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Belgian Society of Gastrointestinal Endoscopy

HUman

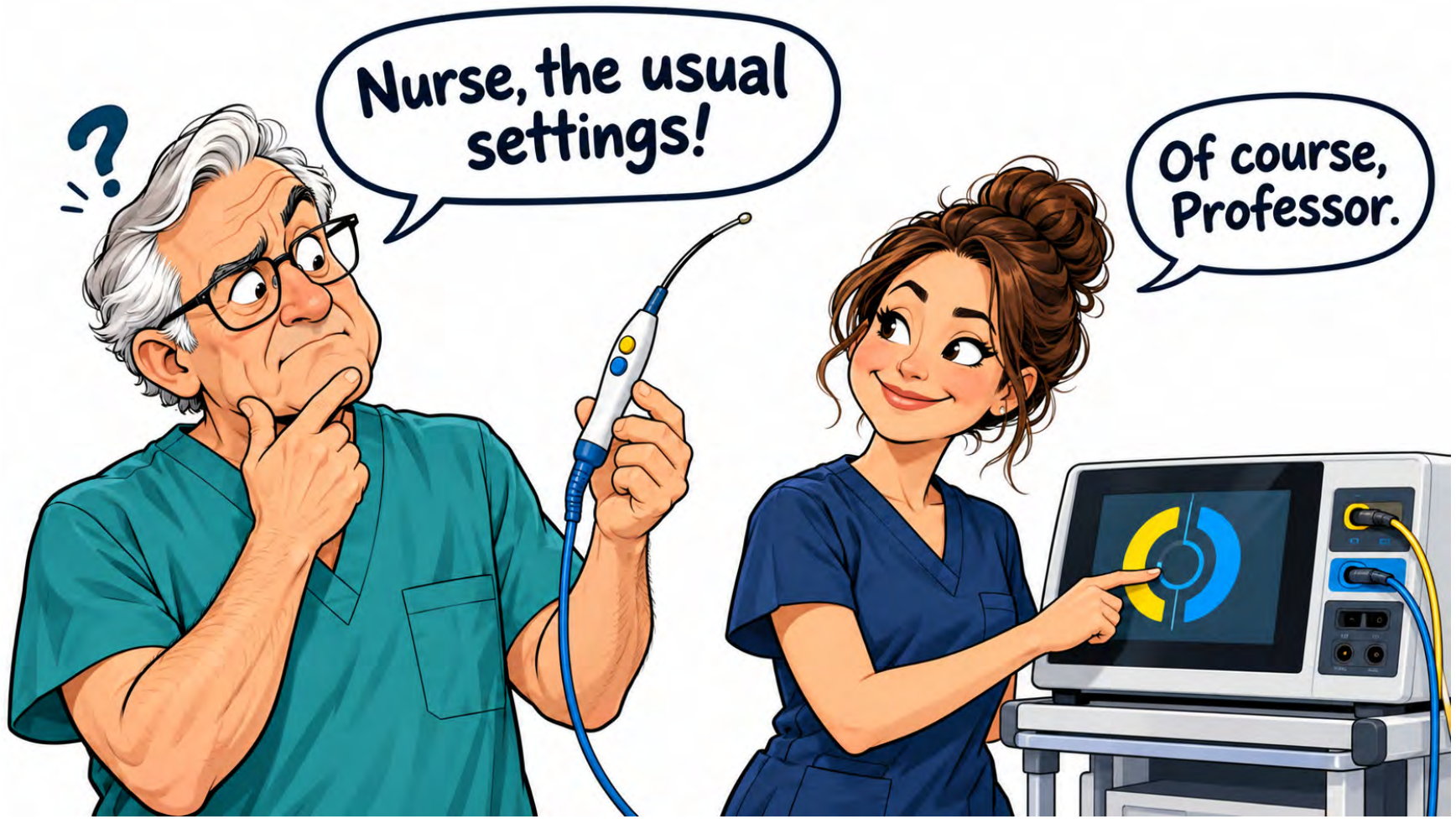
Understanding electrosurgery in GI endoscopy

ENDOSCOPY BASIC COURSE



Youssef Mourabit

My fellowship introduction to electrosurgery



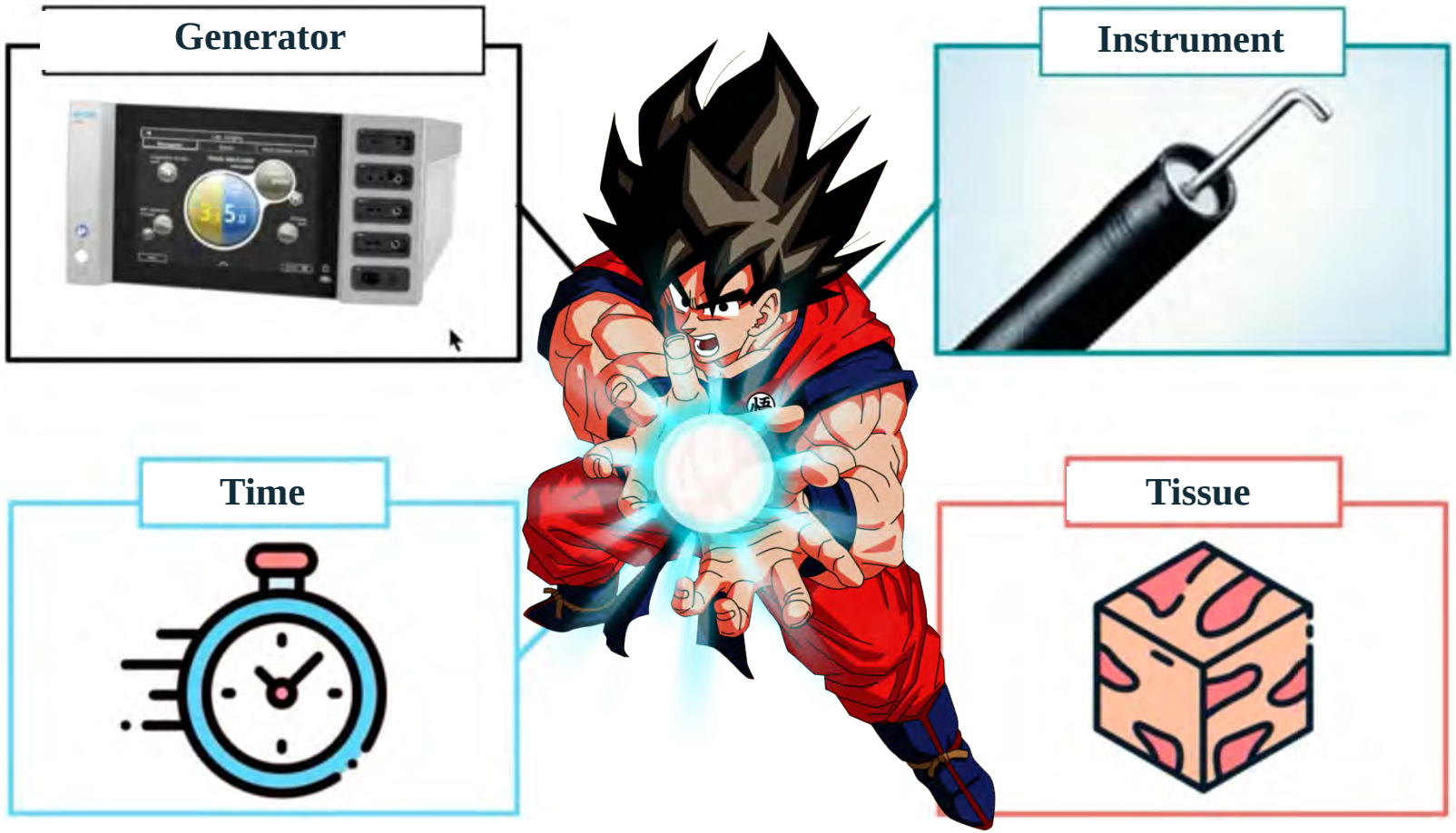
Today: understand the machine and the principles behind the settings.

