Electrosurgery for Cervical Intraepithelial Neoplasia

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Women with cervical intraepithelial neoplasia now have a number of treatment options including cold-knife conization, laser ablation, and loop electrosurgery but, all too often, the physician’s preference is the determining factor in selection of therapy. This detailed presentation of the advantages and disadvantages of electrosurgery will help the physician to decide whether this procedure truly fits the needs of a given patient.

Most women with cervical intraepithelial neoplasia (CIN) are of childbearing age, and want to preserve their fertility. In addition to sparing reproductive capability, treatment for CIN must also achieve an acceptable cure rate, minimize immediate side effects, and avoid anatomical compromise with stenosis or an incompetent cervix. Although nitrous oxide cryosurgery remains the mainstay of therapy for ectocervical intraepithelial neoplasia, the electrosurgical loop procedure meets all objectives when conization is required. Moreover, using electrodes of various sizes allows the physician to tailor the amount of tissue removed to the patient’s individual needs.

BACKGROUND

Cold-knife conization is effective for deeper endocervical disease, but has been associated with a high level of intra- and postoperative bleeding and subsequent low-birthweight deliveries.

The advent of laser ablation for ectocervical disease and laser-assisted conization for endocervical disease offered substantial improvements. While there has been much debate over the use of cryotherapy versus laser therapy, laser destruction of the entire transformation zone has shown a better cure rate for high-grade lesions covering more than one quadrant of the cervix. However,
Laser is associated with increased cost and complexity when compared with cryotherapy or cold-knife conization.

The loop electrosurgical excision procedure (LEEP) has improved the management of CIN still further. Indeed, it has even been predicted that cervical loop electrosurgery would replace laser and cryotherapy for the treatment of most cases of cervical dysplasia, and this expectation has been realized in many instances. Today, LEEP is the most common method for managing CIN in Great Britain and France.

LEEP is not necessarily the same as conization. For example, ectocervical LEEP sampling removes only the distal 8 to 10 mm of cervical tissue, limiting complications in patients who need no further exploration. It would be nearly impossible to perform a similar flat conization with the cold knife or laser. A deeper conization may be performed by taking a second endocervical sample usually using a smaller loop after the initial ectocervical sample is obtained. Such an electrosurgically assisted conization procedure has been termed a cowboy-hat configuration to describe the resulting cervical defect (Figure).

**EQUIPMENT**

The equipment requirements for LEEP are listed in Table 1. Electrosurgery units (ESUs) generate the current for LEEP cutting and coagulation. When the radiofrequency current is passed through the wire loop, the energy is transferred to the adjacent tissues. The loop of wire does not become hot until it comes into contact with tissue, whereupon the intracellular water boils spontaneously. Only the cells in close proximity to the loop are affected.

Modern ESUs offer three variable current settings i.e., cutting, blended cutting, and coagulation obtained by changing the current’s waveform. A continuous, high-frequency current provides for pure cutting, while coagulation requires short, interrupted bursts of current. Combining these two currents produces a blended effect that allows for both efficient cutting and limited coagulation to control bleeding. The frequency varies from 500,000 to 4,000,000 cycles/sec. ESUs are generally maintenance-free, and are relatively inexpensive compared with laser units.

The electrosurgical effect on the target tissues depends on five factors the time in contact with the wire loop.
tissue, the intensity of the current, the frequency of the current, the waveform of the current, and the electrode size. By regulating these factors, the surgeon can excise tissue with minimal damage while allowing for adequate histologic evaluation. The more advanced ESUs have microprocessors that adjust power output to maintain a constant preset level; as tissue resistance changes during the procedure, the output is automatically varied to maintain a uniform cut.

