

Penile sparing surgical approaches for primary penile tumors: preserving function and appearance

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Contributions: (I) Conception and design: PE Spiess, RE Carrion; (II) Administrative support: All authors; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: AS Baumgarten, JS Fisher; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Abstract: Penile cancer is a rare and potentially disfiguring disease. There are multiple treatment options for primary penile lesions. Penile sparing approaches offer an attractive option as they can provide several quality of life benefits without detrimental oncologic outcomes. With appropriate diagnostic evaluation and staging, penile sparing techniques provide proper cancer control with improved cosmetic and functional results. Regardless of the chosen treatment modality, a commitment to close follow-up remains a critical component of all treatment considerations. The goal of this review is to provide an overview of the multiple treatment strategies for primary penile tumors with a focus on penile sparing surgical approaches.

Keywords: Penile cancer; penile preservation; topical therapy

Submitted Jan 08, 2017. Accepted for publication Mar 15, 2017.

doi: 10.21037/tau.2017.04.01

View this article at: <http://dx.doi.org/10.21037/tau.2017.04.01>

Introduction

Penile cancer is a rare disease representing 0.4–0.6% of all malignancies in the United States and Europe (1,2). However, penile cancer accounts for 10% of all malignancies in African, Asian, and South American countries. This disease is most common in men aged 50–70 years old, with the most important risk factor being the presence of an intact foreskin (3). Madsen *et al.* also noted a significant risk of penile squamous cell carcinoma (SCC) in patients with phimosis (4). Circumcision has been viewed as a preventative measure against penile cancer, citing the lower incidence of developing the disease among men circumcised at birth, most notably the rare finding of penile cancer in the Jewish population (3,5). Multiple other risk factors for the development of penile cancer have been established including smoking, balanitis, number of sexual partners and human papillomavirus (HPV) (3,5,6). These

risk factors emphasize the importance of patient education and lifestyle modification in the overall management and prevention of penile cancer.

Treatment of penile cancer has evolved over time, with less invasive treatment (surgical and non-surgical) approaches being more amenable for lower stage/grade disease in order to obtain satisfactory cosmetic results, as well as preserve sexual function. Penile sparing techniques may be utilized for tumors exhibiting favorable histologic features and located in favorable anatomical sites (i.e., distal or foreskin involving). These consist of Tis, Ta and T1 tumors (and in some cases select T2 tumors) and grades 1–2 (7). Therefore, the evaluation and staging of penile cancer is of the utmost importance when pursuing such treatment options. Multiple innovative modalities are now available to aid in the diagnosis of penile cancer and to assist in determining the best treatment option for each individual patient.

Clinical evaluation and risk factors

Penile carcinoma typically presents in older men with a visible skin abnormality or palpable nodule on the glans or prepuce of the penis (8-10). Evaluation of penile carcinoma begins with a thorough patient history focusing on pertinent risk factors. The presence of an intact foreskin has been identified as an important risk factor, with Maden *et al.* reporting more than a 3-fold increase in risk compared to men circumcised at birth (5). Studies have shown that a history of phimosis has been associated with a 7- to 10-fold increase in penile cancer, likely due to the chronic inflammation present from the retention of normal desquamation products and secretions known as smegma (11,12).

Evidence has shown that “pre-malignant” lesions such as bowenoid papulosis (BP), erythroplasia de Queyrat (EQ), Bowen’s disease (BD), lichen sclerosus (LS), balanitis xerotica obliterans (BXO), penile horn, leukoplakia, subtypes of balanitis, and malignant giant condylomata acuminata are linked with an increased risk of penile carcinoma (13). These lesions can be HPV-related or associated with chronic inflammation. Tobacco exposure has also been shown to increase risk of penile cancer in a dose-dependent fashion and has been demonstrated independent of confounders in population-based case control studies (5,11,14,15). Additionally, patients undergoing psoralen and ultraviolet A (PUVA) photochemotherapy for psoriasis are at an increased risk of developing penile cancer, with an incidence 286 times greater than the general population (13,14,16).

