



***Radiofrequency surgery:
offering a novel approach to ano-rectal diseases***

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ABSTRACT

Background - Radiofrequency surgery is a method of utilizing high frequency [3.8 to 4MHz] radio wave energy to incise, excise, or coagulate tissues. Radiofrequency (RF) is a relatively new modality that is being used for ano-rectal surgeries with increasing frequency. Radiofrequency energy consists of an alternating current that moves from an active electrode that is used within the area of treatment to dispersive electrodes that are placed on the patient. As the RF energy is applied, frictional heating of tissues results, with cell death occurring at temperatures between 60 and 1000°C.

Objective - This paper discusses pre-clinical and early clinical experience with radiofrequency for various ano-rectal procedures namely hemorrhoids, anal fistula, anal polyps, sinuses and anal papillae. An Ellman dual frequency radiofrequency generator was used to carry out the procedures. This study is intended to be somewhat of a "how we do it" manual, explaining the principles of radiofrequency.

Conclusion - Radiofrequency proctological procedures are simple to perform with many advantages over the more traditional techniques. The procedures take less operative time, the postoperative recovery is accelerated and the incidences of complications are

negligible. Nevertheless, randomized and comparative evaluation with conventional techniques is called for to establish the long-term efficacy and reliability of radiofrequency surgery.

Keywords - *Radiofrequency, Proctology, Electrosurgery, Hemorrhoids, Anal fistula*

Introduction to Radiofrequency surgery

The use of electric currents in medicine has been documented almost since electricity itself was discovered. Low frequency alternating currents are used in physiotherapy for their ability to cause contractions in muscle fibres.

Radiofrequency is a refined type of electro surgery that utilizes a wave of electrons at a frequency between 2 and 4MHz to incise, excise, ablate or coagulate the targeted tissue¹.

Radiofrequency surgery has a lengthy documented history of use in oral, ophthalmic, plastic, and gynecology surgery. It was first used for the treatment of snoring. Gradually, its use in the practice of dermatology², cosmetology, cardiology, neurosurgery, hepatology, and ENT³⁻⁴ procedures gained momentum and popularity. It has multi-faceted usages in the respective medical fields⁵. However, there have been few published reports of its use in proctology.

Surgeons and proctologists have used this instrument very sparingly, and that too more out of curiosity than a serious attempt to utilize its vast potentials. The reason perhaps, might be that they were satisfied with the results of the conventional techniques employed by them, or were not sure about the use of this tool in the ano-rectal surgery for want of sufficient literature on the subject.

For a surgeon practicing proctology, there are few important goals to achieve. The aim of attempting a new technique should be of minimizing tissue damage and obtaining an assured haemostasis during reconstruction, excision, or ablation process.

Radio surgery can simply be termed as an electro surgery at radiofrequency. The term 'radio' is used because the frequency of the device creating these waves is comparable to radiowave frequency used for broadcasting. It is necessary here to dispel any possible misconception about radio surgery by discussing two other, older modalities namely, 'electrocautery' and 'hyfrecation' that are quite different from radio surgery.

Electrocautery involves the passage of low frequency, low voltage, and low wattage alternating current (0.5 – 1.5 MHz) through the electrode, which resists the flow of current and becomes hot. In electrocautery, the heat [rather than the radio wave] is transferred to the soft tissue by convection. Massive cell destruction results from the application of cautery and the destruction caused by this cauterization are equivalent to that of a third degree burn.

While in hyfrecation, a highly modulated high frequency current of low wattage and high voltage is supplied to the electrode, and the surface of the tissue is burnt by a spark which is produced between the tip of the electrode and the tissue. Its effect is mainly superficial and it cannot be used to incise the tissue.

The high frequency radio surgery and its results should also not be confused with diathermy, electric cauterization, or spark producer. With radiofrequency, the targeted tissue temperatures stay localized within a 60-100°C range thus limiting heat dissipation and damage to adjacent tissue. In contrast, electrocautery, diathermy, or laser temperatures are significantly higher (750-900°C) which result in a very high heat propagation, which is far in excess of the desired therapeutic need⁶.

Electro surgical machines operating at frequencies below 3 MHz causes the electrode itself to heat and it has been found that these electrodes, if made of steel, tend to melt away with repeated use. It has been determined that the ideal frequency for achieving effortless cutting of tissues is approximately 4 MHz⁷.

Radiofrequency energy has been used extensively in many different medical applications and specialties for its ability to achieve a precise and controlled thermal ablation of soft tissue. The heat for this ablation is generated by a natural resistance of the tissue, which comes in the path of the waves released through the electrode tip of the device. The cellular water in the soft tissues gets heated and when the temperature reaches 100⁰C, it starts boiling and produces steam, which results in cellular molecular dissolution of individual tissue cells. The cells exposed to these waves are destroyed while the surrounding tissues remain unaffected. This property of radiofrequency eliminates the possibility of undue damage to the normal tissues, while improving the surgical precision⁸.