The electrode tips are made of stainless steel or tungsten wire, and some have an adjustable depth gauge. The loops vary in width from 5 to 25 mm; loops of 15 to 20 mm are used for ectocervical excisions, while endocervical samples are usually obtained with 10 mm loops. The depth of the loop can range from 5 to 15 mm, with depths of 7 to 10 mm correlating with the depth of the cervical glands. Loops are designated as either round (R) or square (S), followed by numbers designating the width and depth. Thus, an R2010 loop would be a round loop that is 20 mm wide and 10 mm deep. Ball electrodes of 3 to 5 mm are used to coagulate the residual tissue and control postexcision bleeding. Electrode tips can be either reusable or disposable; reusable electrodes must be monitored carefully for signs of breakage or carbon build-up.

Smoke evacuators are essential to maintain visualization of the cervix, and their filters and tubing must be changed on a regular basis to ensure optimal operation and reduce the possibility of aerosolized pathogen exposure from evacuated viruses. The consequences of inhaling this material are unknown, but most viruses can survive electrosurgery. Human papillomavirus (HPV), hepatitis B virus (HBV), and human immunodeficiency virus (HIV) have been found in the LEEP smoke plume, but no infections have been directly attributed to such exposure. However, it has been suggested that patients with HIV should not undergo laser or LEEP procedures owing to the risk from aerosolized pathogens.

Most manufacturers recommend the use of insulated instruments for cervical electrosurgery. Insulated speculums are covered in a rubbery, nonconductive material to prevent complications when the activated electrode touches the instrument surface. Companies offer reusable insulated LEEP speculums, as well as disposable, single-use vented speculums. Laser speculums are not suitable for LEEP, as they reduce light reflection but not electrical current. It must be remembered that if the nonconductive speculum coating is torn on the surface in contact with tissue and the electrode touches any other breach in the coating, the entire electrical charge will exit through the exposed metal into the tissue causing severe vaginal burns. Thus, the coated instruments must be inspected prior to each use. However, if the electrode tip touches a noncoated speculum, the charge is dispersed over a large area and produces no harmful effects.

**INDICATIONS**

The uses and indications for LEEP have evolved rapidly over the last decade. While some authors advocate restricting LEEP to conization, most feel that routine ectocervical LEEP excision is appropriate for patients with ectocervical dysplasia. The current indications for LEEP are outlined in Table 2, and the contraindications are listed in Table 3.

Many physicians prefer LEEP over cryosurgery and laser for managing ectocervical disease. The complications of cold-knife conization and the expense and difficulty of laser are well documented,
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as are the effectiveness, low cost, and low complication rate of LEEP. With cryosurgery and laser ablation, the operator must be an expert colposcopist to avoid missing microinvasive or invasive cervical cancer, whereas LEEP permits pathologic examination of the excised specimen for missed disease. The surgical margins can also be checked to ensure that they are disease-free. LEEP is also less traumatic to the cervix than cryosurgery, and the tissue heals rapidly with minimal postoperative vaginal discharge.

A see-and-treat approach is appropriate for some patients i.e., a patient who is at high risk or who has an abnormal Papanicolaou smear can undergo colposcopy and treatment in the same visit. By contrast, cryosurgery and laser vaporization must await the results of a colposcopically directed biopsy to rule out the presence of invasive disease. This is important in the management of CIN in third world countries where cervical cancer is associated with high morbidity and mortality, and can also be useful for patients with limited access to medical services or those who are noncompliant with follow-up. However, most electrosurgeons prefer to obtain the results of colposcopic biopsy and endocervical curettage (ECC) prior to performing LEEP to rule out microinvasion and invasive cancer.

Cryosurgery is still preferred for low-grade ectocervical disease when treatment is indicated and for focal low-grade ectocervical lesions. Cryosurgery is not associated with cervical incompetence and severe bleeding, and less tissue is removed (3 to 5 mm versus 7 to 18 mm).