Four contributors to the tissue effect

$$Qw = I^2 \times R \times t$$

Heat = current² x resistance x time

Generator, instrument, tissue and time form the thread of this presentation



1 Generator

Mode and effect shape the output.

2 Instrument

Geometry and contact concentrate current.

3 Tissue

Hydration and drying change impedance.

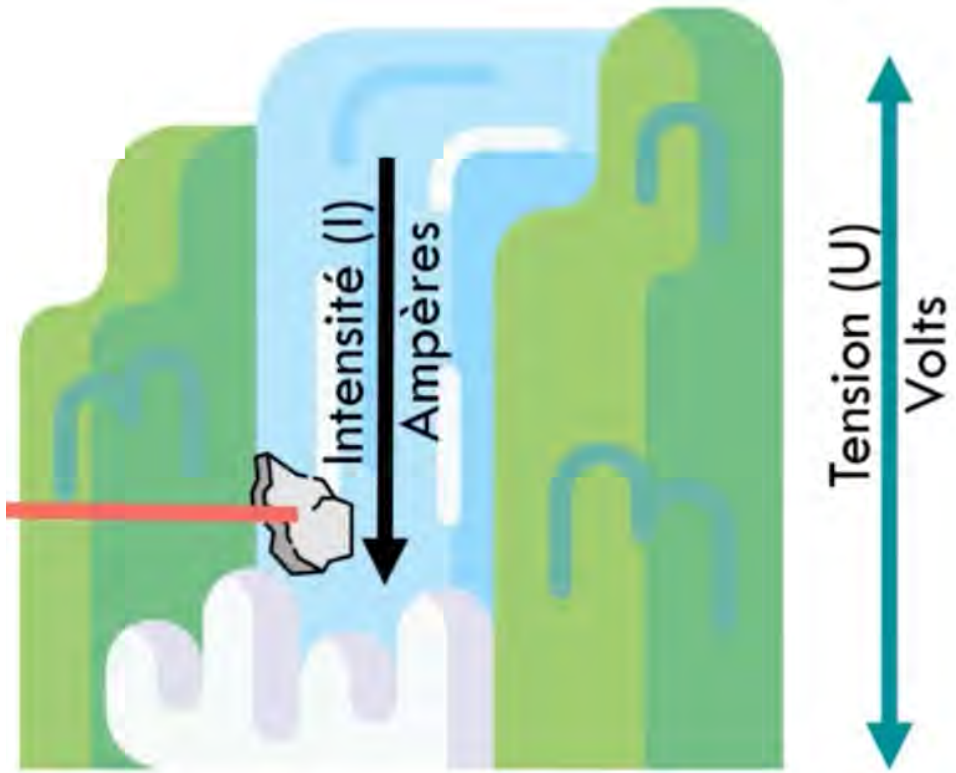
4 Time

Duration and repetition add exposure.

Framework adapted from your teaching illustration. Physics: ASGE 2025; ESGE 2010.

Energy and impedance: the essentials

Generator output meets a load set by tissue and instrument contact.



Impedance Z (Ω)

Opposition to RF current. It changes with tissue and contact.

Power P (W)

The rate of energy delivery.

Energy E (J)

Energy delivered over the activation time.