Pathology, diagnosis, and staging

The diagnosis of penile cancer is made by clinical evaluation and interpretation of histologic characteristics. Presentation of penile carcinoma varies, and the lesion may be characterized as an induration, papule, pustule, verruca, erosion, ulcer, or exophytic mass (17). A painless lesion is the most common sign of cancer, though it can also be associated with a rash, pain, discharge, bleeding, or a foul preputial odor (8,17,18). The physical exam provides invaluable information for diagnosis and staging. Careful assessment must be made with regard to size, location, fixation, and involvement of corporal bodies, through inspection of the base of the penis and scrotum. Rectal and bimanual examinations provide information on the presence of pelvic spread, with specific focus on bilateral palpation

to assess for inguinal lymphadenopathy (17). The 2010 update of the tumour, node and metastasis (TNM) staging system by the American Joint Committee on Cancer (AJCC) for penile tumors is shown in *Table 1* (19,20). Clinical examination of the penile lesion cannot be overstressed as an important part of accurate diagnosis of penile cancer. The size, site, number of lesions, and characteristics (flat, ulcerated, etc.) are important descriptive findings that are the first steps in accurately defining the lesion and staging appropriately (21).

In cases where physical exam is difficult to perform, imaging studies may serve as useful adjuncts for staging purposes. Pharmacologically-induced erection combined with magnetic resonance imaging (MRI) has demonstrated adequate staging capabilities and can help determine whether limited surgical approaches can be performed, especially in cases of suspected corporal involvement (22-24). MRI is the most sensitive imaging modality for penile carcinomas due to soft tissue contrast and assessment of fascial planes. In addition, endoluminal coils may be used to further enhance these images (25-27). Assessment of lymphatic invasion is essential to staging and treatment. If nodes are non-palpable on exam, the European Association of Urology (EAU) recommends ultrasound with 7.5 MHz in order to enhance nodal detection. Ultrasound can also serve as a guide for fine needle aspiration (FNA)-biopsy in men with clinically palpable nodes (27,28).

The most recent AJCC guidelines for pathologic diagnosis recommend incisional or punch penile biopsies for large lesions, with excisional biopsies reserved for more superficial or localized lesions able to be completely removed without substantial impacts on surrounding penile tissue (19). The 2014 EAU recommendations suggest penile biopsy is not indicated if there is no doubt about the diagnosis, or if treatment of lymph nodes is postponed until after treatment of the primary tumor and/or histological evaluation of sentinel nodes (29). SCC accounts for 95% of cases and has been classified into multiple subtypes by Cubilla and colleagues, seen in *Table 2* (30). Other tumors that may involve the penis include melanomas, basal cell carcinomas, lymphomas, and sarcomas (31).

Pathologic grading can be assessed by the degree of cellular differentiation, and is an important predictor of metastatic nodal cancer (19). According to the AJCC, a grade of GX suggests it cannot be assessed; G1 a well-differentiated tumor and no anaplasia; G2 a moderately differentiated tumor with <50% anaplasia; G3 a poorly differentiated tumor with >50% anaplasia; and G4

Table 1 TNM staging system for penile cancer

Types	Clinical stage definition
Primary tumor (T)	
TX	Primary tumor cannot be assess
T0	No evidence of primary tumor
Tis	Carcinoma in situ
T1a	Tumor invades subepithelial connective tissue without LVI and is not poorly differentiated (i.e., G3–4)
T1b	Tumor invades subepithelial connective tissue with LVI or is poorly differentiated
T2	Tumor invades corpus spongiosum or cavernosum
T3	Tumor invades urethra
T4	Tumor invades other adjacent structures
Regional lymph nodes (N)	
NX	Regional lymph nodes cannot be assessed
N0	No palpable or visibly enlarged inguinal lymph nodes
N1	Palpable mobile unilateral inguinal lymph node
N2	Palpable mobile multiple or bilateral inguinal lymph nodes
N3	Palpable fixed inguinal nodal mass or pelvic lymphadenopathy unilateral or bilateral
Distant metastasis (M)	
M0	No distant metastasis
M1	Distant metastasis

The above table depicts the staging of penile carcinoma by tumor type, invasion, node positivity, and distant metastasis. TNM, tumour, node and metastasis. Reprinted with permission from (19).

an undifferentiated tumor (19,32). Perineural and lymphovascular invasion, and high histological grade appear to be the most important adverse prognostic factors associated with high mortality (33). In patients with non-palpable nodes on clinical exam, pathologic grade is combined with tumor size to predict occult nodal metastasis. Multiple risk-stratification systems exist and help determine indicated treatment options, with the EAU system shown in *Table 3* (20,21,33,34). Depending on the risk of nodal metastasis, surgical staging of lymph nodes or dynamic sentinel node biopsy (DSNB) may be indicated for further evaluation (32).

