extensive supporting staff and resources.

Circumcision

In low stage (Tis, Ta, and T1) and low grade (G1, G2) lesions located in the distal prepuce, circumcision may be an acceptable treatment. Reported local recurrence ranges 15.4–50% [38, 39].

Wide local excision (WLE)

Wide local excision is used to excise the penile cancer in the glans or the rare location on the penile shaft. The defect can be closed by primary suturing; however, if the defect is large, STSG is used [40]. For T1 and T2 tumors, the 5-year local recurrence rate is 63% [31].

Glans resurfacing (GR)

In extensive premalignant lesions and CIS, GR is an acceptable option. It can be offered in Ta and T1a disease as well. GR involves excision of the epithelium and subepithelial tissue followed by covering of the skin defect usually by STSG

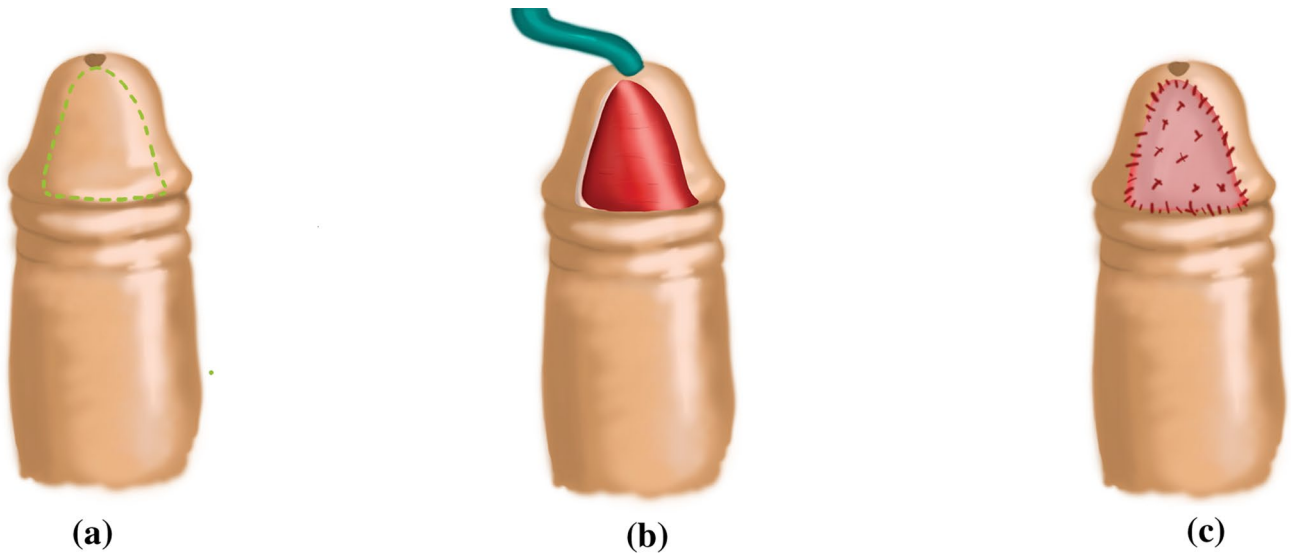

Fig. 1 **a** Circular perimeatal and coronal incisions and division of the glans into quadrants, **b** excision of epithelium and subepithelial tissues of the glans, **c** split thickness skin graft (STSG) is used to cover the defect

(Fig. 1) [41]. Buccal mucosa is not suitable for coverage as it requires a humid environment [42].

Glansectomy (GL)

GL is one of the modalities of management of glandular Ta, T1 and T2 PC [39]. Partial GL can be performed in small sized distally located lesions, up to stage T1a [43]. Lesions occupying > 50% of glans size and those close to the urethral meatus are not suitable for partial GL and total GL is indicated. Since in these cases, the urethral meatus will be tilted and forward directed urinary stream is not achieved. The corporal tip can be covered with advancement of penile skin, urethral advancement and spatulation or STSG. Parnham et al. reported on 177 patients who underwent glansectomy and STSG with a mean follow-up of 41 months. The authors reported local recurrence rate of 9.3%, mortality rate of 10.7% and reoperation rate for complications as meatal stenosis and graft loss in 9% [44].

