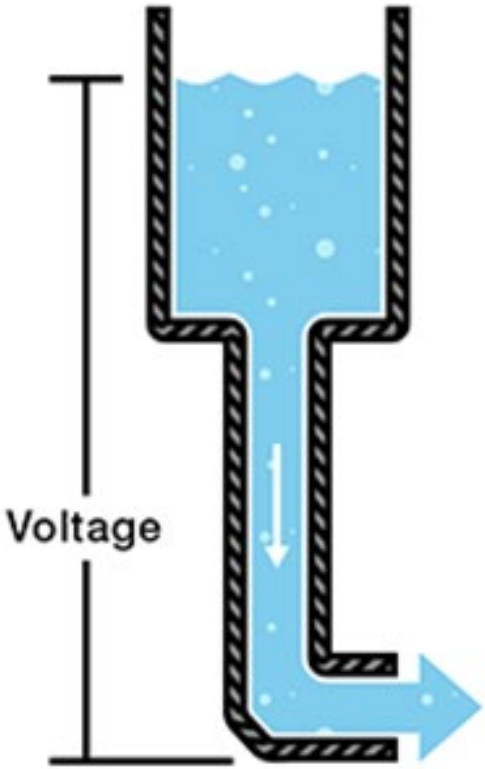
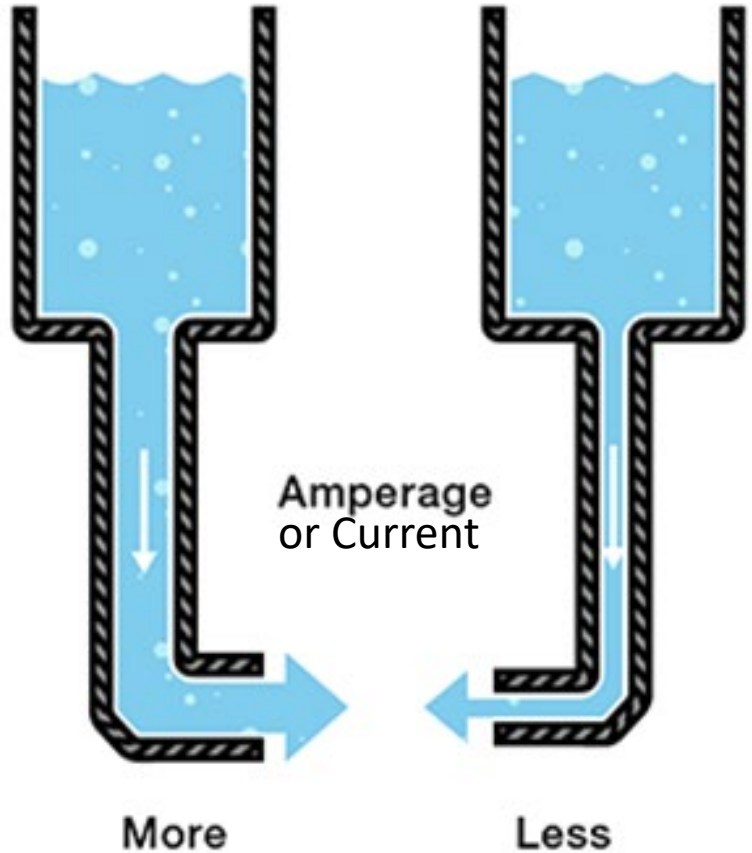
Electrosurgery:
The use of electricity to produce thermal tissue damage.

Matheen Mohamed

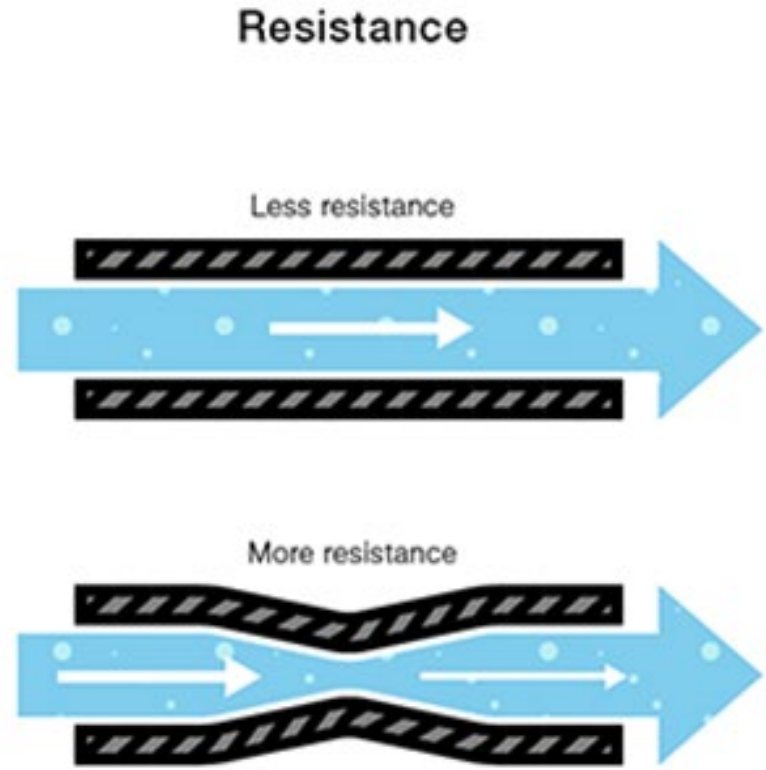
Please read my notes on Electrosurgery (to enhance your understanding of this topic)



“Pressure”



“Volume” of flow
per unit time



Types of devices

Electrocautery (from Greek kauterion = branding iron)