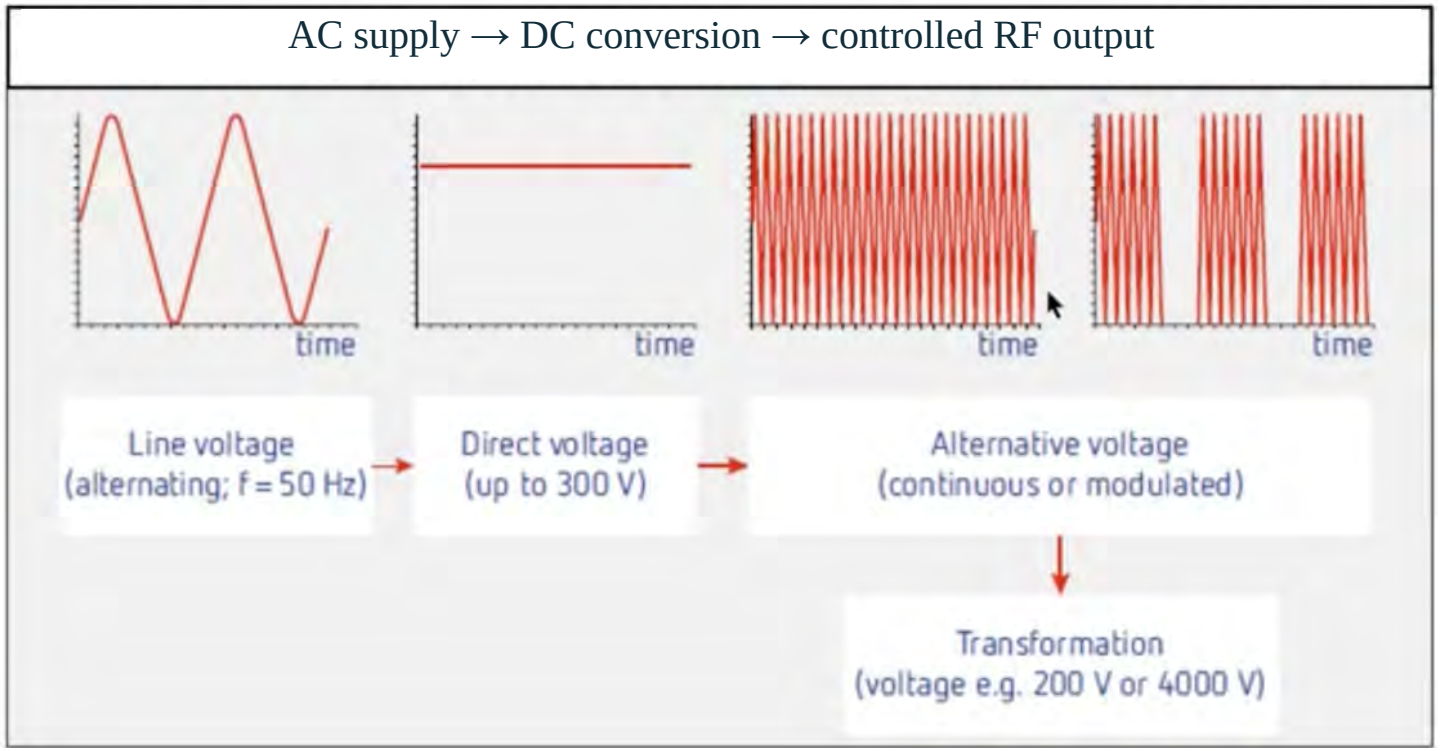
$$I \approx V / R \quad P \approx V \times I \quad E = P \times t$$

Same watts + different contact or time = different tissue effect.

Physics: ASGE 2025; ESGE 2010. Waterfall analogy from your supplied illustration.

From mains electricity to RF energy

The generator converts the supply, then controls the delivered waveform



RF carrier

Many VIO 3 modes use a nominal 350 kHz carrier.

Modulation

Bursts and pauses change the delivery pattern.

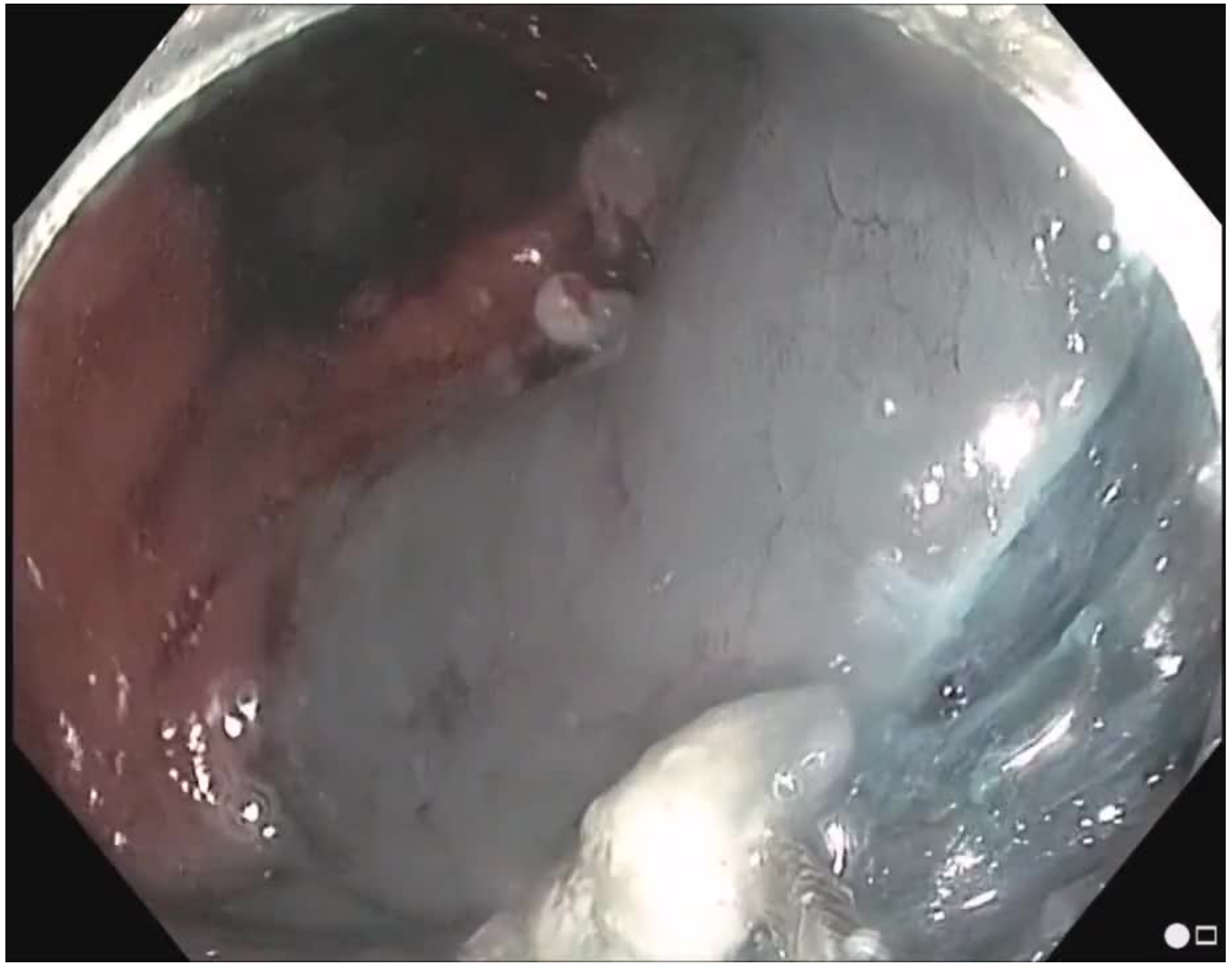
Feedback

Output adjusts as the tissue load changes.

