Erectile dysfunction is the most common side effect after prostatectomy. There are currently five categories of available treatment options for erectile dysfunction for men following radical prostatectomy. The first and most common treatment is oral phosphodiesterase type 5 inhibitors (sildenafil, vardenafil, or tadalafil). Despite their popularity, these medications do not always produce an erection sufficient for intercourse after prostatectomy. The second treatment option is the noninvasive option of either a venous constriction band or the vacuum constriction device. Both treatments use a venous occlusive tension band or ring to maintain erection by retaining blood in the penis. The vacuum constriction device also utilizes external suction pressure to create an erection prior to application of the tension ring. The third treatment option is Muse®, an intraurethral suppository containing alprostadil that dilates the penile blood vessels. The fourth treatment option involves penile injections. The fifth treatment is the penile prosthesis, in which artificial rods are surgically implanted into the corpora cavernosa to provide penile rigidity. Oral agents, the vacuum device, Muse, and injections have been used for penile rehabilitation to encourage spontaneous return of erectile function in men after radical prostatectomy with varied success. Untreated erectile dysfunction after radical prostatectomy has been associated with penile atrophy and further diminished erectile function. Therefore, it is critically important that clinicians provide comprehensive information about the positive and negative aspects of all treatment options and the penile rehabilitation potential of each. This will enable patients to make informed treatment choices about early intervention for erectile dysfunction.
1998; Mulligan & Moss, 1991). Prevalence of erectile dysfunction in men after prostatectomy has been explored in many studies and has been reported as high as 88% (Korfage et al., 2005). In a study of 1156 post-prostatectomy men, erectile dysfunction was identified as a major problem adversely impacting quality of life (Potosky et al., 2004). Meyer, Gillatt, Lockyer, and Macdonagh (2003) reported that as long as 92 months post-prostatectomy, more than 75% of the men in the study were sad or fearful about the problems related to erectile dysfunction, and over 70% felt quality of life was adversely affected. In light of the high survival rates associated with prostate cancer, issues impacting quality of life, such as erectile dysfunction, need to be addressed and treated.

**Erectile Dysfunction after Prostate Removal in Men with Prostate Cancer**

Removal of the prostate continues to be a gold standard treatment option for prostate cancer against which all other treatment options are measured (Zippe et al., 2001). The etiology involved in erectile dysfunction is multifactorial. Not only can nerve conduction be compromised from the dissection of these nerves away from the prostate, but nitric oxide synthesis may also be diminished (the cavernosal nerve is a source of synthesis for nitric oxide) (Carrier et al., 1995). Nitric oxide is the primary chemical that mediates smooth muscle relaxation and vasodilatation. In an effort to minimize post-prostatectomy erectile problems, nerve-sparing techniques have been developed (Walsh & Mostwin, 1984). Despite these nerve-sparing techniques, erectile dysfunction remains a problem for the majority of men after radical prostatectomy (Penson et al., 2005; Walsh, Marschke, Ricker, & Burnett, 2000). The quest continues to find better techniques to improve erectile function after radical prostatectomy.

Efforts to improve outcomes and reduce recovery time after prostate removal include the use of robotics for radical prostatectomy. Robotic-assisted prostatectomy is a minimally invasive surgical technique that uses a laparoscope and approximately 5 to 6 small ports of entry to remove the prostate rather than the traditional open retropubic or perineal method of prostatectomy (El-Hakim & Tewari, 2004). The surgeon sits at the control counsel and uses hand controls that allow each of his movements to be translated into movements with the robotic instruments while simultaneously filtering tremors, scaling movement to size, and providing full range of motion and ergonomy. The cameras in the scope provide a three-dimensional magnified image for the surgeon. In terms of erectile function, the hope is that the robotic-assisted method will provide a more precise surgical technique, less manipulation, and better visualization of the nerves for erectile function during prostate removal.

Initial reports of erectile function are varied. No conclusive evidence has been reported to determine if potency rates are better with robotic prostatectomy versus open prostatectomy. Menon and associates (2007) reported that of patients with normal erectile function before surgery, successful intercourse was achieved by 70% to 100% of men who had undergone nerve-sparing techniques, although only half of those men reported a return to the normal Sexual Health Inventory for Men (SHIM) score without the use of medication. Madeb and associates (2007) reported that 62.2% of patients who had bilateral nerve-sparing robotic-assisted prostatectomy had mild or no erectile problems. Still another report from Tewari and colleagues (2008) stated that 87% of previously potent men regained potency after surgery within one year. Further research directly comparing traditional open radical prostatectomy methods to robotic-assisted prostatectomy methods needs to be done to determine whether potency rates are better with the newer technique.