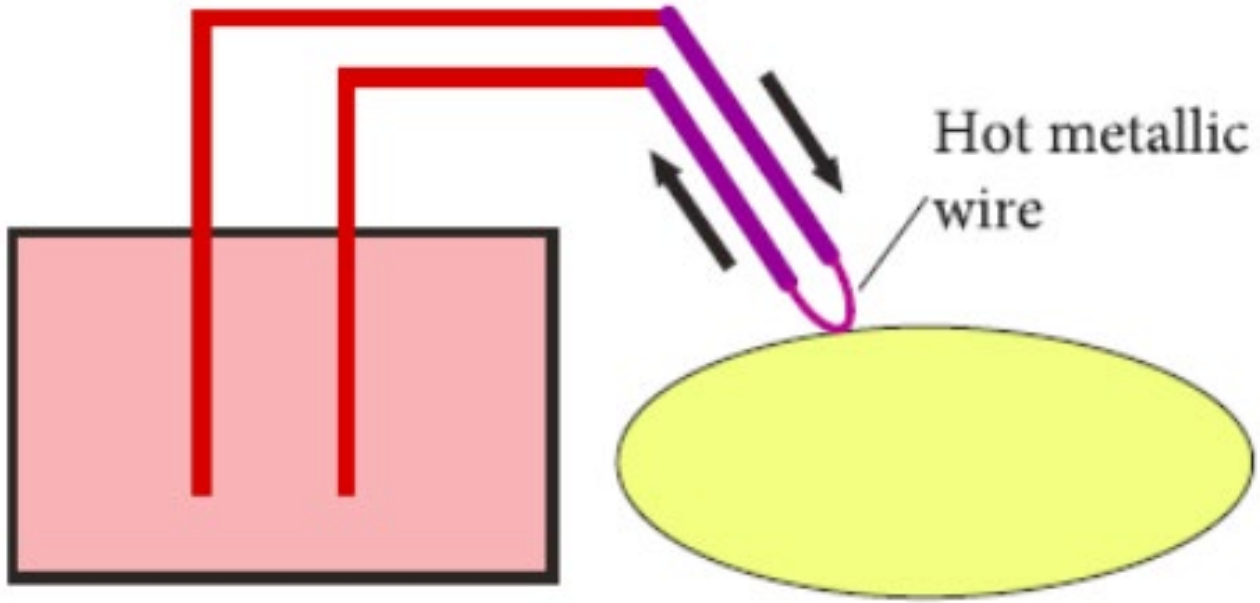
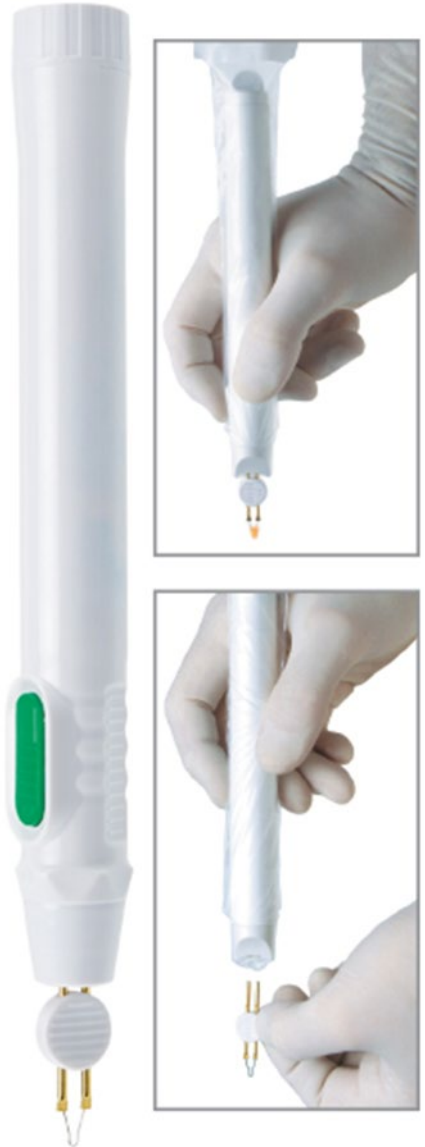


Fig 2. An electrocautery circuit. No current flows through the patient's body. Current heats the tip of the probe, which can then be used to heat superficial tissue layers.



Electro-Cautery
(Thermal Cautery)