Carrier frequency, peak voltage and duty cycle describe different things.

Conversion illustration: supplied teaching material. VIO 3 RF specifications: Erbe user manual.

What is happening in this video ?





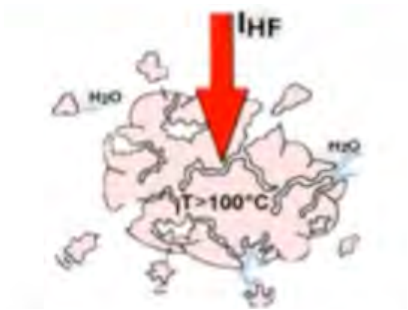
What is happening in this video ?





Cutting and coagulation: tissue effects

Generator output shapes heating. Contact, tissue and time still matter.



CUTTING



COAGULATION

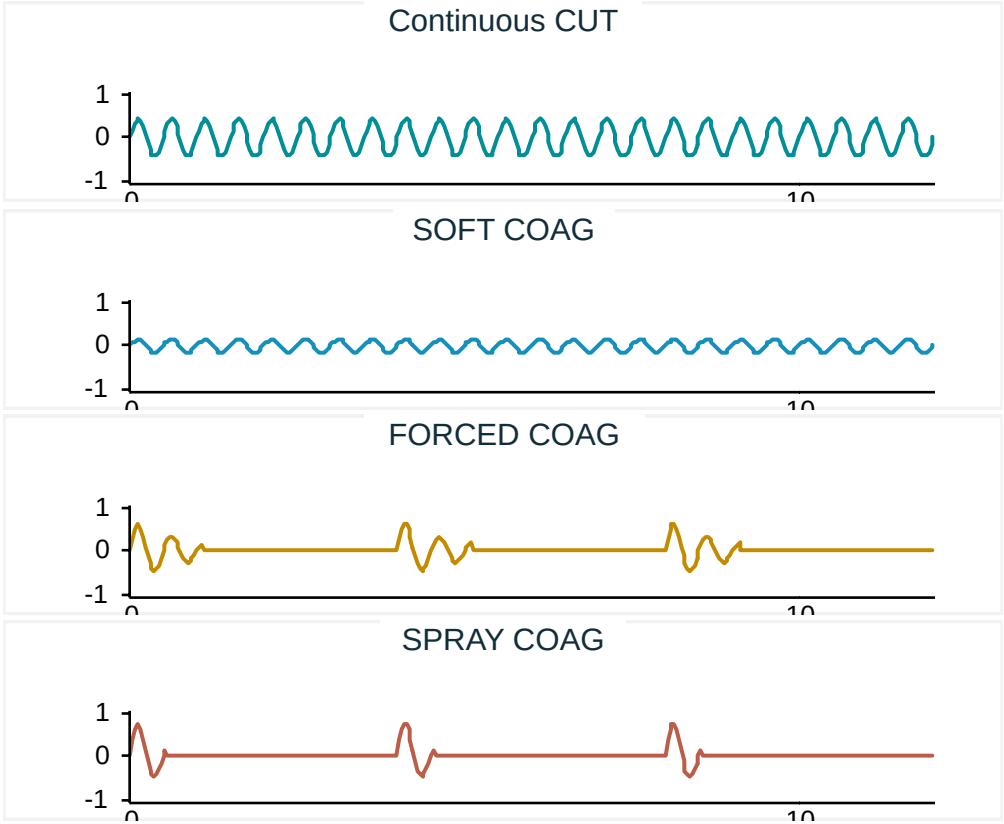
	Cutting	Coagulation
Heating	Rapid heating to boiling	Slower heating, often below boiling
Cellular effect	Water vaporization and rupture	Protein denaturation and shrinkage
Visible result	Tissue separation	Blanching, drying and haemostasis

Prolonged exposure can deepen injury with either effect.

Cell illustrations: supplied teaching material. Mechanisms: ASGE; ESGE; Erbe Principles.

Waveform modulation: CUT and COAG

The waveform is one contributor. Contact, tissue and time complete the effect.



Continuous delivery; tip arcing produces rapid vaporization.

Low-voltage contact coagulation. QuickStart adds a brief initial pulse.

Modulated, higher peaks; rapid contact coagulation with arcing.

Modulated, very high peaks; sparks cross a gap for surface fulguration.

SOFT COAG shows that coagulation can use continuous current.

Schematic voltage vs time; common arbitrary scale. Not measured ERBE traces or setting values.

Mode behaviour: Erbe VIO 3 user manual, pp.97–102; ASGE 2025.

Reading the VIO 3 console

Read back the selected instrument, mode, effect and activation assignment



Program / instrument

Confirm the program and selected output.

Mode and effect

Read the yellow CUT and blue COAG fields separately.