In addition, LEEP costs 4 to 5 times more than cryosurgery. Laser units cost about 10 times more than ESUs, and laser surgery is more often performed in an ambulatory surgery setting which is more expensive than an office procedure. Histologic review of tissue specimens also adds to costs. Thus, LEEP has economic benefits over laser vaporization, but is more costly than cryotherapy. Cryosurgery is indeed effective for managing low-grade, single-quadrant cervical lesions, but cure rates decrease sharply as the severity and size of the lesion increase. Laser was previously thought to be effective here because the lesion could be vaporized selectively, but the ensuing high recurrence rates led surgeons to prefer removal of the entire transformation zone. With the destruction of the entire transformation zone by laser therapy, cure rates rose to 95%. This experience also applies to LEEP and cryotherapy, where the goal of therapy is removal of the entire transformation zone and any abnormalities identified on colposcopy. Excellent cure rates have been reported with LEEP.

The management of ectocervical CIN by laser or cryosurgical ablation requires prior colposcopy with visualization of the entire squamocolumnar junction and transformation zone, and the entire lesion must be viewed both medially and laterally before treatment. Endocervical curettage results must be negative for dysplasia in the endocervical canal. Moreover, the colposcopic impression, histologic biopsy results, and ECC and Papanicolaou smear findings must correlate within 1 of difference. There must be no suggestion of glandular involvement with dysplasia or of invasive cancer on the Papanicolaou smear or histologic specimens. For cryosurgery, the instrument tip must provide adequate coverage of both the transformation zone and the lesion, and patients must be compliant with follow-up. Conization is indicated for cases that do not meet all of the criteria for ablation, and LEEP is generally the preferred method.

**PREGNANCY**

The management of cervical microinvasive carcinoma during pregnancy is frequently associated with significant morbidity, and the tissue changes of pregnancy interfere with diagnostic sampling. The morbidity of LEEP during pregnancy appears to be similar to that of cold-knife conization, and occurs primarily when the procedure is performed in the third trimester. Limited studies suggest that when the patient absolutely must undergo a procedure for invasive cervical cancer during
pregnancy, cold-knife conization is preferred. If possible, it is best to wait 3 months postpartum to perform any conization procedure.

**PROCEDURE**

**Consent**
Before performing LEEP, the patient must be informed of all possible risks, benefits, and complications, and her consent is obtained and documented by signature. Educational diagrams and color pictures are helpful in explaining the procedure. The potential for bleeding, stenosis, infection, disease recurrence, postoperative pain and discharge, and cervical incompetence with pregnancy must be clearly defined. The absolute necessity for follow-up should be emphasized. Complications are more common in patients who require deeper endocervical sampling.

**Timing**
It is important to rule out the presence of pregnancy. LEEP is best scheduled when menstrual flow is not occurring so that postoperative bleeding can be monitored. Optimal timing of the procedure is within 7 days of completion of the menstrual cycle, or at least 4 days in advance of the next menstrual period. After LEEP, there may be significant cervical swelling that could occlude the endocervical canal and lead to retained menses. Performing LEEP right after menses minimizes the likelihood of pregnancy and reduces the chance that postoperative bleeding will be confused with menstrual flow.

**Anesthesia**
Because uterine cramping and local pain can occur during LEEP despite local anesthesia, use of preoperative ibuprofen or another nonsteroidal anti-inflammatory drug (NSAID) is recommended. Patients who are very anxious may be candidates for anxiolytic agents such as sublingual lorazepam. It is of utmost importance that the patient remain still during the procedure, and use of relaxation techniques and constant patient monitoring can be helpful here.

The most common anesthetic for LEEP is lidocaine with epinephrine; injectable vasopressin is occasionally used to assist with hemostasis. A long needle is required to inject local anesthetic into the cervix. A simple method involves a 3-in needle extender applied to a 5-mL syringe. A needle is attached to the end of the extender to facilitate submucosal infusion of anesthetic into the cervix. A 25- to 27-gauge needle is usually adequate; a 20- to 25-gauge spinal needle can be utilized, but may be slightly more costly. More costly still is the use of a Pitockey needle, but this allows for optimal control. Deep injections are not required to obtain total pain relief.

