

Three-piece Inflatable Penile Prosthesis: Surgical Techniques and Pitfalls

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INTRODUCTION

Penile prostheses were first developed 30 years ago.^[1,2] At least one-third of patients with erectile dysfunction (ED) do not respond to conservative treatment, particularly to phosphodiesterase type 5 inhibitors and intracavernosal injection therapy. Half of the patients with ED have severe and irreversible damage and will be candidates for penile prosthesis surgery.^[3]

The system consists of two intracorporal cylinders, a scrotal pump, and a fluid reservoir that is placed in the abdomen. The two main manufacturers of the cylinders, pumps, and reservoirs are Coloplast and American Medical Systems (AMS). Antibiotic-coated devices that aim to minimize the risk of infection have recently been reported.^[4,5]

There have been some recent advances in pump, reservoir, and cylinder design. Innovations in pump design have made deflation easier. The development of lockout valves by AMS in 2006 has also substantially reduced the issue of autoinflation. Reservoirs with special textures that limit encapsulation are now available. For the cylinders, models with a larger girth and controlled length expansion capabilities, and rear-tip extenders that connect in place

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ABSTRACT

Penile prosthesis surgery plays a vital role in the treatment of erectile dysfunction (ED). As far as outcome is concerned, it is one of the most rewarding procedures for both patients and surgeons. We describe our surgical technique for implantation of the three-piece inflatable penile prosthesis and point out the major surgical pitfalls accompanying this procedure and their specific management. The psychological outcome of penile prosthesis surgery is also discussed. Different surgical approaches are available when performing the procedure. A number of procedure-related problems can be encountered and a thorough knowledge of these is of paramount importance. Penile prosthesis surgery has a favorable psychological outcome. Surgery for implantation of an inflatable penile prosthesis is a rewarding procedure, with a high yield of patient satisfaction. Urologists should have thorough understanding of the surgical pitfalls peculiar to this procedure and their management.

Key words: Penile prosthesis, psychological outcome, surgical pitfalls

to avoid disconnection from the cylinders in the proximal corpora, have contributed to greater efficiency of inflatable penile prosthesis.

This article concentrates on our surgical techniques and the management of the main pitfalls that are encountered during the insertion of a three-piece penile prosthesis system.

INDICATIONS

- Failure or rejection of first- and second-line therapy of ED
- Peyronie disease with severe erectile deformity
- Irreversible organic cause of ED
- Penile fibrosis
- Post priapism, not responding to nonsurgical treatments
- Phalloplasty, following penile penectomy or gender change
- Psychological impotence, after failures of all other treatment

RELATIVE CONTRAINDICATIONS

- Spinal cord injury (due to increased risk of infection and erosion)

- Diabetes mellitus (due to increased risk of infection)
- Genital sores and dermatitis

COMPLICATIONS

- Mechanical failure
- Infection
- Erosion
- Others, e.g., inadequate cylinder length, pump/reservoir kink and change in position, and autoinflation

PATIENT COUNSELING AND CONSENT

Preoperative counseling of prospective candidates is mandatory about the different methods available for treatment and explanation of how prosthesis work. Patients must be fully informed that any preexisting natural erection will be lost and that the procedure is irreversible. Another important fact that the patient must be aware of is that the length of the fully stretched flaccid penis preoperatively will be the maximal length obtained with a penile prosthesis.

PREOPERATIVE PREPARATION

Active infection anywhere in the body should be excluded, but especially in urine and skin. Patient should be encouraged to brush the genitalia with strong soaps for few days prior to the procedure. Preoperative antibiotics targeting gram-positive bacteria are recommended before skin incision. In addition, the following are vital:

- Shaving immediately before the procedure
- Alcohol-based skin preparation and a minimum of 10 minutes scrubbing should take place prior to the formal prepping and draping
- Draping for scrotal incision should be with extremity drape and self-adhesive special drapes if possible
- Face masks, disposable gowns, and double-gloving are mandatory
- Traffic in and out of the operating room should be minimized and there must be laminar air flow if possible

SPECIAL EQUIPMENT

- Scott retractor, transverse penile strap, and hook retractors
- Small Deaver or similar retractors
- Brook's cavernosal dilators or Hegar dilators
- Rosello cavernotomes for cases of corporal fibrosis
- Furlow inserter with Keith needles
- DeBakey forceps and Metzenbaum scissors
- Long-blade nasal speculum
- Absorbable sutures for corporotomy, dartos fascia, and skin closures