**Treatment of Erectile Dysfunction and Penile Rehabilitation after Prostatectomy**

The goal of erectile dysfunction treatment after radical prostatectomy is an erection sufficient for sexual relations. There are five well-established treatment options for erectile dysfunction, and several of these treatment options have also been utilized for penile rehabilitation in men after prostatectomy. The first option includes all oral phosphodiesterase type 5 (PDE-5) inhibitors. The second option is non-invasive and involves venous occlusive devices to retain blood in the penis during intercourse. This option includes the venous constriction loop (such as the Enhance Magna® loop or Actis® loop) and the vacuum constriction device. The third option is the urethral suppository alprostadil (Muse®) (Vivus, Inc., Mountain View, CA). The fourth option involves penile injections. The fifth and final option is a penile implant.

The clinical challenge is determining which treatment option is best for an individual patient. Insufficient research is currently available to provide clear guidance; therefore, treatment selection is generally motivated by patient and/or clinician preference. All treatment options should be presented to facilitate informed decision making. Each treatment has advantages and disadvantages. The potential benefits and limitations of each treatment option are presented in Table 1. Patients will have varying motivation levels in terms of sexual function, and motivational level may also change during the post-prostatectomy time period. Miller and associates (2006) reported that as many as half of patients (N = 650) reported indifference about
erectile dysfunction after prostate cancer treatment, yet the use of at least one erection treatment aid was an independent determinant of more favorable sexual health-related quality of life.

The goal of penile rehabilitation after radical prostatectomy is to maximize erectile function recovery through the use of available medications and devices. An important outcome indicator for successful penile rehabilitation is a spontaneous erection that is rigid enough for successful sexual relations. It is thought that erectile dysfunction after radical prostatectomy is related to cavernosal nerve neuropraxia leading to hypoxia and fibrosis of the tissue of the penis (Moreland, 1998; User, Hairston, Zelner, McKenna, & McVary, 2003). Cavernosal smooth muscle is dependent on oxygenation of the tissue for normal function. Treatment for erectile dysfunction that results in increased blood flow and oxygenation of the cavernosal smooth muscle may improve tissue oxygenation and decrease fibrosis and collagen formation (Montorsi et al., 1997; Padma-Nathan, McCullough, Giuliano, & Al, 2003).

**Oral PDE-5 Inhibitors**

Oral PDE-5 inhibitor agents continue to be treatment of choice for men with erectile dysfunction. Unfortunately, the failure rates of these medications has been reported to be as high as 80% among men who have undergone prostatectomy (Daniel, Israilov, Segenreich, & Livne, 2001). Oral agents are usually taken approximately one hour prior to sexual

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pros</th>
<th>Cons</th>
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| Oral PDE-5 inhibitors              | • Quick and easy to administer  
• Discreet  
• Cost approximately $12 to $25/pill  
• Suitable for travel | • Poor efficacy rate in men after prostatectomy  
• Side effects possible (headache, nasal congestion, flushing, stomach upset) |
| Venous and vacuum constriction devices | • Non-invasive  
• High efficacy rates  
• Fairly quick and easy after “mastered”  
• Suitable for travel  
• May be incorporated into foreplay | • Cumbersome and awkward  
• Messy  
• Time consuming  
• Cool feeling to penis  
• Penis is wobbly at the base  
• Challenges and comfort of wearing tension rings during sex  
• May have side effects of bruising, pain, or discomfort  
• Vacuum device costs approximately $450 to $550 |
| Intraurethral suppository (Muse®)  | • Simple to use  
• Less invasive than injections | • Expensive  
• Side effects may occur (pain, burning, hypotension, increased heart rate, dizziness, and lightheadedness)  
• Some patient uncomfortable with putting medication in urethra  
• MUSE costs approximately $30 to $50 each |
| Penile injections                  | • High efficacy rates  
• Reliable treatment | • Invasiveness-Need to inject the penis each time for erections  
• Side effects possible (pain, bruising, bleeding, priapism, and Peyronies)  
• Need to refrigerate some medications  
• Comfort level with self injecting and the hassle of doing this procedure  
• FDA-approved injections cost approximately $30 to $50 each  
• Some injectables must be refrigerated making travel challenging |
| Penile implant                     | • High efficacy rate  
• High satisfaction rates  
• No travel issues | • Permanent  
• Side effects (pain, injection, mechanical failure, and erosion of the device through the skin)  
• Permanent option  
• The penile implant surgery costs about $8000 to $12,000 |
relations. Oral agents work by inhibiting PDE-5, an enzyme that attacks cyclic guanosine monophosphate (cGMP). Without the PDE-5 enzyme to diminish cGMP, cGMP levels are increased. The cGMP is released during sexual arousal and is part of a group of chemical mediators that lead to smooth muscle relaxation and penile engorgement. Sexual thoughts and/or genital stimulation about 45 to 60 minutes after ingestion of the PDE-5 inhibitor is necessary to activate the chemical cascade leading to an erection.