Socket / activation

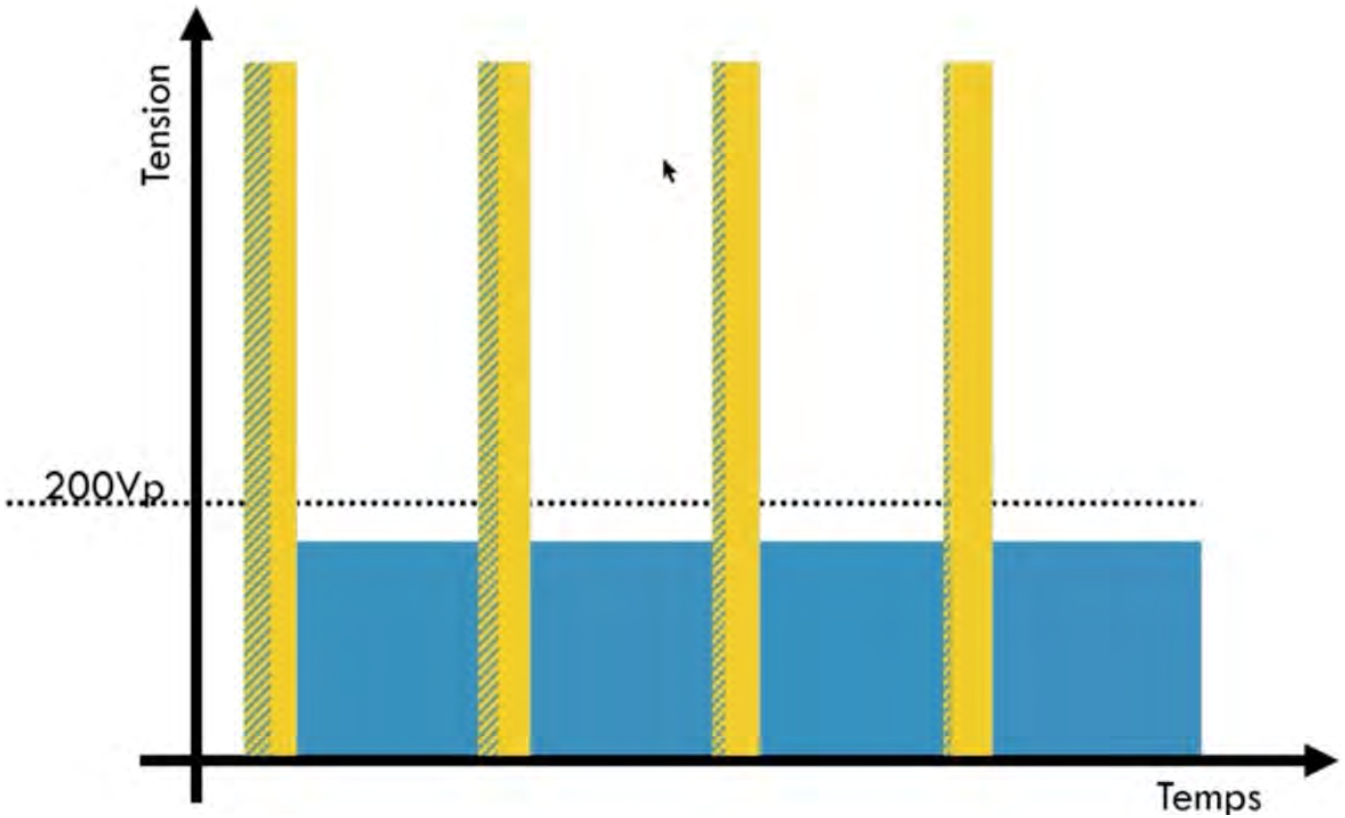
Check the socket, pedal and NESSY status.

Photo: Erbe VIO 3 product website. Display numbers illustrate the interface, not a treatment protocol.

The ENDO CUT cycle and its controls



Fractionated cutting alternates with intervening coagulation



Yellow: cutting phase Blue: intervening coagulation

The interval includes both a cutting phase and the following coagulation phase.

Effect

Intensity of the intervening coagulation. Levels 1–4.

Cut duration

Length of each cutting phase. Levels 1–4.

Cut interval

Start of one cut to start of the next. Levels 1–10.

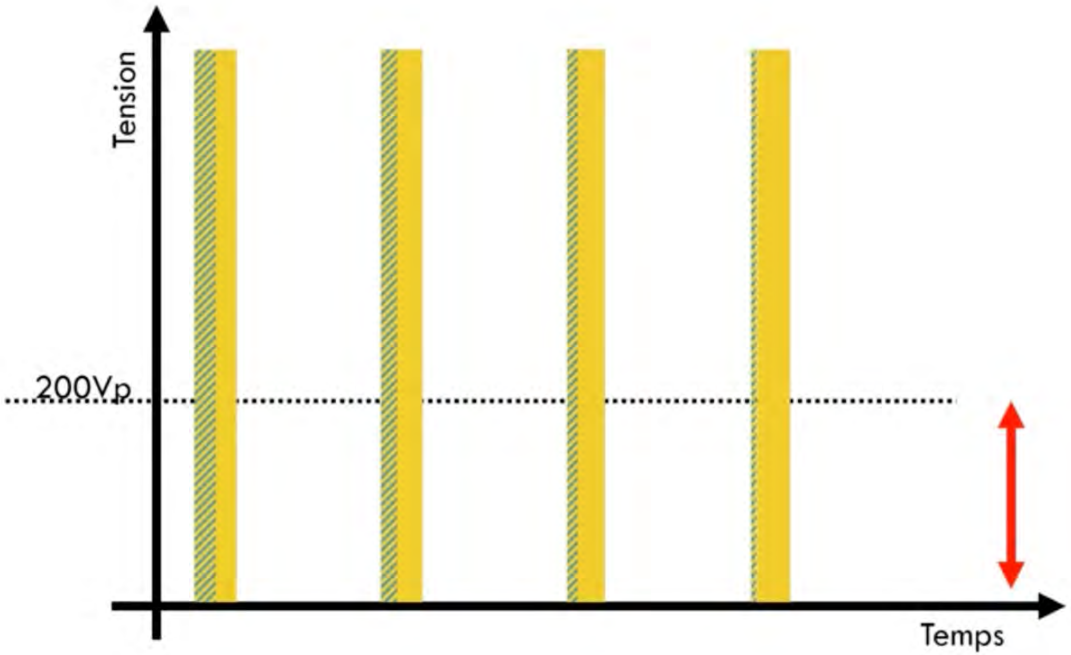
Supplied schematic. The 200 V line is a teaching reference, not a universal threshold. VIO 3 manual, pp.93–95.