High Frequency Electrosurgery: Principle

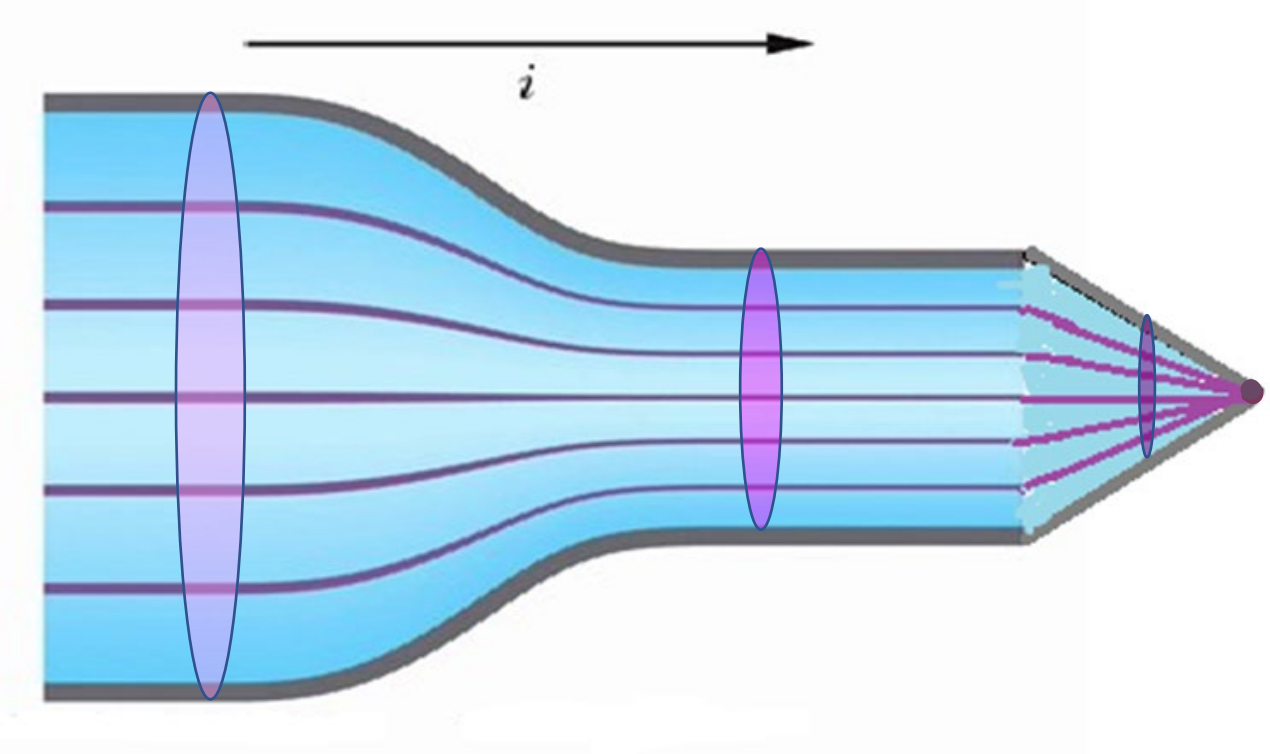
- At Low frequency (eg 50 Hz to <1000 Hz {1KHz}): Neuromuscular stimulation and tetany

- At high frequency >1-100 KHz, N-M stimulation decreases and then become negligible at frequencies 100-300Khz.

- *Principle: As the frequency of the current increases there is not enough time for depolarisation and repolarisation to occur. → makes electrosurgical devices safe & prevents electrocution. Instead heat is produced at the tissue.*

Tissue	Resistance
Dry skin	Very High resistance: charring
Moist/wet skin	Low resistance
Blood	Very Low resistance: hence diathermy ineffective in a bloody field
Fat	High resistance
Muscle	Lower resistance than fat

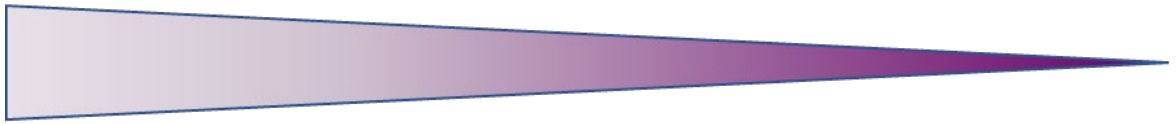
Concept of Current Density (Current Concentration)



The current in the cross-section of a cylindrical conductor is the same at all points.

Current density is defined as follows:

Current density = Current ÷ cross-sectional area of the conductor



The current density increases as the cross-sectional area of the conductor decreases

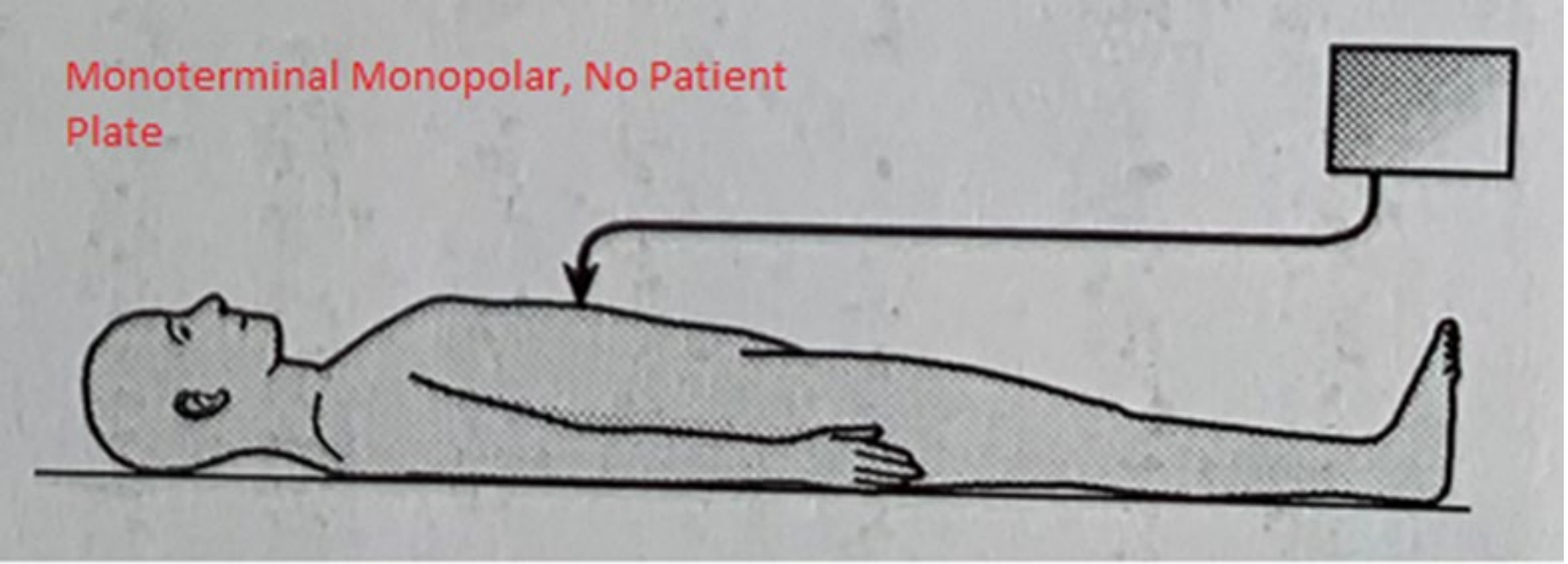
A Sharp or fine tip has higher current density than a blunt tip

A Patient plate has low current density c/w an electrode

Poles versus Terminals

- Poles: the number of "**high current density**" contact points with the patient at surgical site.