Non-surgical treatment modalities

These penile sparing techniques may be used for tumors exhibiting favorable histologic features with low risk for metastasis. These consist of Tis, Ta, and select T1 tumors (3).

Topical therapy

For carcinoma-in-situ (CIS), therapeutic options include topical therapy with 5-fluorouracil (5-FU) or imiquimod, but more data is needed to determine long-term outcomes. Alnajjar *et al.* observed a 70.3% response-rate, with a 57% complete-response rate in a review of 44 men treated with topical chemotherapy (5-FU first line, imiquimod second line) at a mean follow-up of 34 months (35). Carcinoma in situ, BP, and pseudoepitheliomatous, keratotic micaceous balanitis respond best to topical therapy options (36). The 5-FU 5% cream was applied over the lesion twice daily for a period of 4 to 6 weeks on alternate days. Fluorouracil provided both high cure rate and retained penile integrity and function (37). Imiquimod 5% cream used 5 to 7 times per week for 6 weeks led to a 79–82% cure rate (38). Topical therapy should not be considered a first line choice in more aggressive penile cancers; a more definitive treatment

Table 2 Penile squamous cell carcinoma subtypes

Type	Frequency (%)	Features	Spread	HPV-link
Usual	48–65	Low-grade, minimal nuclear atypia	Superficial	No
Papillary	5–15	Low-grade, hyperkeratosis, papillomatosis	Superficially invasive into erectile tissue	No
Warty	7–10	Koilocytes and fibrovascular core with papillomatosis and jagged irregular stromal borders	Penetration of corpus cavernosum or spongiosum	Yes
Basaloid	4–10	Ulcerated, irregular mass with uniform and small basaloid cells; central necrosis with predominance of mitotic figures and evidence of apoptosis	Deeply invasive into corporal bodies	Yes
Verrucous	3–8	Low-grade with straight papillae and well-differentiated cells, hyperkeratosis with inter-papillary keratin	Superficial pushing borders	No
Sarcomatoid	<1	Ulcerated or rounded polypoid mass with squamous and spindle cell components, mimicking features of sarcomas	Deeply invasive into surrounding tissues	No

The above table describes the various subtypes found in penile carcinoma and the relative frequencies of these subtypes in the general population. The histological features associated with these cancers differentiate them through pathological evaluation. The aggression of spread varies by subtype and is depicted above to show means of spread as well as associated with the human papillomavirus (HPV). This table has been referenced with permission from (30).

Table 3 EAU risk stratification of nodal metastasis in penile cancer

Classification	Stage and grade	Risk of nodal involvement (%)
Low risk	pTis, pTaG1–2, pT1G1	<10
Intermediate risk	pT1G2	9–12
High risk	pT1G3 or pT2 to pT3	>75

The above describes the classifications of low, intermediate, and high risk penile cancers. The different stages and grades of cancers and the risk of nodal involvement associated with each. P, penile; T, primary tumor; G, grade. Data referenced from (20,21).

modality such as surgical resection should be utilized.

Laser ablation

Carbon-dioxide and Nd:YAG lasers have proven effective in treatment of CIS, with comparable recurrence and survival among patients with partial penectomy, radiotherapy, or laser therapy (39,40). Laser therapy provides beneficial cosmetic results with good sexual function and has demonstrated clinical tumor control in Tis and T1 disease with variable recurrence treated with re-ablation. It has also been used successfully in select cases of T2 disease in combination with lymph-node resection (39–45). Tewari *et al.* describe the procedures of laser ablation used in patients refusing penectomy with the intent of preserving