SURGICAL STEPS

A Foley catheter is first inserted into the urethra and the bladder is emptied. A spigot is applied. A Scott retractor is then placed below the penis. A transverse skin incision is made at the penoscrotal junction. The incision can be modified to an inverted T-shape and extended when better corporal exposure is needed during difficult surgery, e.g., when there is corporal fibrosis. The dartos fascia is now exposed and incised. Skin hooks are placed. The tunica albuginea of both corpora are exposed and the urethral catheter is palpated in the midline. This facilitates urethral exposure and minimizes its potential damage. A stab wound is made with a scalpel into each corpora and, using Metzenbaum scissors, a 2-cm vertical corporotomy is performed between two nonabsorbable 2-0 stay sutures. Corporal dilatation is performed and directed laterally to avoid urethral injury. The corporal space is dilated with Brook's dilators or Hegar dilator from 10 mm up to 14 mm. Proximally, the dilator can be felt to hit on the ischiopubic ramus. An equal depth of the dilators should be achieved when performing proximal dilatation; this ensures that proximal perforation is highly unlikely. Both corpora are irrigated with antibiotic solution. Distally, the glans of the penis is palpated until maximal limit of dilatation is achieved by feeling the tip of the dilator bilaterally. At each side, a measurement is recorded proximally and distally each towards approximately mid-point of the corporotomy incision and, added together which determines the final length of the cylinder implant. There should be no more than 1 cm discrepancy between the two sides. Cycling of the connected corporal cylinders and pump is performed two or three times using sterile saline. This ensures the removal of any air bubble. The connecting tubes are gently clamped with rubber-shod clamps. The same preparatory steps are repeated for the reservoir. The rear tip extenders of the cylinders are attached at this stage when needed. The proximal part of the corporal cylinder/rear tip extender is inserted first, and the back of a DeBakey forceps may be used to facilitate a gentle pushing into the corporal space. Then, the Furlow instrument is inserted distally and laterally to avoid any 'crossover' into the contralateral corporal space. The Furlow is used to pass the Keith needle at the tip on each side to facilitate the distal placement of the cylinders. The corporotomies are closed using the 2-0 absorbable stay sutures. A subdartos pouch is made for the pump in the middle of the scrotum or the hemiscrotum. A small incision is made through the dartos fascia and a long-blade nasal speculum or ring forceps is used to create the space. The pump is inserted into the subdartos pouch, ensuring that the deflation button lies anteriorly and inferiorly. The tubing from the pump is preferably passed through separate stab

incisions in the dartos fascia to emerge from the posterior aspect of the pouch. The opening of the top part of the pouch is closed with 2-0 nonabsorbable suture. Connection between the tubing of the pump and the cylinders is made. The reservoir tubing from the pump remains intact at this stage. A 50-ml syringe filled with normal saline is attached to the reservoir tubing. This allows testing of the prosthesis cylinders to ensure the function and quality of erection. In preparation for the reservoir placement, the spigot is removed from the Foley catheter and the bladder is fully drained. The size of the reservoir depends upon the surgeon's preference. However, a previous surgery on one side would make placement on the contralateral side preferable. The external ring is identified using a small Deaver retractor and the index finger is used to palpate the spermatic cord, pushing it medially to protect it. A closed Metzenbaum scissors is then used to puncture the transversalis fascia. This permits access to the retropubic space. The index finger is inserted again to create a space. The retropubic location of the space is confirmed by feeling the back of the pubic bone, the symphysis pubis and the Foley balloon inside the bladder. A long-blade nasal speculum is inserted through the created transversalis fascia defect, the blades are gently spread apart, and the reservoir is inserted into the newly created retropubic space. Alternatively, a Deaver can be placed to expose the space to permit placement of the reservoir. The reservoir is then filled with normal saline up to 5 mL above its manufactured capacity. With the tubing to the filling syringe left open, the syringe should spontaneously fill to 5 ml. If it fills more than this, the position of the reservoir space needs to be checked again to ensure that there is no pressure around the reservoir. Some reservoirs have lockout valves to prevent autoinflation. The correct position of the reservoir is confirmed again by palpation and it is ensured that the reservoir tubing is exiting through the transversalis fascia defect. The final connection between the pump and the reservoir is completed and a last check is made of the connections between the three tubes. The rubber-shod clamps are removed and inflation and deflation of the prosthesis is carried out few times to make sure that it is functioning properly. We prefer not to leave a drain routinely unless there is a particular concern, e.g., bleeding. If needed, a drain may be left *in situ* through a separate stab wound incision. The wound is then closed in two layers. The dartos fascia is closed with 2-0 absorbable suture and the skin is closed with 3-0 absorbable suture.