ENDO CUT: effect controls coagulation

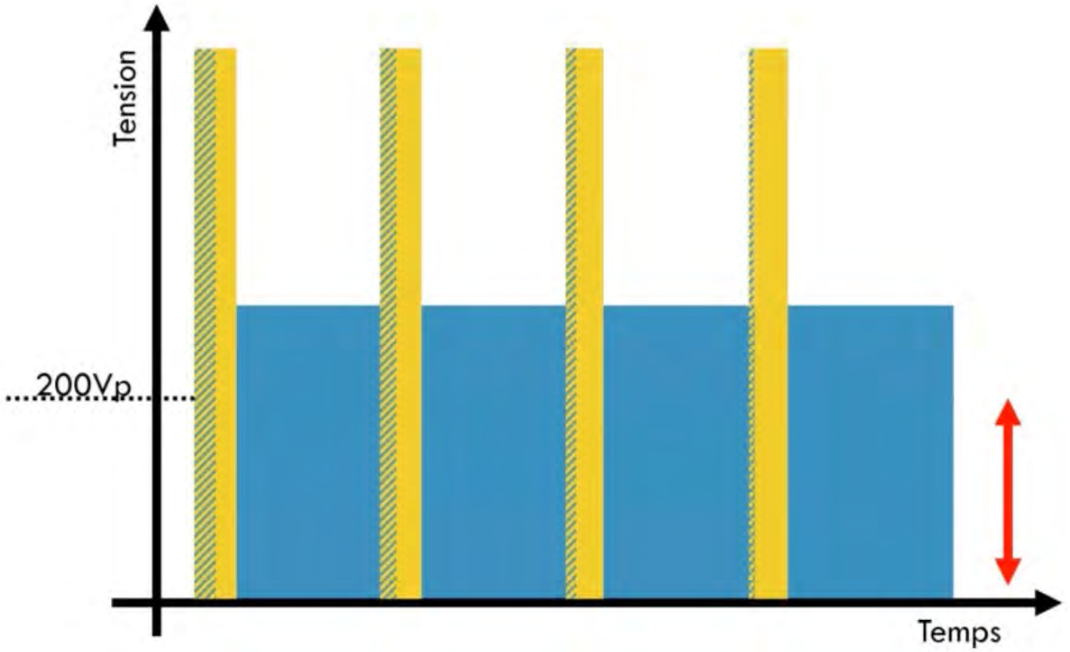


Compare the intervening phase while keeping the cutting pattern in view

Lower effect example



Higher effect example

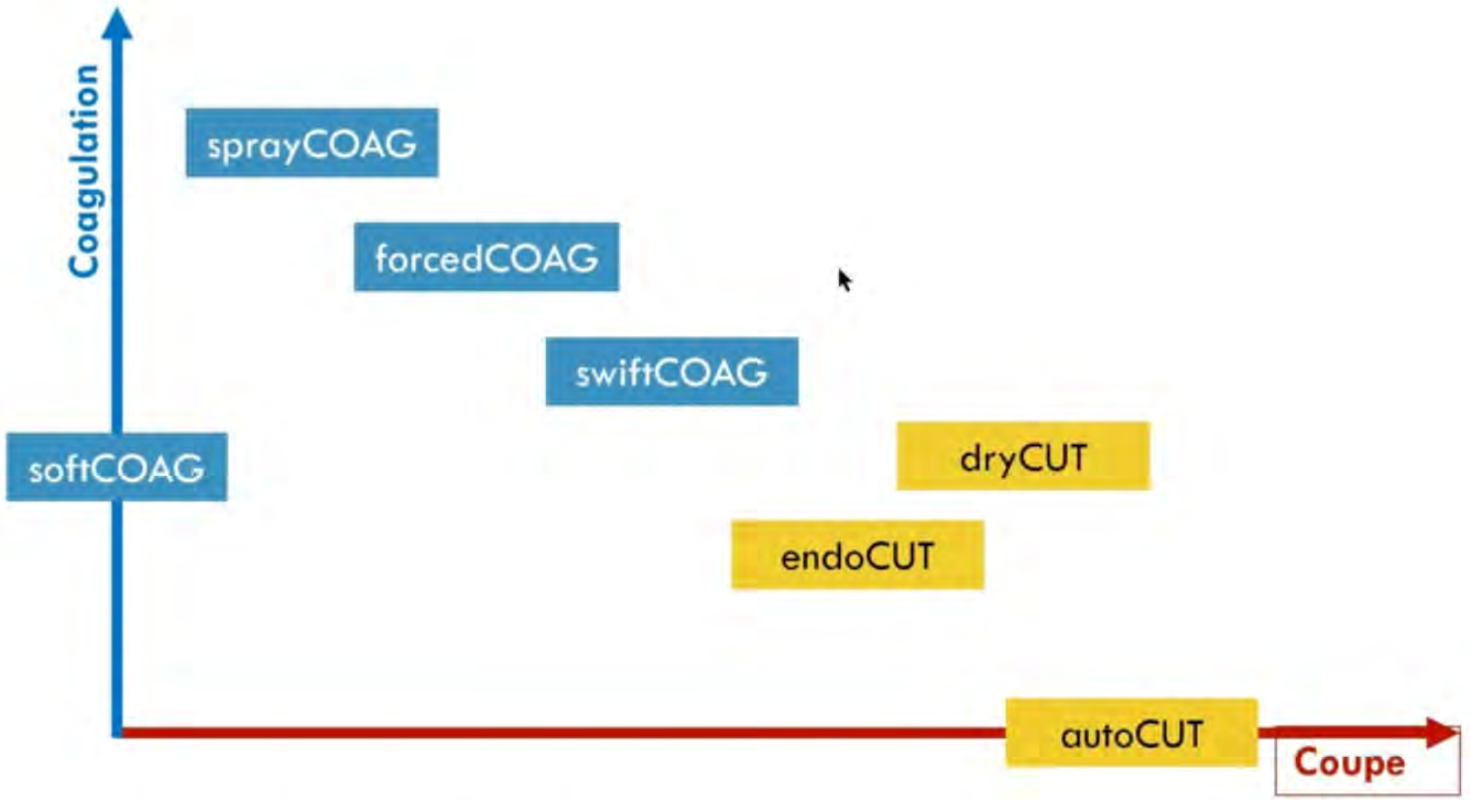


Effect changes intervening coagulation. Duration and interval remain separate.

Supplied schematics, not calibrated traces. VIO 3 ENDO CUT effect range: 1–4.

VIO 3 modes: a range of tissue effects

Generator modes describe output. Instrument contact shapes the tissue effect.



SWIFT / FORCED

Different cutting tendency and coagulation behaviour.