The greatest advantage of oral agents is simplicity of use and the ability to proceed with sexual encounters more naturally than with most other treatment options. Patient preference for PDE-5 inhibitors is probably related to this ease and discretion. If an oral agent is effective, the medication can be taken privately an hour or more before the sexual situation. Oral PDE-5 inhibitors are also one of the least expensive pharmacological options, costing approximately $12 to $25 a tablet. Traveling with the medication is not problematic since it needs no refrigeration.

The biggest disadvantage to using PDE-5 inhibitors is their limited effectiveness in this population and the agent-associated side effects. Side effects most commonly include headache, facial flushing, nasal congestion, and nausea. PDE-5 inhibitors are contraindicated in patients taking nitrates (McMahon, Samali, & Johnson, 2000). These medications should be used cautiously in men on alpha blocker medications, men with renal impairment, or men with certain heart conditions, such as QT prolongation.

Emerging research continues to support the early use of oral PDE-5 inhibitors for penile rehabilitation. Researchers evaluated erectile dysfunction in 76 men with normal pre-operative erectile function who underwent bilateral nerve sparing radical prostatectomy (Padma-Nathan et al., 2003). These men took sildenafil 50 to 100 mg nightly for 36 weeks beginning four weeks after surgery. Results revealed that 27% of the men taking sildenafil versus 4% in the placebo group had a return of spontaneous normal erections. Replication of this study by McCullough, Levine, and Padma-Nathan (2008) found that men using sildenafil 50 to 100 mg nightly had improved nocturnal erections compared to men treated with placebo. In addition, nightly sildenafil administration decreased penile fibrosis, and this finding supports the premise that sildenafil may improve endothelium-dependent vasodilation (Desouza, Parulkar, Lumpkin, Akers, & Fonseca, 2002; Schwartz, Wong, & Graydon, 2004). These studies combined with other research about oral agents for penile rehabilitation provide clinical evidence that oral PDE-5 inhibitors promote improved blood flow to the penis and may enhance return of spontaneous erections after radical prostatectomy.

Some urology health care providers encourage patients to take oral agents for penile rehabilitation (if not contraindicated) after surgical removal of the prostate. Providers may instruct the patient to take one of the three (sildenafil, vardenafl, or tadalafil) oral agents either daily or three times a week for penile rehabilitation. It could be financially challenging for patients to use an oral agent that frequently because of limited access to erectile dysfunction medications (without having to pay for them out of pocket) in some institutions (such as the Veterans’ Administration) or due to limits allowed by some insurance providers. Therefore, it is important for patients to understand that although they may be using PDE-5 inhibitors for penile rehabilitation after radical prostatectomy, these agents are not likely to produce an erection sufficient for penetrative sex. Appropriate education on the use of these medications will alleviate disappointment and false beliefs that these medications should be working to produce an erection sufficient for intercourse. The patient must understand the benefits of penile rehabilitation so he will be more likely to continue using the treatment for that specific purpose. PDE-5 inhibitors may also be used in combination with other treatment options, such as the vacuum device or Muse®, for penile rehabilitation.

**Venous and Vacuum Constriction Devices**

Non-invasive options are used externally on the penis to provide an erection sufficient for intercourse. One option is a venous constriction loop, which is an adjustable elastic loop placed and tightened around the base of the penis. This adjustable band is used to maintain blood within the penis during sexual relations and should not be worn for more than 30 minutes at a time. This device is only helpful for men who obtain but cannot keep an erection because it will not make the penis harder; rather, it is designed to decrease venous flow back into the body. This treatment is completely non-invasive and very simple to use. The venous constriction loop costs about $10 to $20, and it is compact for travel. Disadvantages are that the tension band must be worn during sexual relations to maintain the erection, and it may be uncomfortable because the elastic can catch or pull on pubic hair.