- Terminals: the total number of connections to the patient: both high and low current density.

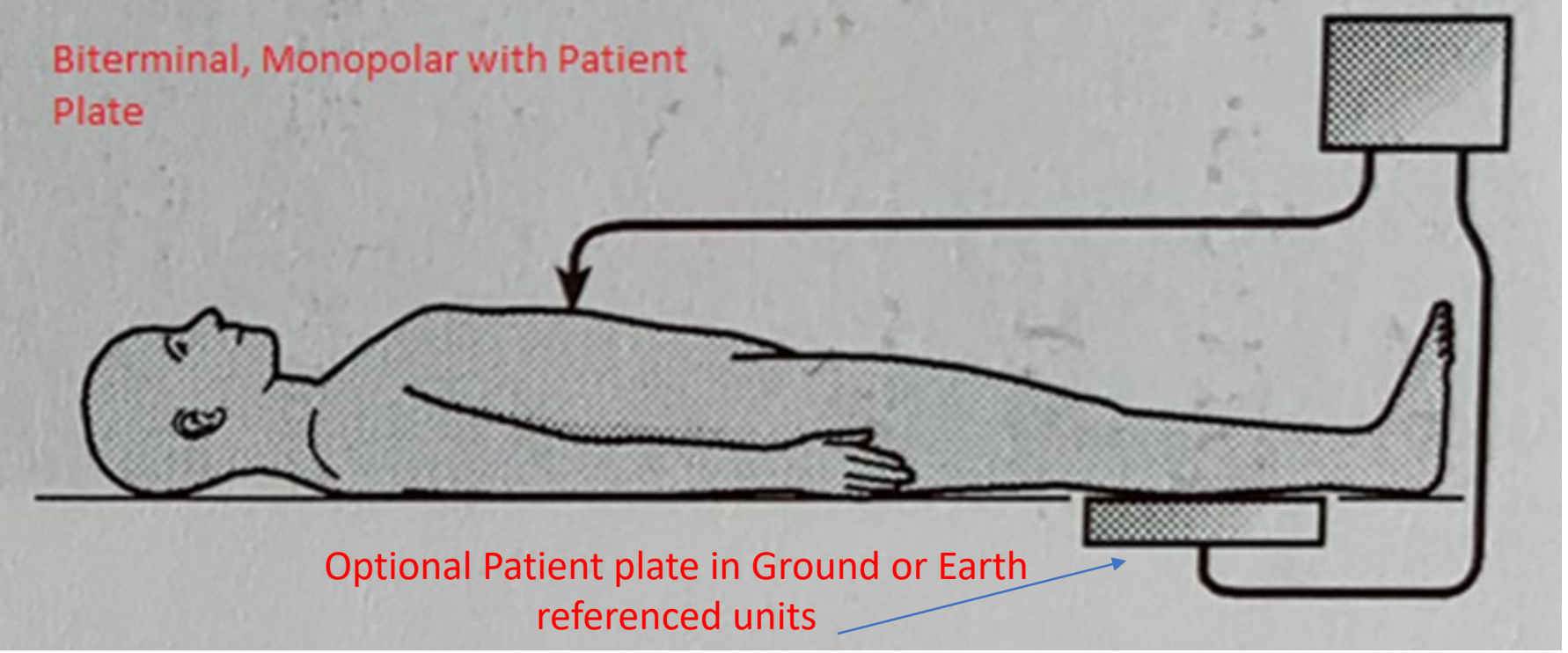


Cutting is not possible with these devices. Only capable of Fulguration (from Latin fulgur = lightning), Desiccation and 'Coagulation' (simulated) . The current dissipates into the body.