penile form and function (46). The procedure involves circumcision with local tumor excision using tangential cuts through the glans or corpora with 3–5 mm margins using CO₂ laser and coagulation of the tumor bed using the Nd:YAG laser. Post procedural defects heal through re-epithelialization and remained open to heal over 7–9 weeks. If excised near the distal urethra, an indwelling catheter may be used for the first postoperative week. If positive inguinal lymph node metastases are found 6 to 8 weeks postoperatively, full inguinal block dissection is the treatment of choice. Typical postoperative care involves day 1 exam, day 4 wound check and twice weekly wound checks until healing is achieved. Wounds may be reviewed at 3-month intervals to determine healing, urinary function, and potential recurrence (46). In laser treatments, the CO₂ laser may be used for macroscopic excision of the penile lesion with a visible 3 to 5 mm margin. This would then be followed by the use of Nd:YAG for coagulation of the tumor bed due to its deep penetrating wave property to better eradicate the tumor (44). In a study by Windahl *et al.*, 13/59 (19%) experienced local recurrence of penile carcinoma with average follow-up of 42 months (12 to 186) and 10 received repeat laser treatment successfully. Cosmetic and functional results were reported to be highly satisfactory, and the option to repeat the procedure in patients with recurrence makes this a good option for conservative treatment.

Radiotherapy

Radiotherapy has been utilized for over 50 years in the treatment of penile carcinoma and may be delivered via external beam or brachytherapy. It is usually indicated for T1-T2 tumors that are smaller in size (<4 cm), but may be associated with severe complications, such as soft-tissue ulceration, meatal stenosis, telangiectasia, and penile necrosis (47-50). Circumcision is prerequisite to radiation therapy to ensure full exposure of the cancer. Poor prognostic factors for response to radiation include total dose less than 60 Gy, T3 or greater tumor, tumors larger than 4 cm, and high tumor grade (49,51-53). Bulky or deep tumors are usually not amenable to radiation therapy and typically require surgical intervention, except in cases of palliative radiotherapy for extensive disease.

Interstitial brachytherapy provides therapeutic comfort to patients as a conservative method of cancer management in this patient population. The methodology involves Gy over the course of 4–6 days with general anesthesia or penile block with systemic sedation (54). This option offers less trips to have radiation completed and a shorter radiation course than external beam, however, this tends to have a higher potential for incomplete tumor removal. Therefore cancer recurrence is an ongoing concern, as unstable bordering epithelium can remain (41,55). Rouscoff *et al.* documented the outcomes of brachytherapy describing local recurrence-free, overall, and specific survivals showing 80%, 65%, and 92% respectively (56). In the largest study of brachytherapy, Rozan *et al.* showed that in 184 males, 78% avoided surgical mutilation of the penis (57).

External beam radiation therapy (EBRT) has been used as both a conservative therapy and in the treatment of patients with recurrence following brachytherapy. In EBRT, one daily fraction of 2 Gy, 5 times every week over the course of 6 or 7 weeks offers a large cumulative dose of radiation. This treatment evenly radiates the affected tissue to reduce tumor burden. A large study on patients receiving external beam therapy resulted in local control rates for stage I and stage II range from 65–90% (57). The data for EBRT compares well with that of brachytherapy, despite procedural differences in the process of Gy dose delivery over time.

Surgical treatment

Since 80% of penile tumors are located on the glans or prepuce, radical surgery may be overly aggressive, disfiguring, and even unnecessary (58,59). Therefore,

penile sparing surgery is of great importance in regards to cosmesis, and functionality, as well as cancer control. The goal of penile cancer treatment is preservation of function and adequate cancer control via tumor resection (60). Data from Romero *et al.* showed only 55% of patients who underwent partial penectomy maintained adequate erectile function for intercourse, with half citing the shame and loss of length as a reason not to pursue sexual relations (61,62). Therefore the importance of a satisfactory cosmetic, as well as functional, outcome without compromising cancer control cannot be overstressed. Depth of invasion, size of the lesion, and involvement of spongiosum, cavernosum, and/or urethra may have significant utility as considerations when choosing candidates for surgical treatment. When these factors indicate surgery for patients, surgeons must have a keen understanding and ability in performing reconstructive surgery, as well as a scrupulous use of frozen section during excision of adjacent tissues to ensure complete tumor eradication. Although patients treated with penile preservation experience more local recurrences, data supports the notion that 5-year cancer specific survival is not jeopardized in appropriately selected patient (63).