The vacuum constriction device consists of a pump attached to a plastic air-tight cylinder and a tension/constriction ring to maintain the erection. To use the device, the penis is placed into the open end of the cylinder that already has a previously applied tension ring around at the edge of the open end of the cylinder. The pump is on the opposite end, and when the device is placed against the body
with the penis inside, suction occurs from the negative pressure and blood is pulled into the penis. Efficacy of the vacuum constriction device, in terms of creating an erection sufficient for intercourse, has been reported as high as 87% to 92% regardless of the etiology of the erectile dysfunction (Turner et al., 1991; Witherington, 1989). The vacuum constriction device is an effective treatment for erectile dysfunction in men after radical prostatectomy, with efficacy and patient satisfaction reported to be greater than 80% (Cookson & Nadig, 1993). In a study using the vacuum device with men after prostatectomy, 76% to 86% of the men (regardless of their nerve-sparing status) were able to successfully use the vacuum device for intercourse (Raina et al., 2006). Long-term use of the device ranges from 50% to 64% after two years (Cookson & Nadig, 1993).

Advantages of the vacuum device identified by patients in a previous study were that it was reliable, non-invasive, fairly quick and easy to use after practice, suitable for travel, and could add to foreplay if the couple is amenable to introducing the vacuum device into foreplay (Soderdahl, Thrasher, & Hansberry, 1997). Disadvantages identified by patients include that it is bulky, messy with the water-soluble gel, time consuming, that the penis had a cool feeling to touch and was “hinged” or wobbly at the base, and that it detracted from the romance of the sexual situation (Soderdahl et al., 1997). The vacuum device is contraindicated for men with a history of priapism, sickle cell anemia, or certain bleeding disorders. When compared with penile injections, both therapies were effective, but the dropout rates were much higher for penile injections versus the vacuum device (60% versus 20%) (Turner et al., 1992). In men who failed to respond to intracavernosal injection therapy, 71% of these men were able to have adequate rigid erections with the vacuum device (Gould, Switters, Broerick, & deVereWhite, 1992). Vacuum devices cost approximately $450 to $550. The vacuum device requires one-on-one training with a highly motivated patient who will regularly utilize the treatment and can work with the device to master it. The vacuum device is in no way discreet, and this may be an important factor for men who are not in a committed, understanding relationship. The vacuum constriction device can also be used in conjunction with oral agents (PDE-5 inhibitors), which has been shown to increase efficacy and satisfaction (Chen, Sofer, Kaver, Matzkin, & Greenstein, 2004).

Recent studies offer promising results for the use of the vacuum device without using the tension ring for penile rehabilitation. In a study by Raina and co-authors (2006), men using a vacuum constriction device daily without tension rings had a 17% return of spontaneous erections and significantly less penile shrinkage compared to an 11% return of erections in the control group. A study by Köhler and colleagues (2007) showed that early intervention with the vacuum constriction device yielded statistically significantly higher International Index of Erectile Function scores than in men who did not use the device. This study also found that participants using the vacuum device had less penile shrinkage. The combination of sildenafil and the vacuum device resulted in 30% of post-prostatectomy men reporting return of spontaneous erections and reports of improved satisfaction over therapy with either sildenafil or the vacuum device alone (Raina, Agarwal, Allamaneni, Lakin, & Zippe, 2005).

Intraurethral Alprostadil (Muse®)

Muse® is an intraurethral suppository of alprostadil (a prostaglandin) used for the treatment of erectile dysfunction. After urination (so the urethra is wet), the Muse applicator is gently slipped into the tip of the penis and goes slightly over an inch down into the urethra. The patient depresses the button on the top of the applicator to release the Muse into the urethra for absorption. The penis is rolled between the hands for a minimum of 10 seconds to dissolve the Muse. Muse is contraindicated in men with a hypersensitivity to alprostadil, men with an abnormally formed penis, or men who have conditions that would predispose them to priapism, such as sickle cell anemia, leukemia, or tumors of the bone marrow. Caution must be used with patients who have low blood pressure or a history of fainting since the medication may lower the blood pressure and cause dizziness or lightheadedness. Titrated dosages starting at 125 to 250 mcg and increasing to 500 to 1000 mcg were given to 384 men with or without nerve sparing prostatectomy; 57% of the men were able to have successful intercourse at least once at home as compared to 6.6% of the men receiving placebo (Costabile et al., 1998). Raina, Agarwal, Zarano et al. (2005) reported similar results, with 55% of men achieving erections sufficient for intercourse with Muse regardless of the use of nerve-sparing surgery.