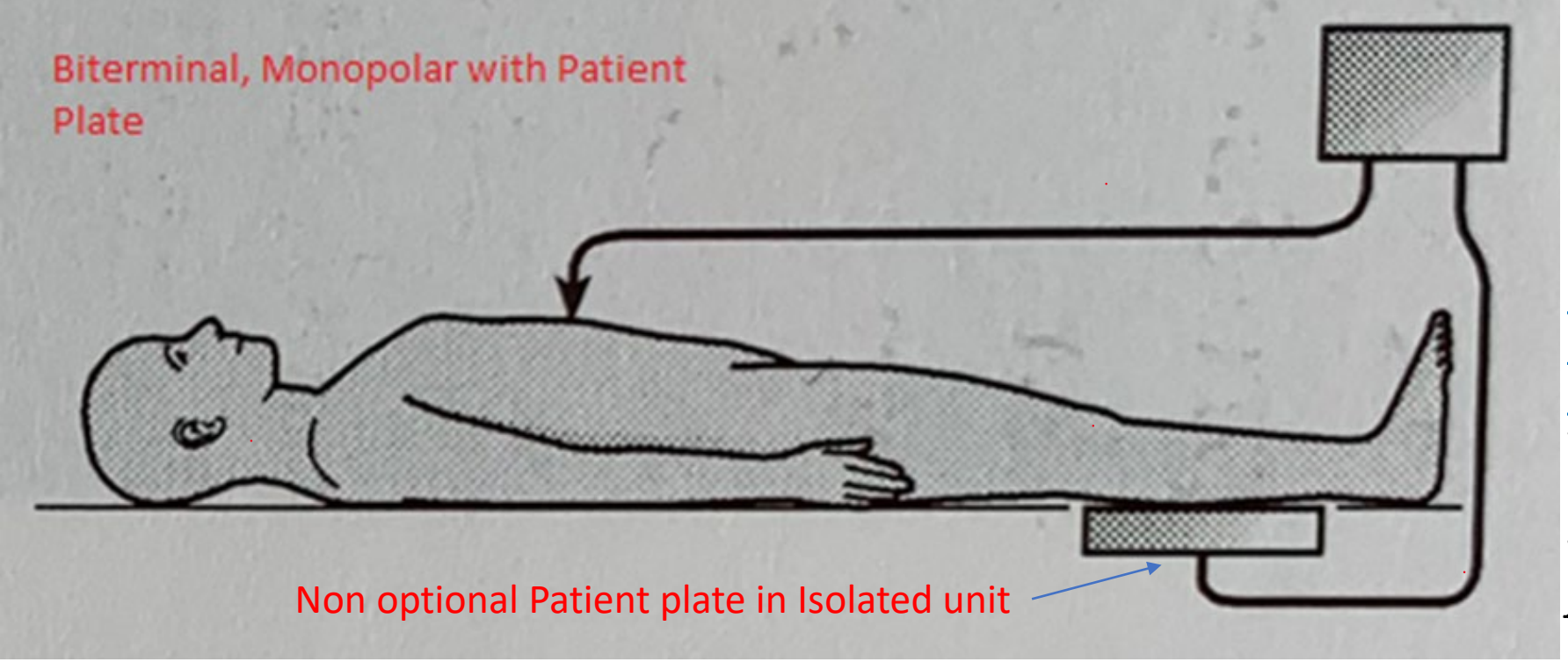

12
ConMed
Hyfrecator 2000
HI
LO
BI
P/P
HI LO BI


AARON 940
HIGH FREQUENCY DESICCATOR
40
Active
Bovie
Power Control
Monopolar
Patient Plate
Bipolar
Footswitch


onopolar
Patient Plate
(Optional)



"Ground referenced" (non-isolated) units such as the ConMed Hyfrecator 2000, Aaron Bovie 940 are capable of this mode but do not produce a pure Cutting or Blended Cutting / Coagulation wave form. They can produce Coagulation with this mode as well as continue to produce Fulguration and Desiccation wave forms.



Monopolar with patient plate using more advanced “isolated” units called “Electrosurgical Generators”: can do all modes including Cutting, Blended Cutting and Coagulation, Coagulation, Desiccation and Fulguration. Eg Ellman Surgitron, Valleylab, Aaron Bovie 1250 or Aaron Bovie 2250. Because they are isolated from the earth, *they can only function if a patient plate is connected.*


Specialist | PRO
1250S
120 WATT ELECTROSURGICAL GENERATOR
120
Bovie
80
Cut
Blend
Coagulation
Fulguration
Bipolar
Power
Return Electrode
Alarm
Foot Control
Monopolar
Bipolar


AARON 2250
ELECTROSURGICAL GENERATOR
Bovie
200
Cut
120
Coag
80
Bipolar

Bovie Generator / High Frequency Desiccator

Hybrid device:
Isolated and Non-Isolated modes are possible

Technical Specifications

The Generator

The left half of the unit is a Bovie generator. It is a floating ground unit that requires a return electrode pad to be used. This isolated power feature helps to ensure your safety as well as that of the patient.

Simplicity is achieved using easy-touch, color-coded membrane pads, and by placing all user controls and outputs on the unit's compact front panel. The ergonomic arrangement of commonly used operating functions, plus a large, comfortable rotary dial, provide quick operating-mode selections and smooth power adjusting with the option of adjusting the power from the handpiece.

Digital Error Detection

Digital error detection means unsurpassed safety for you and your patient. The Aaron 950 continuously monitors every aspect of the unit's output. At the sign of any problem, the machine instantly disables the output and displays the appropriate error code on the display.