Partial penectomy (PP)

Traditional PP involved a 2 cms safety margin which in contemporary surgical practice is no longer needed. The remaining penile stump following partial penectomy should be sufficient for forward directed urinary stream otherwise TP should be performed. PP has a reported local recurrence rate ranging from 0 to 8% and sexual function is preserved in 20% of patients and the majority of patients were able to void in standing position [45, 46]. Patients undergoing PP should be counseled about the risks of urethral meatus stenosis (6%) and urine spraying during micturition necessitation sitting down when urinating [46].

There are reported techniques that help to increase the length of the penile stump these include: (1) division of the suspensory ligaments of the penis, (2) dissection of the corpora from underneath the pubic arch, (3) division of the penoscrotal web horizontally and suturing it vertically, (4) performing a V–Y plasty on the dorsal penile skin at the penopubic junction area.

Urethra sparing penectomy

This technique was reported with success in few patients in whom the PC involved the corpora cavernosa and spared the urethra. In the remaining corporal stumps, a pair of malleable penile prosthesis are placed and wrapped in vicryl mesh. A rectangular flap from the scrotal skin is created with the base at the pubis and used to wrap the penile prosthesis. The urethra can be mobilized from the perineum and brought to the tip as a neourethra (Fig. 2). Bissada described this technique with success in 3 patients [47].

Oncological and functional outcomes of PCS

Oncological outcomes

The major concern regarding PCS is the risk of recurrence (local, regional and distant) which is reported to be 20% for PP compared to 27% in those receiving a more conservative PCS [48]. The survival outcomes of PCS were described from national databases. Recently, Kamel et al. reported and compared the survival of PCS to PP and TP from the National Cancer Database (NCDB). A total of 4238 PC patients with T1/T2 disease were examined. There were 1,211, 2,360, and 584 patients in the PCS, PP, and TP groups, respectively. The 5- and 10-year overall survival rates for PCS, PP, and TP were 88% and 74% vs. 85% and 72% vs. 79% and 63%, respectively ($P \leq 0.001$). In addition, in a multivariable model for predictors of patient survival, PCS did not predict poor patient survival (hazard ratio = 0.88, CI: 0.64–1.21) [49]. We summarized oncological outcomes of PCS from select studies in Table 2.

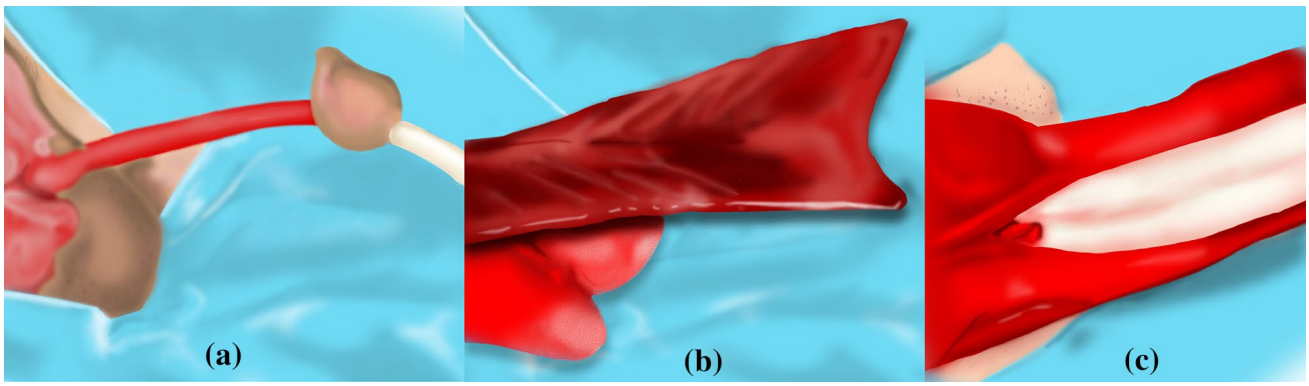

Fig. 2 Urethral sparing penectomy. **a** Corporectomy performed, sparing the urethra, **b** rectangular scrotal flap, **c** malleable penile prosthesis wrapped in vicryl mesh