The radiofrequency unit functions with the active electrode concentrating the high frequency energy at its tip, and then transmitting it to the passive electrode which returns the waves to the unit, making them more effective⁹.

The radiofrequency unit- While there are different radiofrequency units in the market, we found the Ellman dual frequency 4MHz [Ellman International Inc, Oceanside, USA] with a proven and successful history of its efficacy, and being available with a multitude of electrode tips, is quite useful to carry out various proctological procedures. The unit produces output power of 100 Watts



Figure 1: Radio Surgical Unit

at two different frequencies i.e. 4MHz and 1.7MHz. While the frequency of 4MHz is used for four standard settings like: 1. Cutting, 2. Cutting and Coagulation, 3. Pure coagulation and 4. Fulguration; the frequency of 1.7MHz is used for bipolar coagulation¹⁰. The unit has a digital display and audible signal to indicate when the unit is activated. The output power intensity to be delivered through the electrode can be preset between 1 and 100.

The high frequency current delivered by the unit is modified by filtering and rectification to produce one of the four waveforms, namely:

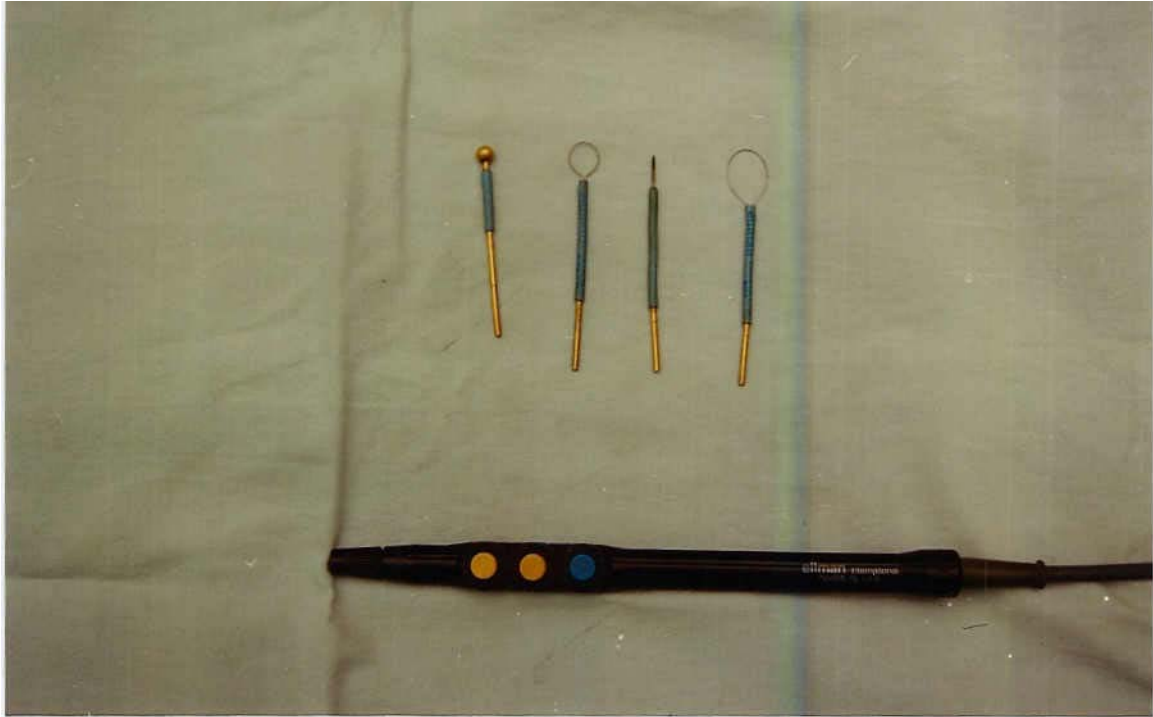
- Fully filtered- suitable for cutting-produces least lateral heat,
- Fully rectified- suitable for cutting but which also produces lateral heat to coagulate,
- Partially rectified modulated-suitable for coagulation and which generates maximum lateral heat,
- Fulguration- spark gap waveform- to produce desiccation or dehydration.

The fifth mode of waveform is bipolar, which is primarily used in microsurgery and as haemostatic current of high precision in wet or dry areas, using a pair of tweezers as electrodes.

An 'antenna' is used to focus the "radio wave" which unlike traditional electro surgical units, does not need to be in contact with the skin of the patient. It could rather be placed in close proximity of the operating field. The unit is activated by a foot pedal. The 'active' or patient electrode is interchangeable with four different modes of activities¹¹.