POSTOPERATIVE CARE

Antibiotics

Antibiotics are usually continued for 48 hours

postoperatively. Some surgeons prefer to maintain antibiotics for a week after surgery and a longer period of time after revision surgery or in special circumstances, e.g., previous penile prosthesis infection.

Urinary catheter

The catheter facilitates identification of the urethra and the corpus spongiosum. It can be removed at the end of the procedure or retained for 24 hours after surgery.

Drain

Some surgeons prefer to use a drain to reduce the edema and to facilitate drainage of hematoma when it occurs. These drains are usually removed on postoperative day 1 or day 2.^[6]

Wound care

The penis is positioned over the suprapubic region pointing toward the umbilicus. The wound is covered with gauze and Mefix[®] tape is applied. The patient is reviewed in the outpatient clinic after 2 weeks to check the wound and to rule out autoinflation.

Pain

Pain following placement of a penile prosthesis is subjective and variable. It may be aggravated by preexisting conditions. For most patients, pain is no longer bothersome by 4–6 weeks.

Using the prosthesis

The cylinders are kept inflated for 24 hours and then partially deflated. This facilitates corporal hemostasis. At 4 weeks, the patient is advised to cycle the prosthesis. Patients are taught to operate the inflatable prosthesis at about 6 weeks. Other clinicians may prefer to leave the cylinders inflated for few weeks to allow creation of an adequate capsule, since keeping the prosthesis deflated after surgery for few weeks might result in prosthetic tip retraction under the glans and the creation of a capsule that is too short. A reasonable method is to leave the prosthesis partially (50%) inflated at the conclusion of the procedure; this will encourage proper modeling of the penis and also maintain good hemostasis.

SURGICAL PITFALLS AND SPECIFIC CONSIDERATIONS

Infection

Despite the use of antibiotics and meticulous sterile

environments and improved surgical techniques, infection rates remained relatively stable over decades till the introduction of antibiotic-coated implants. *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Pseudomonas*, and *Candida albicans* are the most common skin-colonizing microorganisms implicated.^[7,8]

It has also been demonstrated that the incidence of infection is doubled (18.8%) in re-operation cases and in secondary implantation, uncontrolled diabetes, and paraplegia, as well as in the hands of inexperienced surgeons.^[9,10] Overall, infection rates are generally 1.8%–10% for first-time prostheses and 7%–21% for replacements.^[11,12]

Regardless of the microbiologic agent involved, it is advisable to remove the infected implant if the patient has not responded to antibiotic therapy. In such cases, all components of the infected implant should be removed to prevent a recurrence of infection. Also, the absence of clinical and microbiological evidence of infection must be ensured before embarking on any further surgery for penile prosthesis. It is essential to advise patients to use physiotherapy with a vacuum device in order to prevent excessive shrinkage of cavernosal tissue and consequent penile shortening.

An alternative to removal of all components and later reimplantation has been described by Mulcahy,^[13] who calls it the ‘salvage or rescue’ procedure. This involves removal of all prosthetic parts and irrigation of the wound with a series of antiseptic solutions, followed by replacement of the prosthesis during the same procedure. It is also demonstrated that the use of systemic antibiotics for 48–72 hours prior to the salvage improves the chances of success, with improvement or resolution of cellulitis suggesting that the chance of the salvage procedure succeeding would be higher. The advantage of the salvage procedure is that most of the length of the penis will be maintained. In addition, it is easier to place cylinders while the cavities in the corpora cavernosa are still open, rather than returning at a later date to create new cavities in the scar tissue.