SPRAY

High peaks support non-contact fulguration.

preciseSECT

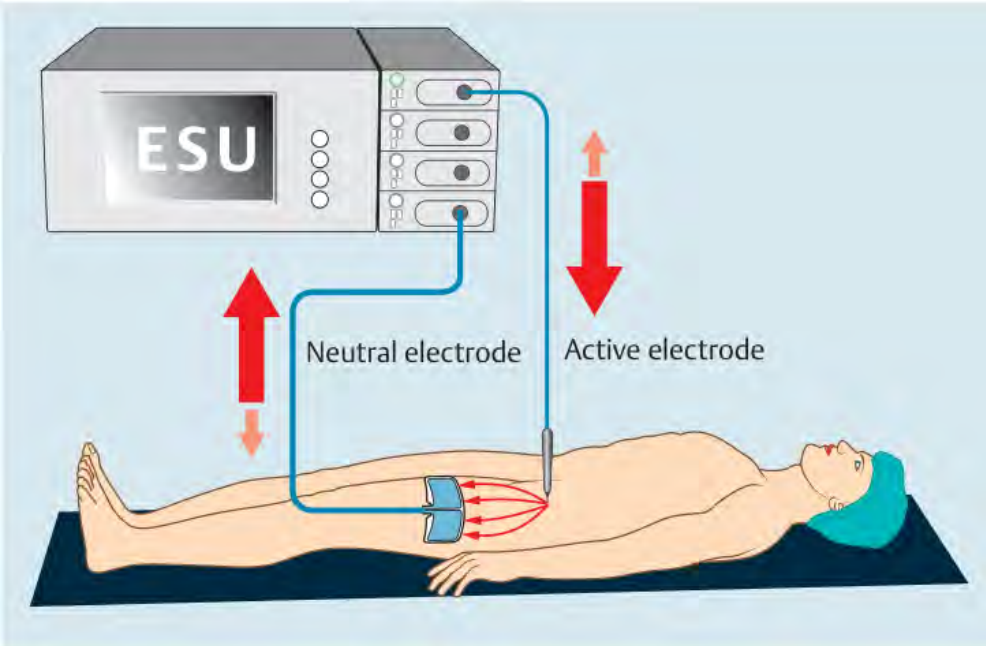
Dynamic modulation adapts to contact and tissue.

This map explains tendencies. Its axes do not predict lesion depth or a safe setting.

Qualitative map from supplied teaching material. Erbe VIO 3 mode overview.

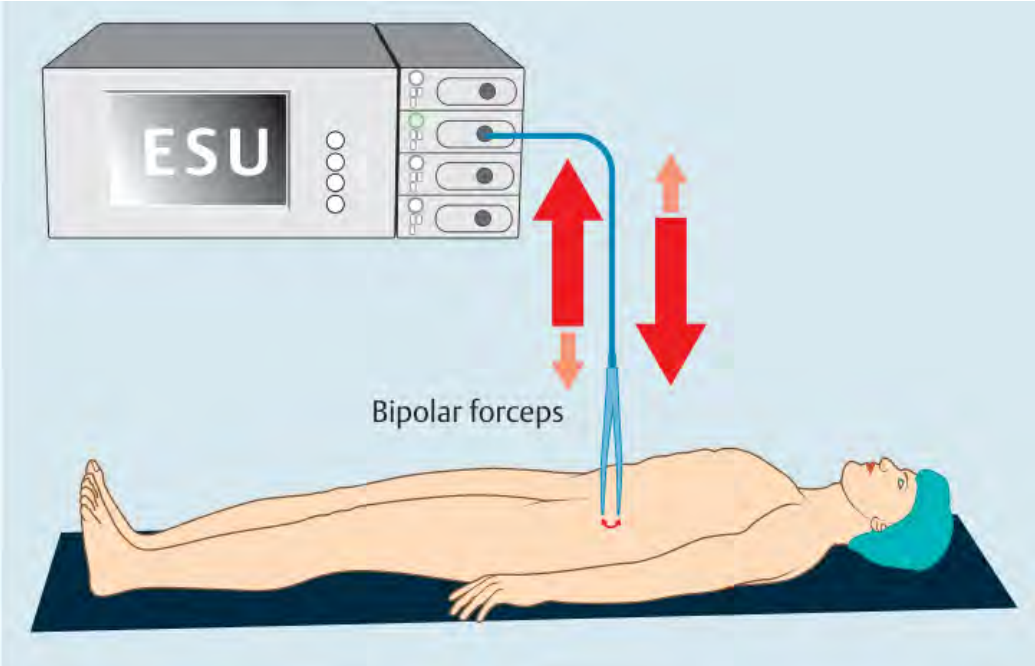
Monopolar and bipolar circuits

Monopolar



Current returns through a dispersive electrode

Bipolar



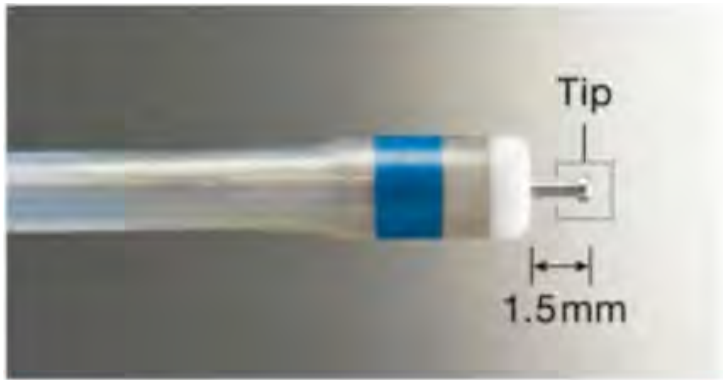
Current flows between electrodes on the device

Circuit figures: Rey et al., ESGE 2010

Contact area and current density

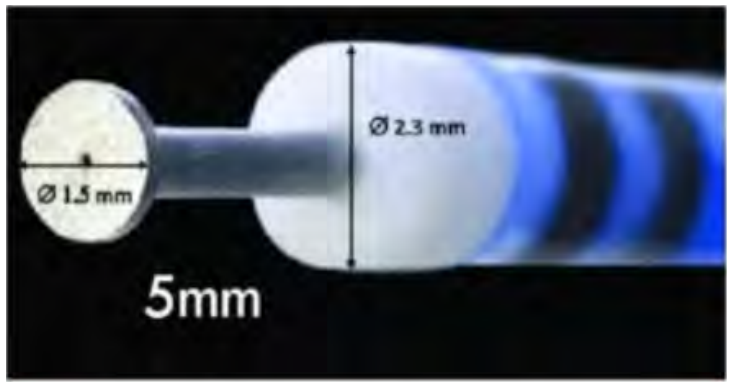
The same mode can behave differently at a fine tip, broad tip or forceps

Fine knife tip



Current concentrates at a small interface.