There are numerous techniques for anesthetizing the cervix. The paracervical block places anesthetic into the 3- and 9-o clock (or 4- and 8-o clock) positions, but this is painful and difficult and provides no advantage over local infiltration. A circumferential infusion of anesthetic to a depth of 5 to 7 mm is more common; blanching of the cervix provides a gauge as to the extent of anesthesia. With any method, careful aspiration is required prior to injection to avoid placement of anesthetic in a large vessel. A patient receiving a submucosal injection of 5 mL of 2% lidocaine with epinephrine can expect to experience mild to moderate pain that has been reported at a level of 2 on a scale of 1 to 10. Such local anesthesia allows for a well-tolerated procedure in the office setting, eliminates the risk of general anesthesia, and markedly decreases cost.

**Procedure**
The patient is placed on the examining table in lithotomy position. LEEP is generally performed under colposcopic guidance. Full-strength Lugol’s solution which lasts longer than acetic acid is applied to the cervix; all nonstaining tissue will be removed. The grounding pad is placed on the lateral thigh, buttocks, or small of the back, making sure that there are no gaps between the patient’s skin and the pad. Maintaining proximity to the gluteal area will reduce the amount of resistance caused by transmission through tissues.

Either a blended or a cutting current is selected at a setting of 35 to 50 W. For electrodes that are 10 to 10 mm or smaller, a setting of 25 to 35 W is recommended, whereas larger electrodes (20 to 10 mm) should be set at 40 to 60 W. If a pure cutting mode is used, the same or slightly lower power settings will suffice, reducing tissue damage and artifact even further.

The power settings must also be adjusted in accordance with the electrode tip size, the effects of aging on the cervical tissue, and any fibrous scarring from previous procedures. For example, ectocervical excision may be performed at 50 W, and then endocervical excision performed at 40 W with the smaller electrode. The key to selecting the correct power level is the ease of excision; the correct power level will allow for the electrode to pass easily through tissues. When the power setting is too low, the electrode will stall, perhaps leading to avulsion of blood vessels and perioperative bleeding. A power level that is too high will produce excess heat and marked sparking,
charring the pathologic specimen and causing the patient to feel a warm or burning sensation. Finally, the ESU is set for coagulation to control bleeding in the remaining cervical stump using the ball electrode at 25 to 50 W.

Refinements
There are variations in the technique of passing the loop through cervical tissues. It can be pushed perpendicularly into the cervix just lateral to the transformation zone, drawn across the cervix, and then pulled out perpendicularly on the other side. This produces a different specimen shape than if a sweeping, saucer-shaped excision is performed. As the cervical glands penetrate 5 to 8 mm into the surface, a saucer-type excision may leave portions of these glands behind but it also reduces the incidence of postoperative bleeding. A shallower saucer excision is suitable for removing large, low-grade lesions. Deep excision of large lesions can lead to cervical exoneration i.e., removal of almost all cervical tissue often leading to a higher incidence of incompetent cervix and postoperative bleeding. Most surgeons direct the deepest portion of the excision to the central part of the cervix, at the os.

Multiple passes may be needed to remove large lesions. Although ectocervical and endocervical specimens must be kept separate, all fragments of ectocervical tissue may be placed in a single container. The surgeon must promote direct communication with the pathologist to meet particular tissue preparation and orientation needs. Most laboratories have abandoned reporting the location of positive margins, as location does not affect follow-up or outcome.

If the ECC is positive or if white epithelium is noted in the canal after the ectocervical excision, then a second narrower, deeper endocervical excision of 10 3 10 mm is obtained (cowboy-hat excision). The endocervical procedure involves the perpendicular placement of a wire loop just outside the canal that is then brought across the canal and withdrawn directly perpendicularly.

Once the deeper excision is completed, the canal is again inspected for the presence of residual disease. If white epithelium is still visible, a second or even third excision may be necessary to remove all abnormal tissue. It is rarely necessary to remove more than 15 mm of tissue from the endocervical canal after the initial 8-mm excision is completed. If deeper endocervical excisions are required, it is probably best to reduce the depth of each pass to 4 to 5 mm.

Following endocervical excision, colposcopy is repeated and the limits of the lesional tissues are revealed. If no endocervical lesional tissue is visible, the procedure may continue with electrocautery of the remaining surgical stump. Some surgeons perform an ECC in the remaining endocervical canal; the need for this is debatable, but it may help to predict recurrence.