Prepuce and distal penile lesions

It is estimated that the prepuce is involved in approximately 30% of penile cancers (60). Traditionally, it was believed that a 2 cm negative surgical margin was required in order to attain adequate cancer control with minimal risk of recurrence. However, studies by Agrawal *et al.* (64) and Minhas *et al.* (65) disprove this theory, citing similar recurrence rates for margins within 10 mm. Consequently, preputial tumors may be properly treated by local excision via circumcision with minimal margins with low risk of recurrence, resulting in satisfactory cosmetic results with maximal preservation of normal tissue and function. One method of performing such delicate procedures is via Mohs' micrographic surgery (MMS).

MMS is the practice of layer by layer tissue excision until it is cleared microscopically from any cancerous appearing elements (60). The result is maximal tissue cosmesis and function. This has been widely used by dermatologic surgeons for excision of cutaneous squamous and basal cell cancers located primarily in the head and neck region. Moh's micrographic surgery has been applied to penile carcinoma in an attempt to spare maximal tissue with the goal of negative margins. Three major studies evaluated the efficacy of MMS, and all revealed relatively high recurrence

rates. Most notably, Shindel *et al.* demonstrated high local recurrence (8/25, 32%) in patients undergoing MMS. However, 7 of the 8 recurrences were successfully managed with repeated MMS (66). Despite the high recurrence rate, the study concluded MMS combined with repeat procedures and vigilant follow-up provided excellent cancer specific and overall survival rates with low risk of disease progression.

Glans treatment

Lesions limited to the glans may be treated by various surgical modalities. The extent of penile preservation and resection is based on degree of invasion and the ability to attain negative surgical margins. This may be achieved by glans resurfacing techniques, partial glansectomy with grafting, or total glansectomy with glans reconstruction.

As the previous standard of achieving a 2 cm negative surgical margin has not shown any benefit in cancer control, isolated lesions of the glans may be treated with partial glans excision with only a 2 mm margin (41,58,60). This allows for greater preservation of the glans with excellent functional and cosmetic results while achieving adequate cancer control. A primary closure may be performed, however, the defect may also be grafted using partial or full-thickness skin grafts from the thigh (58). In patients where the majority of the glans was removed, McDougal reported use of a penile shaft skin advancement to cover the defect with excellent cosmetic result (59). For low grade and low stage tumors of the corona, Brown *et al.* (67) employed a subtotal glans excision without grafting. This technique preserved the distal urethra with normal voiding function and no recurrence in a 12-month follow-up period.

For patients with CIS, total glans resurfacing (TGR) has proven to be an effective and attractive treatment option. TGR involves utilization of a skin graft after removal of the epithelium and subepithelium of the glans to the level of the corpus spongiosum (68). This technique has been used for BXO and has shown promising results in limited studies for CIS (36,68), with an overall recurrence rate of 4 percent as demonstrated by Shabbir *et al.* (36).

With urethral involvement or large glandular lesions, a total glansectomy is the treatment of choice (55,69-71). A split-thickness skin graft with urethral spatulation is performed after exposing the bilateral corpora cavernosa to form a neo-glans (69,71). Recurrence rates with this procedure have been reported to be as low as 6% (69). Palminteri *et al.* (55) described patient satisfaction with

postoperative phallic appearance, with the majority of patients regaining satisfactory level of sexual function and therefore abating the psychological impact often associated with penile cancer. Complications noted involve poor graft take and graft-overgrowth with intrusion of the urethral meatus (72).

Corpora and proximal penis

Traditionally, corporal invasion has been treated with partial penectomy with a 2 cm negative surgical margin. The paradigm has now changed with a 10 mm margin for grade 1-2 lesions and 15 mm margins for grade 3 lesions (70,72). This has allowed for greater preservation of cavernosa and penile length. Therefore, small and relatively confined T2 tumors may be managed with excision and grafting with glans reconstruction (41). This emphasizes the significance of glans reconstruction, as it provides satisfactory cosmetic and functional results without compromising cancer control. It is also important to note that multiple studies advocate the use of frozen section during the procedure to attain negative margins (41,71,73).

Deeply invasive SCC of the shaft that does not involve the corpora may be treated more conservatively. This is achieved by removal of the skin and subcutaneous tissues with subsequent split-thickness skin grafting. This eliminates drainage areas from which seeding may occur (74).