1. A Needle electrode, which is used for making incisions;
2. Loop electrodes, which are used for excision and shaping tissues;
3. Ball electrode, which is used for coagulation; and
4. Rod electrodes, which are used for fulguration and desiccation of the tissues.

Figure 2- Hand piece and electrodes of the radiofrequency device



We have been working with this equipment for the last 5 years to perform most of the proctological surgeries. The property of simultaneous cutting and coagulation achieved by this machine has attracted us most. Such versatility of the tool is of utmost utility in most procedures performed within the ano-rectal area, which is quite vascular and having very limited accessibility. While operating in such a difficult area, bleeding and oozing from the tissue often hampers clear vision of the operative field, rendering the procedure difficult and a time-consuming job. Radiofrequency surgical techniques successfully overcome these deficiencies.

Indications of 3.8 - 4.0MHz dual frequency Radio surgery -

Radiofrequency surgery can be used to tackle a variety of anal lesions. They include-

- Hypertrophied anal papillae
- External hemorrhoids
- Sentinel tags in anal fissures
- Perianal warts and condylomata
- Rectal polyps
- Fibrous anal polyps
- Perianal and pilonidal sinuses

- Post fissure antibiomas
- Perianal papillomas
- Biopsies
- Fistula in ano
- Hemorrhoids
- Rectal prolapse

Surgical Techniques

Most applications are accomplished with under local anesthesia, short-term general anesthesia or under a caudal block.

While many different electrodes are available with the unit, we could perform most of the procedures using the loop, the ball and the fine needle electrodes.

Hypertrophied Anal Papilla

They immediately disappear on coming in contact with the activated ball electrode in coagulation mode (12).

External Hemorrhoids

Small masses are coagulated with the ball electrode. However, a large sized mass is required to be shaved off with the round loop electrode kept in a cutting and coagulation mode. Any bleeders from the base could well be coagulated with the ball electrode.

Sentinel Piles in Fissure in Ano

Sentinel pile or tags are a common accompaniment of chronic anal fissures. If the tag is small, it could be directly coagulated with a ball electrode. In case it is large, then it is excised with the round loop by first securing the bleeding points and coagulating them thereafter (13).

Perianal Warts and Condylomata

These could be shaved off using a loop electrode in cut and coagulation mode. Once all of them are removed, the operated area is 'sterilized' by rolling a ball electrode on coagulation mode to ensure removal of invisible warts and the viral colony. The intra-anal warts could preferably be coagulated rather than being excised.

Rectal Polyp

It is better if they are dealt with within the anal canal. A longer length ball electrode is passed through the proctoscope, and a coagulation field is encircled around the base of the polyp. The pedicle is then coagulated until the mass is separated. This ensures a negligible bleeding which could be secured by coagulation with the help of the ball electrode in coagulation mode.

Fibrous anal polyps

These are forms of exaggerated anal papillae. These could be coagulated *in situ* using the ball electrode, but when these are large enough, these may be shaved off with a loop electrode after coagulating the base (14).

Perianal and Para sacral Sinuses

These include the pilonidal sinuses, post anal sinuses, and post-traumatic sinuses. Methylene blue dye mixed with hydrogen peroxide is injected in the sinus opening, which spreads out in the sinus tract. The tracts so identified, are then incised and laid open with the needle electrode. The bleeding points are secured by coagulating them with the ball electrode (15). The wound is left open to heal by secondary intension.

Perianal Papillomas

These can precisely be removed using a loop electrode of a suitable size. The raw area left behind may require a touch of a ball electrode in coagulation mode to arrest any oozing from the base.

Perianal Antibiomias

These are also known as antibiotic granuloma, organized abscess, sterile abscess etc. The aim of treatment is to curette the complete cavity, which could be achieved by incising the center of the lump using a needle electrode in cut and coagulation mode. All the granulation tissues, which feel hard with little bleeding, are scrapped out with a round loop electrode until a soft red base is reached.

Biopsies

Biopsies can be performed for suspected growths in and out of the anus. A round loop electrode is the best tool. It should be used on a cutting mode, so that with only a minimum lateral thermal damage, the histology is not distorted (16).

Fistula in Ano

With a needle electrode on cut/coag mode, the fistula tract is slit opened over the director probe, which is inserted in the tract. The edges of the wound are shaved off by the loop electrode to create a pear shaped wound tapering towards the anus. The bleeding points are held in the hemostat and are coagulated (17).

Hemorrhoids

Radiofrequency surgery is useful in the treatment of both, early and advanced grades of hemorrhoids. The non-prolapsing internal hemorrhoids could be directly coagulated *in-situ* with the ball electrode of a sufficient length under a surface anesthesia as an office procedure (18).