Type of incision

The penoscrotal approach avoids possible injury to the dorsal sensory nerves, provides easier and more complete corporal exposure, and allows the pump to be anchored in the scrotal pouch. In a review by Montague and Angermeier,^[14] for most primary penile prosthesis patients, the AMS Ultrex[®] prosthesis is recommended because it produces expansion in both girth and length of the penis. In primary patients with long penises and in men

with Peyronie disease, the AMS 700CX[®] prosthesis is recommended. For secondary implants (penile prosthesis reimplantation), the urologist can still offer most of patients the AMS Ultrex[®] device. However, in men with previous urethral erosion or cylinder crossover complications, the recommendation is to use the AMS 700CX[®] prosthesis. When corporal dilation is limited because of cavernosal fibrosis, for instance after removal of an infected penile prosthesis, the smaller size AMS 700CXM[®] cylinders are a better option.^[14]

Cavernosal fibrosis

The multicomponent inflatable penile prosthesis has undergone sequential modifications that have afforded important functional advantages and have greatly reduced the potential for mechanical failure. This was made possible by the introduction of the Ultrex[®] cylinder, which consists of bi-directionally woven Dacron[™] and Lycra[™] layers situated between inner and outer layers of silicone. This allows expansion in girth from 12 mm to 18 mm, while resisting any possible aneurysmal bulge. However, oversizing and deformity maybe encountered. Montague and Angermeier^[14] described a cylinder measurement technique that avoids the problem of oversizing that may occur particularly in the case of the length-expanding Ultrex[®] penile prosthesis, when cylinders that are too long can result in an S-shaped cylinder deformity. These types of deformities are sometimes difficult to diagnose. Wilson and Delk published an outstanding review describing the newer tools and techniques to enhance placement of an inflatable device in patients with severe fibrosis.^[15] This includes the use of specially designed cavernotomes for dilating fibrotic corpora, the use of downsized prosthetic cylinders, alternative procedures to fix cylinders in the face of perforation (as opposed to primary closure of the perforation), and replacing the original cylinders 1 year after the modified cylinders have served as tissue expanders. The cylinder sizing is of great importance.^[15]

Corporal sizing

A 2-cm corporotomy incision is used and the distal measurement is from the distal end of the corporotomy and the proximal measurement is from the proximal end of the corporotomy as outlined earlier within the surgical steps. The two measurements added together determine the total cylinder size. The aim is to insert a cylinder that extends to each end of the corpus cavernosum and lies comfortably inside the open corporotomy. With the cylinder completely filled with normal saline it will be possible to ascertain the final appearance. The use of a cylinder that does not match

the length of the corpus cavernosum may result in the so called S-shaped cylinder deformity.

Difficult corporal closure

Straightforward corporotomy closure can be attained using horizontal mattress sutures or simple closure with absorbable stay sutures pre-placed on each side of the corporotomy before corporal dilatation. This prevents possible damage to the cylinders. When severe intracorporal fibrosis is encountered, corporal dilatation to accommodate the cylinder and subsequent closure over the prosthesis is usually challenging.

Various materials have been utilized to cover the cylinders when primary closure of the tunica albuginea is not possible. These include synthetic graft, tunica vaginalis flaps, processed cadaveric dura mater, processed cadaveric skin, and processed cadaveric pericardium.^[16–21]

Corporal perforation and urethral injury

If corporal fibrosis is anticipated, wider transverse incisions or vertical penoscrotal incisions are the best approach for proximal exposure of the tunica albuginea. With careful dilation of the corpora cavernosa, the majority of the complications can be avoided.

If distal corporal perforation is identified during dilation (e.g., a distally placed dilator comes out the meatus or, when irrigating the distal corpora, the fluid emerges out of the meatus), the safest course of action is to terminate the procedure. An injured urethra should be repaired over a Foley catheter. Another procedure can be re-scheduled after 6 weeks. However, another option in cases of urethral perforation is urethral mobilization and suturing of the albuginea and urethral defect, followed by continuation with the procedure for prosthesis insertion.

If the patient has a previous history of distal perforation or severe distal corporal fibrosis and previous urethral erosion, the urethra should be repaired through a circumcision incision. In addition, the patient should be warned about the possible need for temporary urinary diversion such as suprapubic catheter, vesicostomy, or perineal urethrostomy.^[22] The patient should receive broad-spectrum antibiotics for 3–4 weeks and a retrograde urethrogram should be performed before the catheter is removed.