Output Power

Generator

Cut	60 watts
Blend	60 watts
Coagulation	60 watts

High Frequency Desiccator

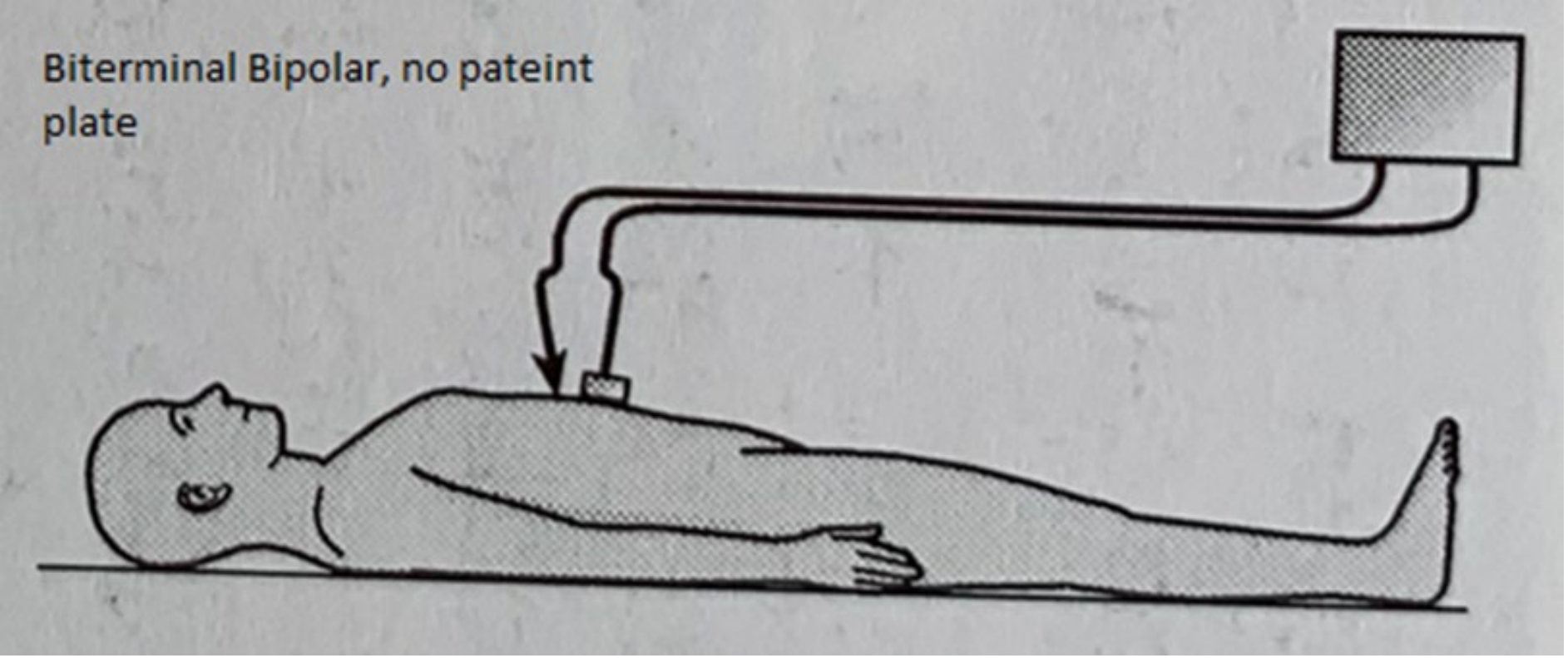
Fulguration	35 watts
Bipolar	30 watts

Line Voltage

A950	120 VAC ± 10%
A950-220	230-240 VAC
Output Frequency	35,000 - 80,000 Hz 350-800 kHz
Line Frequency	50-60 Hz

Available Accessories Include:

» Handpiece (A801-EU)
» Handpiece Drapes (A910)
» Footswitch (A1203)
» Footswitch, Waterproof (A1203W)



Bipolar forceps without patient plate: here one prong of the forceps is acting as the dispersive or return electrode (ie the patient plate) and the other prong as the active electrode.

All of the above devices are capable of this mode (Hyfrecator 2000, all Aaron Bovies as well as the bigger units such as Valleylab and Ellman Surgitron).

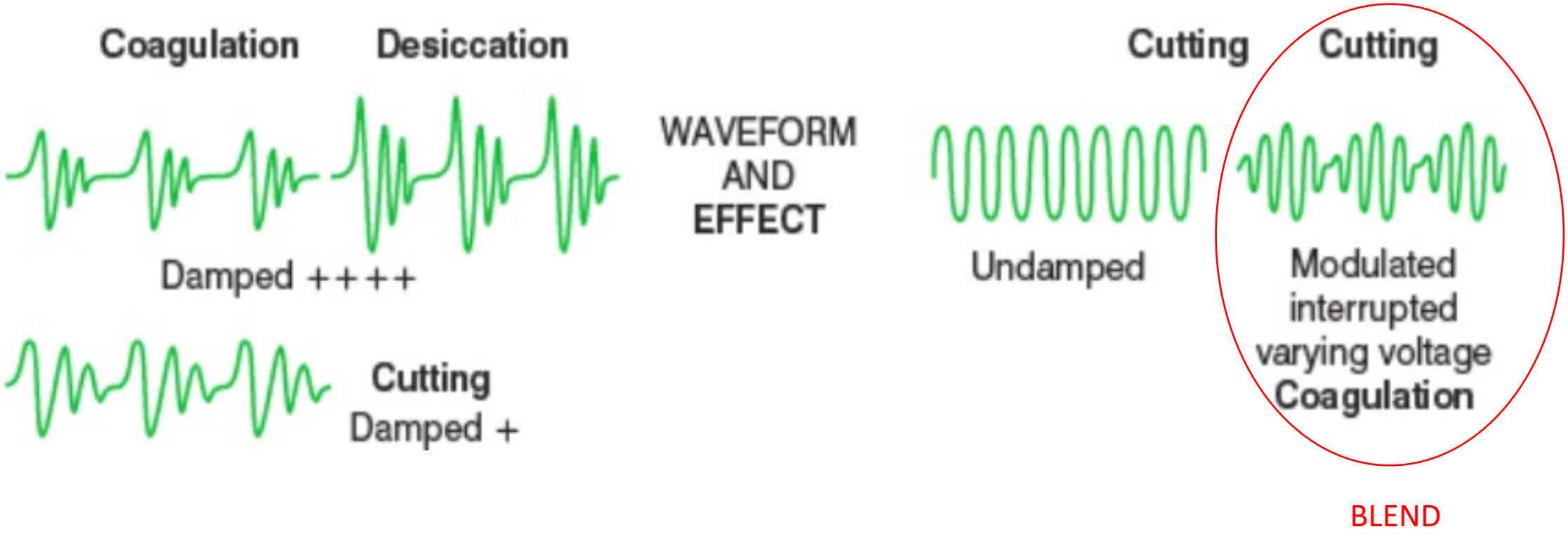
This mode is only good for coagulation.