The advanced and prolapsing hemorrhoids are first ablated with a ball electrode and then the ablated hemorrhoidal mass is plicated with absorbable sutures to ensure fixation of the anal cushions to the underlying structures. The results of this procedure are more assuring when compared with the conventional surgical techniques (19).

Rectal Prolapse

Radiofrequency has been used as an adjuvant therapy in elderly patients with rectal prolapse. A circumferential coagulation of the anoderm is made with the ball electrode and then a Thiersch's stitch is tied to encircle the anal verge. Radiofrequency coagulation

induces fibrosis and create a zone of band around the anal verge which helps in tightening the anal opening and preventing prolapse (20).

Post-Operative Care

Almost all the abovementioned procedures are carried out as a day care surgery. Analgesics, antibiotics and stool softeners are prescribed according to the requirement. No specific wound care is found needed.

Complications

No major complications have been encountered with these procedures. Few minor ones to mention are:

- Deep dissection can cause more scarring and longer time for healing of the wounds.
- Excessive release of power produces more smoke and charring.
- Accidental burns either on the patient or on operator due to unintended activation of hand piece have been reported.

Precautions to be taken while operating with the radiofrequency unit

Approximately ten seconds should be allowed for the tissues to cool between repeat applications of the electrodes. The two factors, which go to make this a good technique, involve the accuracy in power setting on the unit and the swift action of the cutting stroke.

Radiofrequency procedure should not be employed by, or on anyone who wears a pacemaker. The instrument should not be used in the presence of flammable or explosive liquids or gases. The skin under treatment should not be prepped with alcohol.

If proper settings are not known, the operator should start with a low power setting and cautiously increase power until an ideal cut is accomplished, without a tissue drag and no sparking. The finer the electrode used, the less would be the lateral heat spread and thus causing least damage to the adjacent tissues. It is recommended that a hands-on introductory course be taken before attempting the use of this technology.

Comparison with other equipments

The other equipments used in the field of ano-rectal surgery include the Infrared coagulator, Cryogun, Lasers and Electrocautry^{21, 22}. A brief account of their comparison with the radiofrequency is as below.

RADIOFREQUENCY	INFRA RED COAGULATION
Multiple applications/uses in proctology surgery.	Limited to coagulating bleeding internal hemorrhoids.
Can cut, coagulate or fulgurate.	Can only coagulate.
Low recurrence rate after treatment.	High recurrence rate in hemorrhoids.

RADIOFREQUENCY	ELECTROCAUTERY OR BOVIE
Simultaneous cut and coagulation.	Requires different modes and adjustments for different applications.
Minimal smoke production.	Produces excessive smoke.
Minimal surrounding tissue damage.	Tissue damage like 3 rd degree burns.
Heats tissues below 100 ⁰ C.	Raises tissue temperature above 500 ⁰ C.
Sterilizes tissues under application.	Can cause postoperative sepsis.
Minimal scarring creates soft supple scar.	Gross scarring and fibrosis.
Faster healing.	Slow healing.

RADIOFREQUENCY	CRYOSURGERY
Tissue interaction can be predetermined with power setting selection.	Difficult to achieve precise tissue destruction.
No tissue adherence or charring.	Probes often stick to the site of application and cause detachment of the tissue with bleeding.
Minimal postoperative edema and discharge.	Extensive edema and profuse discharge from the treated area.
Result is immediately visible.	Uncertainty of result due to variable tissue response.
Multiple uses in proctology.	Used for the treatment of hemorrhoids alone.

RADIOFREQUENCY	LASER
Adaptable for multiple uses in proctology.	Limited applications in proctology surgery.
Equally effective for cutting and coagulation.	Good cutting effect but poor coagulation.
Unit cost much less.	High instrument cost.
Portable.	Limited mobility.
Inexpensive treatment.	Costly treatment.
Easy anal canal access due to variable electrodes.	Limited access in the anal canal.
Faster healing.	Risk of misdirected reflected beam and delayed wound healing.

Other advantages of radiofrequency surgery –

Radiofrequency surgery allows cutting without pressure, and, consequently, there is little tissue damage and minimal scarring²⁴. The electrode tip is sterile, as is all the tissue being exposed to it²⁵. Healing is by granulation, with a soft and supple scar²⁶. It could be performed with ease even in the depth and in difficult areas like the anal canal. There are minimal incidences of postoperative infection, thereby achieving faster wound healing with negligible use of sutures etc.

The electrodes are reusable and may be kept in cold sterilization solution when not in use.

CONCLUSION

Use of radiofrequency in performance of various proctology surgeries results in less trauma to the cells, less fibrous scarring and less postoperative discomfort. The procedures are cost effective as no expenses of recurring nature are incurred. The radiofrequency tool having a versatile use in various surgical procedures can prove handy for the practicing surgeons.

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