The advantage to Muse is that it is simple to use and does not require a needle injection through the skin as with the penile injections. Muse can remain unrefrigerated for up to 14 days when maintained at room temperatures between 30 to 86 degrees Fahrenheit, so it is easy to transport. The disadvantages of Muse are that it does not always produce an erection sufficient for intercourse, is expensive if not covered by insurance, and may also have significant side effects. The most commonly reported adverse effects are pain or burning, hypotension, dizziness, lightheadedness, and fainting. The greatest challenge to using Muse...
in the first year after prostatectomy is that penile pain may occur with higher doses of 500 to 1000 mcg, potentially causing discontinuation of use, according to anecdotal reports (Mulhall, 2008). Since pain is common after prostatectomy, the first dose of Muse should be given during a routine post-prostatectomy office appointment, assessing blood pressure before and after administration, and using lower drug dosages initially (Costabile et al., 1998; Raina, Pahlajani, Agarwal, & Zippe, 2008). Muse costs between $30 to $40 per dose. Muse can also be used in combination with a PDE-5 inhibitor post-prostatectomy to increase efficacy. In one study, 83% of the men reported improved efficacy and satisfaction with the combination of Muse plus PDE-5 inhibitors versus Muse alone (Raina, Nandipati et al., 2005). This study of 19 men with erectile dysfunction (not limited to men post-radical prostatectomy) reported that erections were sufficient for penetration 80% of the time. Specifically with post-prostatectomy men (N = 23), researchers found that of the men who were unsatisfied with results from sildenafil alone, 83% had improved penile rigidity and sexual satisfaction with the addition of Muse, with reports of sufficient rigidity for vaginal penetration 80% of the time (Nandipati, Raina, Agarwal, & Zippe, 2006).

Muse may also have a role in penile rehabilitation. The starting dose of Muse is typically 125 to 250 mcg to minimize the side effect of pain that may commonly be experienced in these patients. Muse may be used in combination with oral PDE-5 inhibitors. In addition, there is emerging research on early intervention with Muse after prostatectomy. The benefits of Muse or injectable prostaglandin in terms of corporal oxygenation were reported as increasing oxygen saturation in the corpora by 37% to 57% despite marginal erectile response (Padmanaban & McCullough, 2006). In a study by Raina, Agarwal, Nandipati, and Zippe (2005), researchers reported a return of spontaneous erections after six months of tri-weekly Muse in 39% of the men as compared to 11% in the observational group. Another study of men with erectile dysfunction after prostatectomy compared early use of Muse to delaying treatment and found that at six months, 40% of men (N = 38) who continued using Muse had a return of natural erections sufficient for penetration (Raina, Agarwal, Nandipati, et al., 2005). One study examined the possible mechanism of penile rehabilitation with Muse and found that 125 to 250 mcg doses improved corporal and glandular oxygen saturation levels, even in the absence of penile rigidity (McCullough, 2007). Further research is needed, but these studies provide evidence that Muse may play a role in penile rehabilitation. Muse may be the treatment of choice for men who would like to improve the efficacy of oral agents and promote penile rehabilitation while not opting for the more invasive and cumbersome injections.

**Intracavernosal Penile Injections**

The patient who desires a treatment option with proven efficacy that provides a fairly natural-feeling erection without a constriction ring may be interested in penile injections. Penile injections use vasoactive medications injected into the side of the base of the penis to dilate the blood vessels of the penis causing penile engorgement. Commonly used injectable agents include prostaglandin E1, papaverine, and phentolamine. Patients may be on monotherapy of prostaglandin in the form of Caverject Impulse® (Pfizer); Edex® (Schwarz Pharma): off-label, non-FDA-approved, compounded monotherapy of prostaglandin E1; or combination therapies using prostaglandin E1, papaverine, and/or phentolamine. Penile injections are contraindicated for men with a hypersensitivity to the medications; for men with conditions that may lead to priapism, including sickle cell anemia, multiple myeloma, and leukemia; and for men with a penile implant or a severely deformed penis (Schwarz Pharma, 2004).

The advantage to penile injections is that they are effective in producing erections sufficient for vaginal intercourse. Penile injections are one of the most efficacious treatment options for men after prostatectomy, with success rates reported as high as 85% to 95% (Claro Je et al., 2001; Dennis & McDougal, 1988). In this author’s previous study (Albaugh & Ferrans, 2010) of post-prostatectomy men at one month after treatment with penile injections, 80% of study participants reported mild or no erectile dysfunction, and 25% reported normal erectile function. At three months, 75% reported mild or no erectile dysfunction, and 35% reported completely normal erectile function. Injections resulted in a significant improvement in erectile dysfunction, and improvement in self-esteem and satisfaction with their sexual relationship. Advantages of the injections identified by patients in previous research included it was quick and easy, not messy, and created a fairly natural erection without using tension rings to maintain the erection (Soderdahl et al., 1997).