Gap between electrode and skin: spark → very superficial charring	**Electrofulguration**
Slow heating of tissue with electrode in contact with skin leads to vaporization of the water content and tissue drying	Electrodesiccation
when tissue is heated below the boiling point → undergoes thermal denaturation	Electrocoagulation
A sudden increase in tissue temperature above the boiling point causes rapid explosive vaporization of the water content in the tissue adjacent to the electrode, which then leads to tissue fragmentation and cutting	Electrosection (or Cutting)

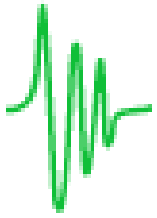
Procedure	Type of current	Mechanism	Voltage	Amperage	Waveform	Effect
Electrofulguration	AC	Alternating current waveform	High	Low	Markedly damped	Superficial carbonisation
Electrodesiccation	AC	Alternating current waveform	High	Low	Markedly damped	Superficial tissue dehydration
Electrocoagulation	AC	Alternating current waveform	Low	High	Moderately damped	Deep tissue coagulation
Electrosection with coagulation	AC	Alternating current waveform	Low	High	Slightly damped	Tissue vaporisation and coagulation
Electrosection	AC	Alternating current waveform	Low	High	Undamped	Tissue vaporisation
Electrocautery (no current passes through body)	DC or AC	direct thermal heating of tip	Low	High	Not applicable	Tissue charring

Waveforms & tissue effects

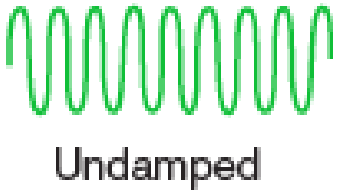
- Waveforms: a pure sine wave with no loss of amplitude with wave progression (Undamped) leads to high heating resulting in pure cutting.
- If the waveform shows a decrease in amplitude as the wave progresses this is known as damping.
- A damped wave usually results in less heat generation resulting in desiccation and coagulation.
- A blended waveform which has slight damping has *both cutting and coagulation* properties.



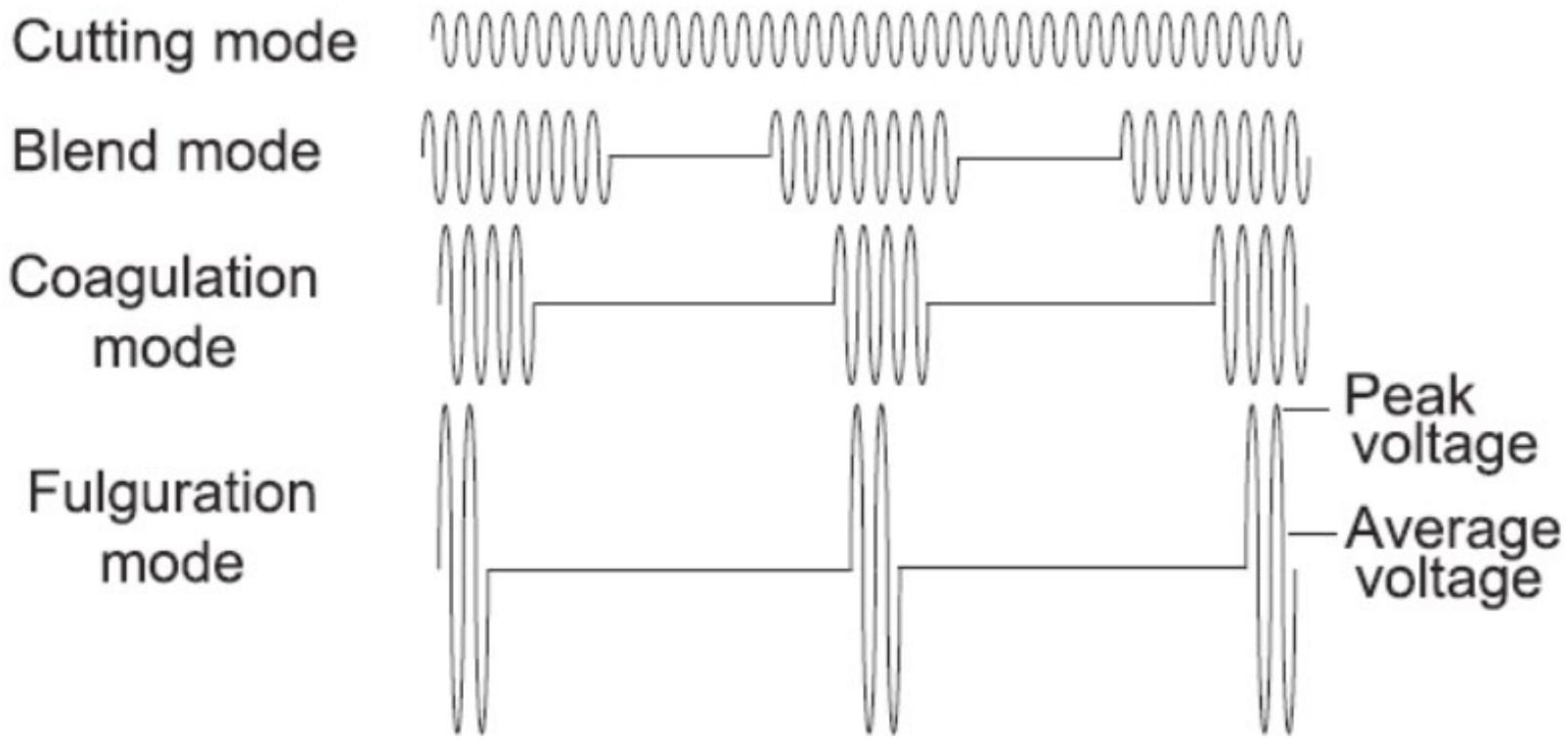
Damping: the reduction in amplitude of a wave as it propagates.



The wave on the left is a damped, whereas the wave on the right is Undamped



Newer units use undamped waveforms for all modes but instead vary the amplitude (voltage) and use continuous or intermittent pulses to produce various tissue effects.



In Theory, the effects of damped currents are the same as interrupted undamped currents

Both coagulation (using a pencil) and cutting generally require a patient plate (indifferent or dispersive electrode).

Without patient plate pure cutting is not possible although some authors claim blended cutting and coagulation at lower power is possible.