If distal perforation occurs during the dilatation of the second corpora cavernosum, the injury should be repaired and then either the cylinder can be inserted on the non-perforated side

with concomitant urinary diversion or the procedure should be abandoned and both corpora irrigated with antibiotics.

Proximal laceration of the urethra during scrotal exposure can be repaired, and insertion of the prosthesis may continue. Care must be taken to avoid contacting the suture lines when closing the urethral and albuginea defects before continuation with prosthesis implantation. Correction for proximal perforation has also been attempted with the use of synthetic graft material to form a ‘windsox,’ however, this technique has been associated with significant postoperative graft infection.^[23]

For proximal perforation of the corporal body during implantation into scarred corporal tissues, a sling of nonabsorbable suture through the rear tip extender has been demonstrated to effectively keep the cylinder base out of the damaged tunica albuginea. When this sling is used most authorities advocate that the prosthesis should not be used for 3 months;^[24] This minimizes trauma and early pressure on the prosthesis during the healing process.

Crossover

Crossovers are rarely complete, i.e., with the tip of both cylinders in one corporal body. The corporal septum tends to have windows, and the typical crossover is indicated by an over-and-back movement. Using the scrotal incision and placing the penis on stretch in the Scott retractor helps the surgeon to avoid this over-and-back movement.

If crossover is suspected, both cylinders should be removed, and the corpora cavernosa should be re-dilated proximally and distally with a size 11 or 12 Hegar dilator in the opposite corpora. If the active dilator hits the opposite stationary Hegar, a crossover situation exists and needs to be managed accordingly. One of the techniques is to place the Hegar dilator on the side in which one of the cylinders resided as a reference point, whether proximal or distal. The surgeon then gently re-channels the crossover side, staying lateral and using the stationary Hegar as the reference point. The cylinder is inserted with the stationary Hegar in place. When the cylinder goes in correctly, the stationary Hegar is removed and the contralateral cylinder is inserted. It is not necessary to repair the crossover because the septum of the corpora is variable, has windows, and occasionally is filamentous.

Pump and reservoir problems

There are three reservoir sizes available with the AMS three-piece inflatable penile prostheses: 50 mL, 65 mL,

and 100 mL. The 50-mL reservoir is used for the CXM prosthesis. The 65-mL reservoir is used for the prosthesis and for the two smaller cylinder sizes of the Ultrex® prosthesis. The 100-mL reservoir is designated for the two largest cylinder sizes of the Ultrex® prosthesis. Correct placement of the reservoir into the retropubic space and a back pressure test are mandatory to prevent the problem of autoinflation of the prosthesis.

In special situations, the retroperitoneal space can be extremely fibrotic and the transversalis fascia thickened. This is often caused by previous surgery, such as cystectomy or renal transplantation, or it may be the result of radiation. The surgeon may elect to insert a two-piece inflatable device, make a separate incision for placement of the reservoir, or consider another location for reservoir placement. Paravesical or abdominal placement of the reservoir may be a better option in previously operated patients.

The pump should be placed in a dependent and easily palpable scrotal position. Particular care should be taken to not dissect or tear small vessels in this region as a scrotal hematoma can easily develop.

When replacing the three-piece prosthesis for malfunction, the best way to manage the reservoir of the original prosthesis is still a matter for debate. Removing a reservoir is far more difficult than its initial placement; a self-retaining long-blade nasal speculum may be used for removal of the reservoir utilizing an extended diathermy tip to cut down on the tubing, which is placed on gentle traction. Some surgeons leave the reservoir of the original three-piece device behind after removing the penile cylinders and the scrotal pump of the malfunctioning device. Rajpurkar *et al.* found that retained reservoirs are not susceptible to infection or erosion and can therefore be left behind.^[25]

Revision

Antiseptic washout and mechanical debridement of the bacterial biofilm within the corporal space are the mainstay techniques during revision prosthetic surgery. It is theoretically advisable to remove reservoirs at the time of revision surgery. Alternatively, new reservoirs may be placed in different locations if the surgeon decides to leave the old one behind because of the daunting task involved in removing some of them.