Despite the excellent efficacy profile and the penile rehabilitation benefits of injections, patients do not seem to accept this option, and dropout rates are often reported as high as 55% to 58% (Dennis & McDougal, 1988; Purvis, Egedebeit, & Christiansen, 1999). Summarizing previous research, Turner and associates (1992) determined that when comparing dropout rates for injections (not limited to prostatectomy patients, but including prosta-
tectomy patients) with those for the vacuum device, the dropout rates for penile injections (60%) were three times greater than for the vacuum device (20%). To increase success with penile injections, it is essential that clinicians assess the potential ability to safely inject into the penis, including the ability to see the injection sites at the base of the penis, as well as having the manual dexterity to safely inject and the cognition to follow the instructions for self-injection. Penile injections require a patient who is highly motivated and can become comfortable with either self-injections or injections done by his partner prior to each sexual encounter.

Identified disadvantages associated with injections included the invasiveness of injections, problems with or fear of prolonged erections, pain, the need to refrigerate some of the medications, and the thought of the injections each time before a sexual encounter (Soderdahl et al., 1997). Some injectables need to be refrigerated, and this can make travel with the medications challenging. Another disadvantage to injections is that the FDA-approved versions of penile injections in the forms of Edex and Caverject Impulse are expensive ($30 to $45 dollars each) and not always available. Both products were on back order for many months in 2008. This lack of availability can be very frustrating for patients, requiring alteration of treatment to generic off-label use of prostaglandin E-1 (which must be refrigerated) or wait for the branded products to become available. Compounded, non-FDA approved, off-label penile injections are available from various compounding pharmacies around the country and are cheaper (though they are often not covered by insurance prescription plans). Other patient-identified disadvantages for penile injections (study not limited to men after prostatectomy) were inconvenience, lack of efficacy, cost, and side effects (Mulhall et al., 1999; Raina et al., 2003). These reasons for lack of use of injections were also identified in the recent pilot study by Albaugh and Ferrans (2010) with 20 men after radical prostatectomy. In terms of lack of efficacy, a total of seven men from this group (35%) were still struggling to find a consistent, effective dose with their injections approximately three months after beginning injections. Titrating injections can be a daunting task given the myriad of agents and doses available. In this recent pilot study with 20 men, it was found that it can take up to eight or more dosage/medication changes before achieving efficacy (Albaugh & Ferrans, 2010). An algorithm for titrating injections in any man using injections for erectile dysfunction was published and serves as a guide for adjusting medications and dosages in patients (Albaugh, 2006).

Pain is the most common side effect with injections. The pain is typically not related to needle insertion, but rather, the side effect of the prostaglandin medication. Results of a recent study found that 40% of 65 study participants rated the needle insertion pain at 0 on a verbal pain scale of 0 to 10 during their first in office self injection (Albaugh & Ferrans, 2009). For men who reported pain from the needle insertion, the average pain rating was only 1.33. $SD = 0.61$ on a verbal pain scale of 1 to 10. However, the pain reported by men is typically from the medication, particularly prostaglandins, rather than the needle insertion. The results of this study conclude that a significantly larger proportion of post-radical prostatectomy men experienced pain from the medication compared with men who had not undergone this procedure (51.9% vs. 23.7%) ($\chi^2[1, n = 65] = 5.5, p = 0.02$) (Albaugh & Ferrans, 2009). In another study that was not limited to men after prostatectomy, pain from injected medication was reported in 29% of men using monotherapy with a prostaglandin product (Porst, Buvat, Meuleman, Michal, & Wagner, 1998).

In the author’s recent study limited to men after prostatectomy (N = 20), about 25% of the men reported pain from the medication (Albaugh & Ferrans, 2010). When pain is a concern, it is recommended to begin with lower dosages of prostaglandin alone or in combination with other vasoactive injectable agents. It has been reported that pain with 10 mcg doses of prostaglandin was an issue in the early post-radical prostatectomy period, and that six out of eight patients using these higher doses of this medication discontinued use of the medication related to pain (Raina et al., 2008). If necessary, prostaglandin can be eliminated altogether in patients who continue to have pain even at lower doses by using alternative vasoactive drugs, such as bimix solution of papaverine and phentolamine. Previous research (not limited to prostatectomy patients) has shown that switching to a trimix (papaverine/phentolamine/PGE1) or even a bimix (papaverine/phentolamine) combination is associated with lower incidence of pain (2.9% for trimix and 0% for bimix) (Daniel et al., 2000). Another promising injectable agent currently under investigation in the United States is a combination of vasoactive intestinal polypeptide (VIP) and phentolamine (Invicorp), which is currently undergoing Phase III clinical trials in the United States. Early results with this Invicorp product shows less incidence of pain (Gerstenberg, Metz, Ottesen, & Fahrenkrug, 1992; Sandhu et al., 1999; Shah, Dinsmore, Oakes, & Hackett, 2007).