Is choosing a low power setting and a longer activation time safer and does it produce the same result as choosing a higher power and a shorter activation time?

NO!

Longer activation times result in more heat conduction and collateral tissue damage before the desired outcome is attained.

Safety

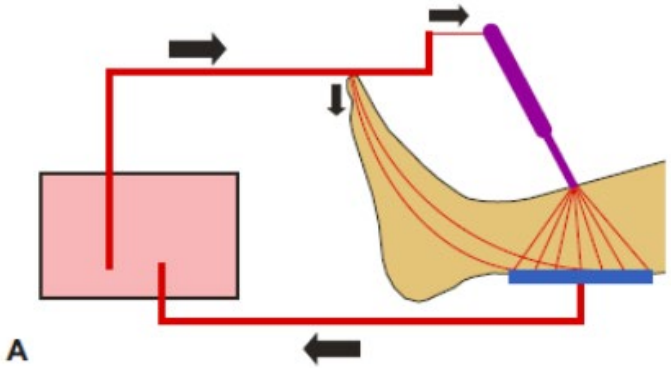
- Operating and electrosurgical unit close to a pacemaker or its leads (within 3-6 inches, 7.5 to 15 cms) can cause interference with pacemaker function including reprogramming (switching from a demand to a fixed pacing output), inappropriate low rate pacing (bradycardia) or temporary loss of pacing (asystole), depleted battery, ventricular fibrillation and other arrhythmias.
- In case of Implanted Cardiac Defibrillators (ICD), electrosurgery can cause the device to discharge.
- Pacemaker failure during dermatological surgery has not been reported but it has for bladder surgery. Newer pacemakers are generally well shielded.

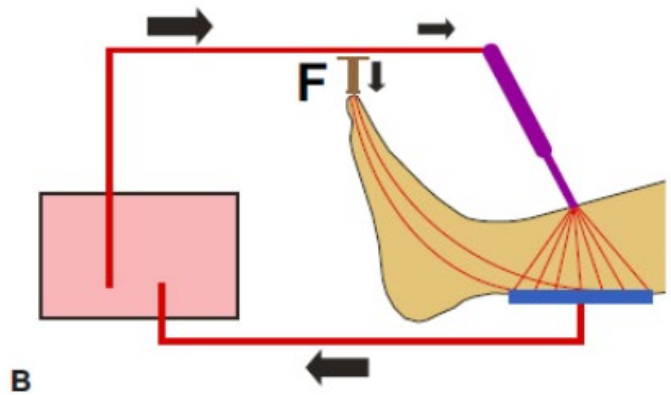
Type of Electrosurgery device/setting	PM and ICD Safety	Modifications and Precautions to increase safety	Comments
Electrocautery	Completely safe	N/A	Poor haemostasis
Electrocoagulation	Safest form of diathermy if used with forceps rather than pencil	Use with Bipolar forceps which does Not require a patient plate: current path is very small between prongs of forceps enhancing safety	If patient plate is to be used, use as for fulguration/desiccation Keep power setting as low as possible & use in short burst <5 seconds.
Electrosection **(really no need to use it as scalpel surgery is safer)**	Less safe than coagulation as needs a plate	Use a conventional scalpel and avoid cutting currents.	If patient plate is to be used follow above comments as for fulguration/desiccation
Electrofulguration & Electrodesiccation: (spreads the current into entire body when no patient plate is used)	Least safe when used without a patient plate. Bit safer with a plate.	1. Use away from PM or ICD, > 6 inches away. 2. Keep power setting as low as possible 3. Use with a patient plate applied away from the heart. 4. Use in short burst <5 seconds each. 5. Use with cardiac rate monitoring.	Pathway of the current from hand piece to patient plate should not pass through the heart

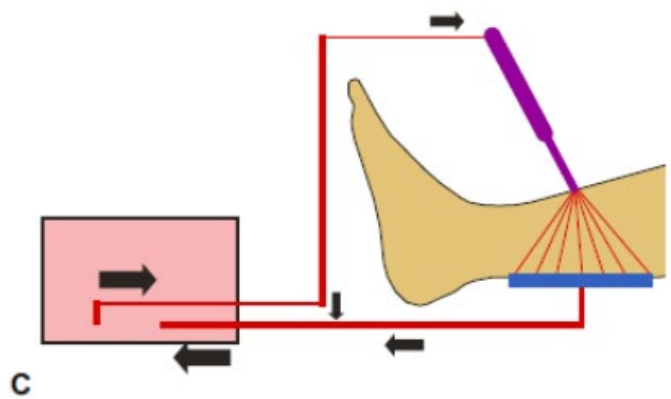
Fire

- There is a risk of fire or explosion if electrosurgical procedures are conducted in the presence of alcohol, oxygen, or bowel gases (methane).
- Bowel gases are highly flammable! Use care in the perianal region or wet pack to cover anus.

- Of note, aluminium chloride solutions used for haemostasis can contain over 90% alcohol. Confirm any alcohol-containing skin preparation has completely dried before proceeding.







In Biterminal Monopolar:

- Current leakage in electrosurgery circuit. Current leakage from active electrode cable to the patient's body may result in a burn.
- Pealing off of the Patient plate can lead to burns.
- Newer "split pads" which measure impedance across the 2 sections of the pads minimize this possibility

In Monoterminal, Monopolar: Accidental burn at the point at which it leaves the patient's body or enters the surgeon's body (usually into the fingers via a small hole in the gloves).

Other issues

- Microorganisms
- Smoke

Practical Use

- Power setting for Desiccation and “Coagulation” of BV: 12-20 watts
- Power setting for Rx of DPN: 0.4 watts to 2 watts
- Power settings for raised seborrhoeic keratoses of face: 0.5 to 3 watts