Table 2 Summary of oncological/functional outcomes of select penile conserving surgery studies

Study	*N*	Type of PCS	F/U (m)	Recur. (%)	TTR (m)	LRM	CSS (%) 5-years	Complication (%)	Functional outcomes
Djajadiningrat [48]	859	PP: 408 OPCS: 451	65	**PP:** L:4, L + R:4, L + D: 1, R ± D: 20 **OPCS:** L: 27, L + R: 5, L + D: 0, R ± D: 9	10	PP[a]	L: 88 R: 33 M: 13	N/A	N/A
Philippou [39]	179	Cir: 13 WLE: 29 GL: 87 PP: 50	42.8	L: 8.9 R: 10.6 M: 5	L: 26.1 R: 26.8 M: 11.7	PP TP	L: 91.7 R: 38.4	Infection: 0.6 Graft loss: 1.8 Corporal tip necrosis: 0.6 Short penile Stump: 1.2	All patients able to void upright
Veeratterapillay [55]	65	GL (total): 46 PG: 1 GR: 3 GL + distal corporectomy: 15	40	GL: 4 GL+ distal corporectomy: 13	15	WLE:2 GL: 1 PP: 1	N/A	Graft loss: 1.5 Graft contracture: 4.5 Meatal stenosis: 7.5	5% poor cosmoses 85%: Good erections at 1 year
Feldman [56]	56	WLE: 25 PG: 14 Circ: 11 Biopsy+ Topical TTT: 4 MMS: 2	65.6	21.4[b]	51.4	N/A	N/A	No urethral or meatal stenosis	All patients able to void upright preserved potency
Bissada [29]	30	Tailored excisions	12–360[c]	L: 10	N/A	WLE: 3	N/A	N/A	Preserved potency
Bandiera-Monte [57]	224	Laser: CO_2± Chemotherapy	66	L: 17.5[d]	N/A	Laser: 30 PP: 8 TP: 1 RT: 1	N/A	Bleeding < 1% Urethral stenosis < 1% Preputial adhesions: 2.7%	Preserved potency
Shindel [58]	33	MMS	58	L: 32	N/A	MMS: 7 TP: 1	96	Infection: 3% PE: 3% Meatal stenosis: 6%	N/A
Shabbir [41]	25	GR + STSG	39	L:4	14[e]	Topical-Chemo therapy ($n = 1$)	N/A	Graft take failure: 1.4%	Preserved potency
Smith [59]	72	GL + STSG	27	L: 4	N/A	WLE ($n = 3$)	17[f]	Graft loss: 2.7 Meatal stenosis: 1.3	Preserved potency
Parnham [44]	177	GL + STSG	41.4	9.3%	8.7	N/A	Near 90% at 50 m	Graft loss partial: 20% Total: 3.4% Meatal stenosis: 2.8%	N/A

Circ circumcision, *CSS* cancer specific survival, *D* distant recurrence, *WLE* wide local excision, *GL* Glansectomy, *F/U* follow-up, *GR* glans resurfacing, *L* local recurrence, *LRM* local recurrence management, *M* metastasis/distant recurrence, *m* months, *N/A* not available, *N* number, *OPCS* other penis conserving surgery, *PCS* penile conserving surgery, *PE* pulmonary embolus, *PG* partial glansectomy, *PP* partial penectomy, *R* regional recurrence, *RT* radiotherapy, *STSG* split thickness skin graft, *TP* total penectomy, *TTR* time to recurrence

[a]PP performed in 70/185 recurrences in OPCS group. A second PP performed in 33/120 recurrences in PP group