Less common side effects include bleeding, bruising, priapism, and penile fibrosis/plaque formation. Priapism (erections lasting more than three to four
hours) has been reported in as many as 11% to 18.5% of men (Claro Jde et al., 2001; Porst, 1996). Priapism lasting three to four hours or longer occurred in four of the 20 patients in the author’s recent study (Albaugh & Ferrans, 2010). Some patients in this study struggled between taking enough medication to produce an erection sufficient for sexual relations and an erection that lasted too long (two to four hours or more) (Albaugh & Ferrans, 2010).

Peyronies disease (curvature of the penis related to plaque formation) is not common, but can be debilitating in terms of sexual activity. In terms of penile fibrosis/plaque/curvature in this recent pilot study, two (10%) of the patients reported a plaque or slight curve with injections (Albaugh & Ferrans, 2010). Total rates of up to 14% of fibrosis/plaque/Peyronies have been reported in the literature related to the penile injections (Schwarz Pharma, 2004). To minimize the risk of developing Peyronies disease, it is important to teach patients to rotate injection sites and hold pressure over injection sites (even if they do not see blood) for five minutes as directed in the prescribing information (Schwarz Pharma, 2004).

Regarding penile rehabilitation, a study by Montorsi and associates (1997) was the first to report on the use of penile injections given early after prostatectomy to improve return of spontaneous erections after prostatectomy. These researchers compared the ability to attain and maintain erections among men (N = 30) who underwent bilateral nervesparing radical prostatectomy. Fifteen of the men received intracavernosal alprostadil three times a week for 12 weeks (study group), and 15 men received no treatment (control group). After six months, the study group had a 67% return of spontaneous erections sufficient for intercourse, while the control group reported a 20% return of spontaneous erections. These researchers hypothesized that the injections improved oxygenation to the tissue and enhanced return of spontaneous erections.

In another study, patients (N = 101) used prostaglandin E1 injections, resulting in increased penile oxygen saturation of 37% to 57% (Padmanaban & McCullough, 2006). Raina and co-authors (2008) reported that 56% (10 of 18 patients) who had used a combination of oral agents and injections of alprostadil had return of partial erections at approximately six months, but they still needed treatment to be able to have sexual intercourse. The researchers also used trimix injections with four additional patients and reported that of the 22 total patients on either alprostadil or trimix, 50% of the patients had return of natural erections at six months. In another study using oral PDE-5 inhibitors for penile rehabilitation, patients who failed the oral agents were treated with intracavernosal injections (Mulhall, Land, Parker, Waters, & Flanigan, 2005). After 18 months, the men undergoing penile rehabilitation had a greater percentage of men able to engage in intercourse unassisted by medication (52% versus 19%, p < 0.001).

A significant difficulty with penile rehabilitation using penile injections is in convincing patients to self-inject approximately three times a week because injections are perceived as invasive and sometimes associated with pain in the early period after radical prostatectomy. In the author’s recent pilot study with 20 patients, patients used the injections an average of about four times per month (Albaugh & Ferrans, 2010). Despite agreeing to try to use the injections at least four times per month, seven men did not use the injections even once per week. Thus, expecting men to use the injections three times a week for the purpose of penile rehabilitation may be an unrealistic expectation. Although researchers found that starting injections in the first month after surgery resulted in better erectile response, participants also reported more pain (Gontero et al., 2003). Even with close observation and titration, pain was still a barrier identified by four of the 20 men in a recent study (Albaugh & Ferrans, 2010).

**Penile Prosthesis**

The penile prosthetic implant is the oldest treatment for erectile dysfunction. The implant is surgically placed within the penis at the site of each corpora cavernosa. The malleable implant is very simple, and the patient simply bends the penis upward when he wants to have sexual relations and bends the penis out of the way when he is not sexually active. There is also an inflatable implant that utilizes a pump in the scrotum to draw fluid into the rods of the penile implant for inflation, and a release mechanism to drain the fluid back into the reservoir.