Peyronie disease

When penile curvature is present, whether due to Peyronie disease or other causes, CX prosthesis cylinders have more

straightening properties than Ultrex® cylinders. The former cylinders are used in conjunction with ‘modeling’ of the penis as described by Wilson and Delk.^[15] Correcting the curvature deformity can be attained without the need for plaque incision or excision. It is necessary during modeling to initially clamp the cylinder input tubes to protect the pump from back-pressure flow. The prosthetic cylinders are inflated to high pressure, the input tube is clamped with rubber-shod clamps, and the penis is grasped with both hands and bent over the inflated cylinders at the region of maximum curvature. Bending is maintained for 90 seconds and then relaxed. It is worth noting that simple prosthesis insertion can produce complete straightening in up to 30% of patients. The rest of the patients may require additional procedures for residual curvatures.^[26,27] A recent retrospective study by Garaffa *et al.* reported that modeling alone achieved more straightening on inflatable prosthesis (84%) than on a malleable prosthesis (54%) and procedures such as tunical plication or incision, with or without graft, can be used for any ventral curvature that persists after modeling.^[28] In another study, Levine *et al.* reported a single-center experience with IPP and straightening maneuvers as necessary in 90 men with medication-refractory ED and Peyronie disease.^[29] Additional intraoperative maneuvers used to straighten the penis following placement of the prosthesis included manual modeling, plaque incision and, if the defect created with incision was greater than 2 cm, an off-the-shelf human processed pericardial graft. In their study, IPP placement allowed reliable and satisfactory coitus for the great majority of men (91%). Mechanical failure was reported in 7%.

Patients with special conditions

For patients with complicated backgrounds such as kidney transplant or a neobladder, a simpler prosthesis should be contemplated than the three-piece inflatable penile prosthesis, for example, the two-piece or semi-rigid implant. Another solution is to place the reservoir outside the usual location (outlined above). In such cases, the surgeon makes a second incision and places the reservoir intra-abdominally or in the retroperitoneal space beneath the kidney. Three months after implantation, a tissue capsule would have formed around the reservoir and this will prevent increase in abdominal pressure from causing autoinflation.

Cold-glans syndrome

A common complaint after the insertion of a penile prosthesis is lack of glans engorgement after inflation. In the majority of patients this is due to inadequate sexual stimulation. In some patients, however, the glans is soft

and cold despite proper sexual stimulation. Mulhall *et al.*^[30] found that most patients responded to sildenafil and reported higher satisfaction than with an implant alone. Lledo *et al.*^[31] have also reported similar results.

PSYCHOLOGICAL ASPECTS OF PENILE PROSTHESIS

The relationship between ED and depression is complex. The former may induce the latter and *vice versa*; in addition, there is the possibility that an independent condition, e.g., substance abuse or a medical condition, may be the cause of both problems. When ED causes depression, it is postulated that the causes include anxiety regarding sexual function, poor self-image, and poor self-esteem.^[31,32] Seidman *et al.* reported that men with ED had high frequency of depressive, somatic, and anxiety symptoms and scored very high on measures of overall psychological distress.^[33] It is also important to consider the psychological impact resulting from relational problems when ED ensues. Correcting ED usually brings about significant improvement in the overall sense of wellbeing and minimizes depressive symptoms.

Different treatment options are available for treating ED, and penile prosthesis represents one of these options. These devices have the highest patient satisfaction rates of all available treatments.^[34] It is also shown in many studies that the dropout rates for participants in ED treatments studies was lowest for surgical implants as compared to other modalities of treatment, including systemic oral treatments.^[35] Tefilli *et al.*^[36] addressed the issue of patient satisfaction specifically by assessing psychosocial adjustment to the penile implant at several time points. They used the frequency of intercourse as a global index of therapeutic success and reported improved sexual frequency, decreased depression, decreased anxiety, and decreased anger as patients achieved satisfaction with the overall function and appearance of their penile implant. They also observed that increased sexual activity was accompanied by diminishing concerns about obtaining and maintaining an erection, which in turn had a positive impact on wellbeing and psychological stability.

CONCLUSION

The surgery of inflatable penile prosthesis is a rewarding procedure with a high yield of patient satisfaction and good psychological outcomes. Knowledge of the different varieties of prostheses available and selection of the ideal device for each patient is important. Urologists should also be aware of the many surgical pitfalls that are peculiar to

this procedure and have a thorough understanding of the management of each.

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