In most cases, there is minimal bleeding (less than 1 to 2 mL) from the remaining cervical tissue. Bleeding from the injection site may be more prominent than that from the base of the excised cervix. If there is significant bleeding after LEEP, the surgeon can focally inject 1 to 2 mL of lidocaine with epinephrine to control bleeding sufficiently to allow for coagulation.

Once all excisions have been performed and the ECC is completed, the base of the cervix is cauterized with a 3- to 5-mm ball electrode at 30 to 50 W. The entire base is cauterized until dry. The margins of unexcised ectocervical tissue are also cauterized to a width of 0.5 cm laterally from the margins to help destroy any minor residual disease and maintain visibility of the squamocolumnar junction after healing. Deep coagulation into the remaining endocervical canal must be avoided, as this may retard the regeneration of columnar epithelium at the cervical os and possibly increase cervical stenosis. Once coagulation is completed, Monsel solution (ferric subsulfate) is applied to minimize further bleeding. Hemostatic sutures are generally unnecessary. The patient is monitored postoperatively for signs of bleeding.

Postoperative Instruction
Following the procedure, the patient is asked to refrain from vaginal intercourse and lifting objects weighing more than 20 lb for 3 to 4 weeks. Straining (e.g., to defecate) should also be avoided. Any bleeding greater than normal menstrual flow should be reported to the physician, as should foul-smelling discharge that persists for more than 3 days. Infection is extremely rare, but patients may develop cervicitis that responds well to acidification of the vagina with boric acid or Trimosan pH 4 Gel (pH 4 vaginal gel).

Postoperative education also includes informing the patient of her lifetime risk of developing cervical, vaginal, or vulvar cancer. Smoking and the use of tobacco or other drugs (e.g., crack cocaine and IV drugs) should be addressed at this time. Sexual transmission of HPV is always possible, even without obvious disease, so monogamy and the use of condoms with new sexual partners should be encouraged. The physician may wish to ask the patient to return to the office in 4 to 6 weeks to discuss the pathology report and check for healing and stenosis. A 4- to 6-month
follow-up is needed for a Papanicolaou smear, and colposcopy should be performed at 6 to 8 months for high-grade lesions. At least 3 Papanicolaou smears should be obtained during the 12 to 18 months following LEEP.

**COMPLICATIONS**

**Bleeding**
Approximately 1 in 500 patients will have significant bleeding during or after LEEP.4,5 The most likely area of hemorrhage is at the 3- and 9-o clock positions, where the cervical arteries are located. The 6-o clock position can also be a source of excess bleeding. Diffuse, significant bleeding is more common in patients less than 3 months postpartum, patients with severe chronic cervicitis, patients with bleeding disorders, and those using aspirin. Bleeding can be controlled by pressure and repeated coagulation. Most ESUs will not coagulate through a pool of blood, especially when it is flowing rapidly. Therefore, a large, cotton-tipped swab is used to dry the base of the cervix prior to electrocauterization. If direct pressure fails to tamponade the bleeding, infusion of 2% lidocaine with epinephrine can produce hemostasis or reduce blood flow that can then be corrected with cautery and application of Monsel solution. If the bleeding continues, vaginal packing can be placed. The patient must then remain supine with her legs extended for 30 minutes to 1 hour. If these methods fail, then a suture ligation may be placed with 2-0 or 3-0 absorbable suture; these materials must be readily available throughout the office procedure. In the rare case of severe bleeding that does not respond to the above treatments, tight vaginal packing should be placed and the patient should be transported to the hospital. Further surgical intervention under more appropriate anesthesia may be required. In extreme cases, operative hysterectomy may be needed to stop bleeding.

Postoperatively, some patients will have bloody spotting for 7 to 10 days, but many women have no bleeding. There is an occasional yellow to bloody watery discharge that is easily controlled with a menstrual pad. The patient must not place anything in the vagina for 3 to 4 weeks postprocedure. The patient should be reevaluated for any bleeding she feels to be excessive, or for the passage of significant clots. This bleeding can usually be controlled with pressure and reaplication of Monsel solution.