Reconstructive modalities

Myocutaneous flaps

Advanced cancers with positive inguinal nodes and/or invasion into local structures may require transposition of nearby muscular tissue for closure. This complements palliative radiation and decreases the burden of wound care and associated skin site infections that cause a drastic increase in morbidity (75). The tensor fascia lata and rectus abdominis flap offer the best closure of wound defects without requiring skin grafting. Large wounds, fistulization, and previously irradiated areas with need for salvage can benefit from the use of transposing myocutaneous flaps to improve outcomes (75). The flaps are not curative but minimize dramatic complications associated with poor wound healing at the site of the surgery. Parkash described the use of flaps in groin block dissection for inguinal node involvement of penile carcinoma (76). Block dissections were performed in 17 patients with penile carcinoma using upper sartorius,

upper gracilis, and lower rectus abdominis following nodal excision. The skin grafted well in 16 of the cases, with one case of significant necrosis. The study notes the limitation of sartorius flaps from an anatomical standpoint and that rectus abdominis flaps are the most reliable and should be taken from the side opposite the site of block dissection. In the case of bilateral dissection, a gracilis flap was shown to be most beneficial, as the rectus abdominis flaps must be done contralaterally (76). In another study by Kayes *et al.*, vertical rectus flaps provided excellent cosmesis for patients with similar dissections and offered favorable outcomes at 14 days (77). In one case, skin coverage was expanded by tensor fascia lata in a larger surgical excision site. The use of myocutaneous flaps involves a thorough determination of blood supply to the underlying muscle to promote rapid healing and minimize necrosis. A suitable blood supply from segmental perforators of both the superior and inferior epigastric arteries has been proven to be a critical measure of success in cases of flap reconstruction. Additionally, the superficial inguinal and circumflex iliac arteries may contribute some supporting branches for effective perfusion and successful grafting. The hospital course involves 3 days of strict bed rest with two large bore drains from the site of flap placement (77). The most important considerations for candidates of this surgery include medical clearance as a surgical candidate as well as an understanding of the nature of this major surgery. Those who are able to tolerate the grafts achieve increased daily function, a reduced risk of exsanguination from friable tissue and the ability to be radiated for recurrent penile squamous cell in the area of the new skin site if needed for adjuvant therapy.

Ventral phalloplasty

One documented means of improved functional outcomes comes from literature by Wallen *et al.* in describing the ventral phalloplasty for optimizing penile length following partial penectomy. The average loss of 1–2 cm following partial penectomy causes significant emotional distress in patients and may be minimized by performing a ventral phalloplasty in patients undergoing surgical resection (78). The procedure offers a simple adaptation that can add to patient satisfaction and be performed at that time of the original cancer operation. The procedure involves reduction of the penoscrotal web using a check mark incision (79). In an original study of 43 patients with ventral phalloplasty and penile prosthesis placement, patients self-reported increased degree of phallic length in 84% and 98% improved

satisfaction from patients (80). The ventral phalloplasty should be considered a routine adjunctive procedure in any procedure with potential penile shortening, and therefore deserves consideration in the case surgical treatment of penile cancer.

Penile prostheses

Cosmesis may be explored further by the incorporation of penile implantation in patients with partial or radical penectomy. Loss of erectile function affects many patients decision to undergo definitive treatment via surgery. In the past, most penectomies involved full or partial resection with potential scrotal tucks to allow the area to heal, eliminating penile function. Patients who have proceeded with variations of penile prostheses in cases of other genitourinary conditions have reported better emotional and functional outcomes. In cases where it could be used, the patient would first require complete healing from partial penectomy to be considered for penile implantation. This could be a future consideration as an adjuvant measure following partial penectomy to help improve symptoms in those who suffer from post-operative erectile dysfunction.

Outcomes and complications

It is imperative to maintain close follow-up with patients undergoing penile preserving procedures (65). Recurrence of local malignancy, nodal invasion, and adverse effects of therapies all warrant close observation in the outpatient setting. In conservative treatments, side effects of therapy at the cancer site can range broadly, while surgical resection seems to primarily affect emotional status of the patient through functional erectile loss and abbreviated length of erections. A recent study completed by Veeratterapillay *et al.* (81) reported a local recurrence rate of only 6%, with 85% reporting adequate erections 1 year postoperatively. In addition, overall survival was not affected, and most patients with recurrence can be salvaged with more aggressive traditional therapies (41,81,82). It was noted, however, that positive surgical margins greatly increases the risk of recurrence and is an independent prognostic factor for recurrence (41,81,82). Pertinent studies and results are reported in *Table 4*.