[b]25% of recurrences after 5 years of follow-up

[c]Described as range

[d]Local recurrences as single event in 20 patients and multiple in 12 patients

[e]Only one recurrent CIS at 14 months F/U

[f]3 recurrences at 4, 19 and 28 months

Functional outcomes

Psychological outcomes There are few studies and with small number of patients that assessed the psychological impact of PC surgical treatments. Maddineni et al. conducted a review on 6 studies with a total of 128 patients. Surgical treatment in the form of PCS was offered in 101 patients; PP ($n=78$), GL ($n=8$), and laser therapy ($n=5$). The results showed an incidence of 53% mental illness, 25% avoidance behavior, 40% impaired overall well-being; post-traumatic stress disorder was also reported in 2 of 30 patients in one study [25]. In a more contemporary report, patients who underwent PCS compared favorably to the general population using the standardized Short-Form-36 (SF-36®) assessing the mental health-related quality of life and this was believed to relate to the coping mechanisms developed by cancer survivors [50].

Urine function Patients who underwent PCS are usually able to void upright and less likely to leak urine than those who received penile amputation. In patients in whom spraying of urine continues to be a problem, the use of a small funnel placed on the remaining penile stump may be helpful. In one study, patients who underwent PCS (excluding PP) were less likely to leak during urination compared to partial/total penectomy (43% vs 83%, respectively) [50].

Sexual function Patients underwent the less aggressive PCS had better sexual functions compared to PP. Kieffer et al. studied 90 patients with PC with 54 patients receiving PP or TP and 36 received PCS. The PCS group reported better orgasmic function, but no difference was observed between the 2 groups in the remaining domains of International Index of Erectile Function-5 (IIEF-5). The type of "more conservative" OSS (laser/local excision/circumcision/GL) did not affect the outcomes of the IIEF-5; however, the group that had the "more aggressive" PCS; PP, reported worse orgasm function after surgery [50].

Follow-up protocols after PCS

Follow-up comprised of local exam to the penis and groin. In the obese patient or those with previous inguinal surgery, groin assessment can be done with ultrasound or computerized tomography scan. Patients underwent PP have the frequency of follow-up as semiannual in the first 2 years then annually for up to 5 years. Patients underwent less aggressive PCS are examined every 3 months for the first 2 years then semiannually up to 5 years then annually up to 10 years [51]. Such follow-up protocol is based on observation that most recurrences after PCS occur in the first 5 years after PCS [52]. Regardless of the follow-up protocol, PC patients underwent PCS are instructed to do regular self-exam and report of any new abnormality. Additionally, in the well-informed patient who is doing regular self-exam, follow-up beyond 5-years can be discontinued [53].

Management of local recurrence after PCS

Patients, who develop local recurrence after PCS can still be managed by another PCS, provided a functioning remaining penile stump is present. In a large cohort of patients with T1/T2 disease underwent PCS local control was achieved in 94% after another PCS and with no increased risk of nodal recurrence or reduced survival [31]. Patients in whom the initial PCS revealed T2 disease represent a contraindication to a second less aggressive PCS (i.e., GL, WLE, GR or laser therapy). These patients are best managed by TP or PP [28].

Role of salvage PCS after failed PC radiation

Few studies reported on the outcomes of PCS in failed radiation. Shabbir et al. reported on 17 patients who had chronic ulceration following radiation therapy for PC. Recurrent cancer was present in 15/17 patients. Management was with glansectomy + Split thickness skin graft (STSG) in 14, WLE + full thickness skin graft in 1, PP and TP each in 1 patient. 16/17 of their patients are recurrence free at a mean follow-up of 3 years and with no problem regarding graft uptake despite previous radiation [54].

Conclusions

Penile conserving surgery (PCS) is an attractive option in the management of PC since in the appropriately selected patient the oncological outcome is comparable to penile amputation. There are obvious advantages; sexual, urinary and psychological over penile amputation. The traditional 2 cm safety margin is no longer needed and a 5 mm margin is enough. Intraoperative FS helps to reduce the risk of recurrence and increase penile length. Since the reported risk of recurrence is higher than total amputation, long-term follow-up and compliant patient are imperative requisites. Local recurrence after PCS, that is promptly treated does not seem to adversely affect patient survival and can be managed with another PCS in select patients. There are various PCS techniques that can be used depending on the location, the tumor grade and stage as well as the experience of the surgeon performing them.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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