**Cervical Stenosis**
Cervical stenosis occurs more frequently in the very young (small cervix) and older (atrophic, estrogen-depleted cervix) patients who undergo LEEP. It is also more frequent in medroxyprogesterone users (lack of estrogen), or if a deep endocervical sample is obtained. Stenosis may be categorized as either complete or anatomic. With complete stenosis, there is neither a visible nor functional opening. In anatomic stenosis, the os is less than 3 mm wide, preventing entry of a standard cotton-tipped swab. Menstrual flow will be blocked by complete stenosis, whereas flow will be nearly normal with anatomic stenosis. Avoiding electrocauterity to the remaining endocervical tissues while extensively cauterizing the ectocervical tissue at the margins may reduce the incidence of cervical stenosis. Using topical vaginal estrogen for 4 to 6 weeks preoperatively in estrogen-deficient women may assist healing and reduce stenosis. Stenosis is resolved by simple endocervical dilation at 4 to 6 weeks postprocedure. In recalcitrant cases, a small loop electrode can be used to excise the os to a depth of 3 to 4 mm. The healing canal then usually remains open, and further cautery should be avoided.

**Postoperative Infertility**
Generally, a single LEEP will not compromise a patient’s ability to conceive or cause cervical incompetence during pregnancy. Depth of incision is a significant factor in cervical incompetence. LEEP usually takes less tissue than cold-knife conization; LEEP excision to a maximum depth of 1.0 cm and a mean frontal ectocervical diameter of 1.8 cm has not been shown to have an adverse effect on subsequent pregnancy outcome or parturition. The risk of cervical stenosis and compromised fertility is higher as more tissue is removed. Removing too much of the cervical canal can also impair sperm transport due to lack of mucus.

**Residual Disease**
The goal of LEEP is to remove all abnormal tissue and the entire transformation zone, but the incidence of residual disease varies from 20% to 30%. Nonetheless, cure rates have been documented at 90% to 95%. When dysplastic tissue is found at the histologic margins, no further immediate surgical intervention is indicated. The surgical base and surrounding ectocervical tissue is coagulated following excision, potentially destroying the areas of residual dysplasia. Thus, electrocautery combined with the reparative and inflammatory response appears to resolve most of
these cases. Positive ectocervical margins after LEEP do carry a higher rate of disease reoccurrence, however. If healing has occurred and follow-up Papanicolaou smears and colposcopic examinations still show persistent disease, further excision of the cervix is indicated. More diligent follow-up is warranted when endocervical margins or ECC specimens above the excision site are positive, or if the woman is postmenopausal and has positive margins. When recurrent high-grade lesions are noted, a hysterectomy may be warranted.

Studies show that positive margins containing low-grade CIN are not associated with clinically significant recurrence. However, higher-grade residual CIN is associated with a higher incidence of disease recurrence especially in smokers. Follow-up Papanicolaou smears at 4, 8, and 12 months and periodic postprocedure colposcopy are imperative to ensure that recurrent or residual disease is detected early.

**CONCLUSION**
LEEP is safe and effective, and has radically advanced the treatment of CIN. Its advantages over other therapeutic options include allowing for pathologic audit of colposcopic diagnosis and histologic adnexal rule out microinvasive disease and confirm excision of the dysplastic lesion and transformation zone; permitting a see-and-treat approach on initial colposcopy; and offering adaptability to all cases of CIN plus the benefits of simple training, inexpensive equipment, low operating costs, and suitability for the office setting. The major disadvantages include potential complications of bleeding and excessive tissue removal and cost exceeding that of cryosurgery. Clinical trials have found LEEP to be faster and easier than laser ablation for treating CIN, with similar complication and success rates and little impact on fertility and pregnancy outcomes. The main concern is that its ease of use may lead to overutilization in evaluating and treating women with low-grade, focal cervical disease.

**References:**


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