The advantage of penile implants is that they are effective, and patients are typically satisfied with this treatment. Satisfaction rates with penile implants are high at approximately 83% to 85%, and complication rates, such as mechanical failure or infection, remain low at 6.4% to 13.7% and 1.7% to 1.8%, respectively (Montague & Angermeier, 2000, 2003). Although penile prosthesis implantation makes the return of spontaneous erections impossible, simultaneous implantation of a penile prosthesis at the time of prostatectomy has been reported to be associated with improvement in quality of life in patients (Ramsawh, Morgenthaler, Covino, Barlow, & DeWolf, 2005). It is a reliable treatment, but because it is the most invasive treatment and can permanently damage the corpora cavernosa, it is usually considered the final line of treatment after other medical treatments.
have failed. The patient who wants to undergo an implant should be a good candidate for surgery and needs to be ready for the permanency of the implant option. Travel is not an issue since the prosthesis is implanted in the body.

Disadvantages to the implant include pain after the procedure, and less commonly, mechanical failure or infection (Montague & Angermeier, 2003). The most common adverse effect of the implant is pain post-operatively after the implant surgery that typically resolves a few months after surgery. Other rare side effects include the typical risks involved with surgery. The penile implant surgery costs about $8,000 to $12,000.

Conclusion

Erectile dysfunction after radical prostatectomy remains one of the most common adverse side effects of treatment. Although some men might not be concerned about erectile function, many men are distressed about this problem and need assistance in determining the best way to move forward to promote and preserve erectile function. Each treatment option has both positive and negative aspects. Patients need to not only decide how and if they want to treat erectile dysfunction, but also make choices in terms of penile rehabilitation to promote blood flow to the penis to promote return of spontaneous erections. Each individual patient has his own unique sexual expression, and the patient and health care professional together can carefully determine how a potential treatment would work within that particular patient's life.

Treatment of erectile dysfunction after prostatectomy can be challenging since there is no definitive evidence to support a particular treatment option over the others. Generally, patients tend to start with less invasive or less cumbersome options. Most patients prefer oral agents because they are discreet and easy to utilize, and if appropriate, this can be a first line treatment. Since failure rates for oral agents remain very high post-prostatectomy, patients should be provided with other more efficacious options for use either instead of or in combination with oral agents to provide sufficient erectile function. Despite the fact that oral agents do not always provide sufficient erectile rigidity for penetrative sex, they have been shown to improve nocturnal erections and blood flow to the penis in post-prostatectomy men (Montorsi et al., 2000; Schwartz et al., 2004). It is crucial for the health care professional to provide appropriate education about the use of oral agents for penile rehabilitation, even if medication is not resulting in a full erection so patients will be encouraged to continue this therapy for penile rehabilitation. In addition, other treatments, such as the vacuum device or Muse, can be used in conjunction with the oral agents to enhance erections and penile rehabilitation. Although the vacuum device is associated with high efficacy and is the least invasive treatment option, it is cumbersome. Another relatively simple treatment option is Muse. Important factors regarding Muse are the issue of pain with alprostadil use after radical prostatectomy and the cost factor. If a patient wants proven efficacy and is highly motivated to carefully use a treatment, penile injections may be the best choice. Finally, when medical treatments have failed, the patient may want to consider a penile implant. The implant provides an effective treatment associated with high patient and partner satisfaction, but not all men are willing to undergo this surgically invasive intervention.

It is critically important for patients to understand that not utilizing any treatment to promote cavernosal blood flow and oxygenation will have long-term ramifications for regaining erectile function in the future. Each year, more research continues to reveal the importance of using treatment for erectile dysfunction to promote corporal tissue health and diminish atrophic changes to the penile tissue. After prostate surgery, nitric oxide synthesis is diminished due to nerve trauma to the cavernosal nerve (Carrier et al., 1995). The lack of nitric oxide and neuropaxia lead to diminished blood flow and oxygenation of the penile tissue, which leads to cavernosal fibrosis and collagen synthesis (Leungwattanakij et al., 2003). Atrophy and penile fibrosis cause further erectile dysfunction after radical prostatectomy; therefore, re-establishing blood flow to the penis is important to preserve and promote optimal erectile function in these men.

By understanding each treatment option and determining the best choice for treatment, health care professionals can help patients find the optimal treatment option for erectile dysfunction and penile rehabilitation. The health care team can help each patient carefully consider their unique sexual lifestyle and how to incorporate erectile dysfunction treatment into their sexual experience so this important component of life need not be lost after prostatectomy.

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Susanne A. Quallilch, ANP-BC, NP-C, CUNP, disclosed that she is on the Consultants’ Bureau for Coloplast.

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