Conclusions

As penile cancer can be a morbid and disfiguring ailment,

Table 4 A comparison of various studies on isolated populations of patients using different treatment modalities to determine the study size, recurrence rate, recurrence free response to therapy, and complications associated with various therapeutic approaches

Study	Treatment modality	Size (number of patients)	RR (%)	Complete response (%)	Complications
Alnajjar HM <i>et al.</i>	Topical	44	43	57	Local toxicity in 10%, 12 % adverse effect of 5-FU
Tietjen DN <i>et al.</i>	Laser therapy	52	11.4	88.6	Recurrence required treatment with laser [3], penectomy [2], and 1 died of widespread metastatic disease (deeply invasive T2), universal failure to control T2 disease
Frimberger D <i>et al.</i>	Laser therapy	29	10	90	No complications listed in study
Windahl T <i>et al.</i>	Laser therapy	67	19	81	7% of patients had postoperative bleeding, 8 died in 42 months
Crook JM <i>et al.</i>	XRT (B)	49	14.7	85.3	Soft tissue necrosis was 16% and urethral stenosis in 12%
Azrif M <i>et al.</i>	XRT (E)	41	38	62	Penile ulceration in 8% and urethral stenosis in 29%
Minhas S <i>et al.</i>	SP	51	4	96	Treated with partial penectomy in cases of recurrence, 3 patients with involvement at surgical margin
Veeratterapillay R <i>et al.</i>	SP	65	4	96	Partial graft loss in 1.5%, graft contractures in 4.5%, meatal stenosis in 7.5%, 5% with poor cosmetic outcome
Li J <i>et al.</i>	SP	32	7.1	92.9	Only 1 reported worsened ED from mild to moderate, 1 patient with grade I wound dehiscence, grade II abscess in 1 patient, 13% postoperative morbidity, hematoma, wound infection, urethra orifice necrosis
Chaux <i>et al.</i>	SP	81	33	67	This study involved only patients with history of recurrence

RR, recurrence rate; XRT (B), brachytherapy; XRT (E), external beam radiation; TGR, total glans resurfacing; PGR, partial glans resurfacing; SP, surgical penectomy, including partial penectomy and amputation for proximal lesions; ED, erectile dysfunction.

every effort must be made to preserve penile length and functionality, while attaining adequate cancer control. Small, localized lesions with favorable histologic features (Tis, Ta, and select T1 tumors) may be amenable to conservative measures such as topical therapies and laser ablation. Previously, lesions confined to the prepuce required circumcision, however, minimal margins achieve adequate prevention in Mohs' Microsurgery and local excision in preserving the foreskin safely. Glandular lesions may be approached based on level of invasion. TGR has shown great promise in the treatment of CIS and premalignant lesions, with satisfactory cosmetic results and excellent cancer control. Further invasion of the glans may require partial or total glansectomy with grafting techniques. Although maximal penile preservation would be ideal, proper cancer control remains the primary goal of treatment and therefore must be pursued in the management plan for each individual patient with adapted techniques to minimize recurrence and improve functional outcomes. Approximately 80% of penile malignancies

may be treated with penile preserving techniques, as the majority of lesions occur distally (55). Patient awareness of various options and outcomes remains vital to further improvement and use of conservative therapy. In advanced disease, physician education and training on the use of myocutaneous flaps, extragenital and scrotal skin grafting, ventral phalloplasty, and, in the future, penile prostheses offers a variety of options to complement surgical treatment while improving postoperative outcomes and minimizing psychological effects associated with functional loss following penile cancer surgery.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Cite this article as: Baumgarten AS, Fisher JS, Lawindy SM, Pavlinec JG, Carrion RE, Spiess PE. Penile sparing surgical approaches for primary penile tumors: preserving function and appearance. *Transl Androl Urol* 2017;6(5):809-819. doi: 10.21037/tau.2017.04.01