Broad electrode tip



A larger interface distributes the current.

Haemostatic forceps



Capture and contact target the vessel.

Current density = current ÷ contact area

Use the instrument instructions to confirm compatible modes.

Instrument photographs from your supplied illustration. Contact principles: ASGE 2025; ESGE 2010.

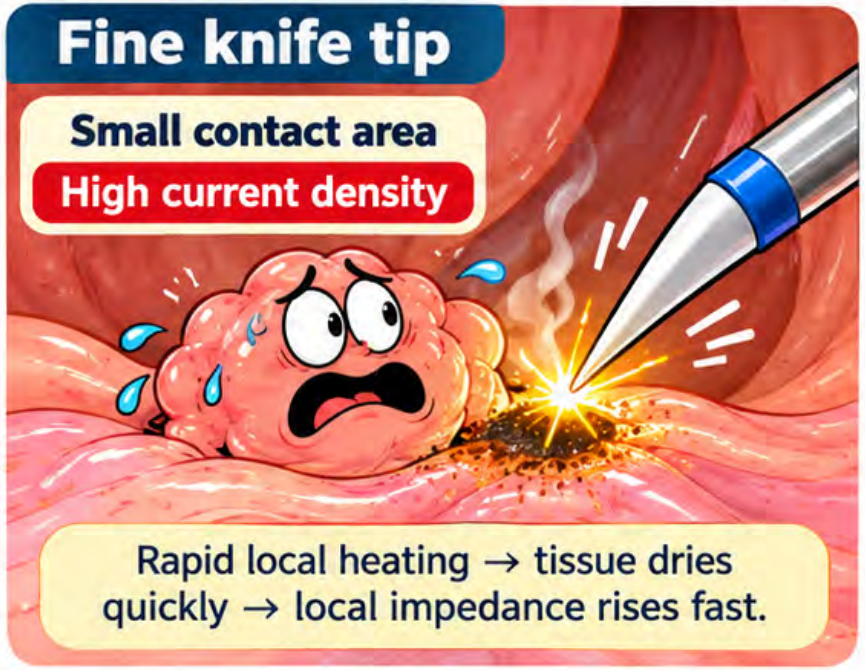
Contact area and impedance

The same mode behaves differently depending on how much metal touches tissue.

Fine knife tip

Small contact area

High current density

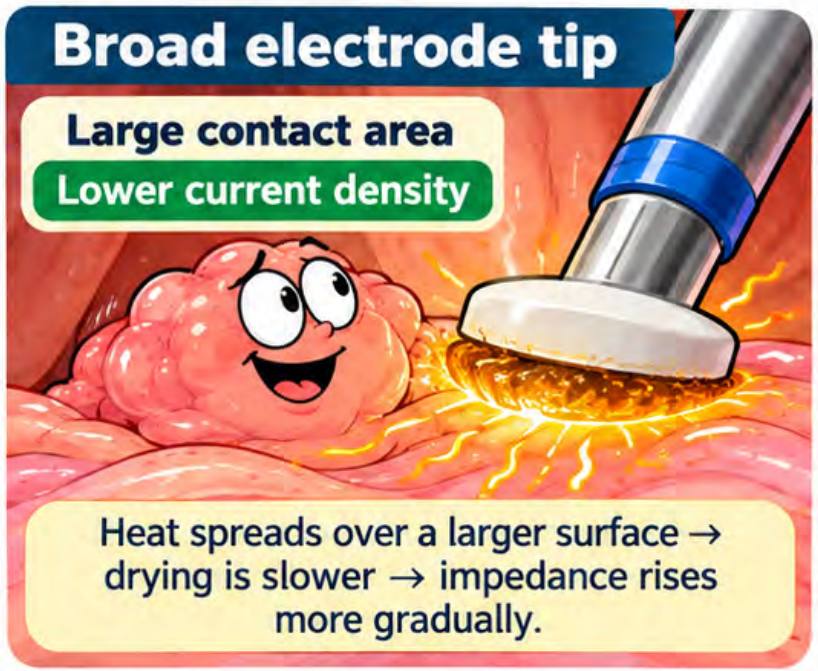


Rapid local heating → tissue dries quickly → local impedance rises fast.

Broad electrode tip

Large contact area

Lower current density

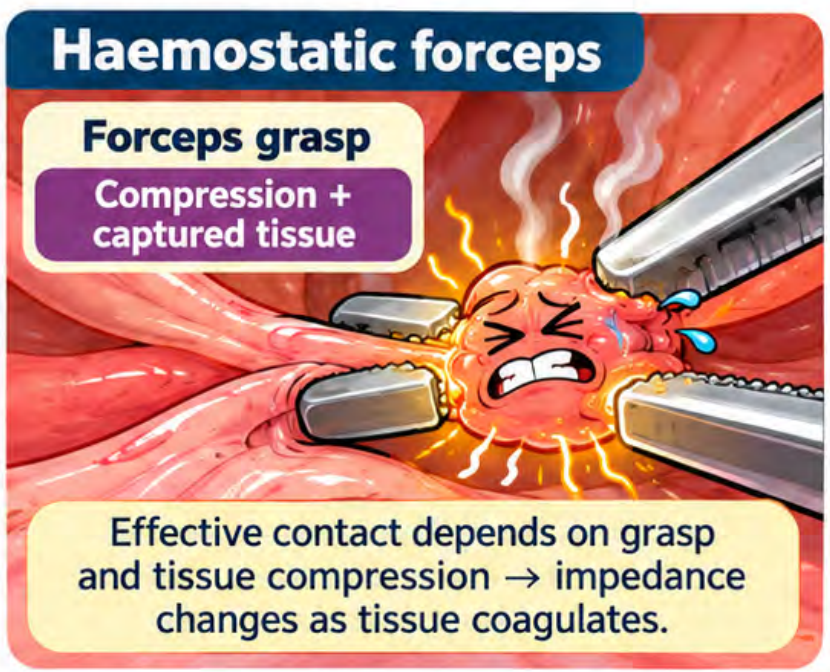


Heat spreads over a larger surface → drying is slower → impedance rises more gradually.

Haemostatic forceps

Forceps grasp

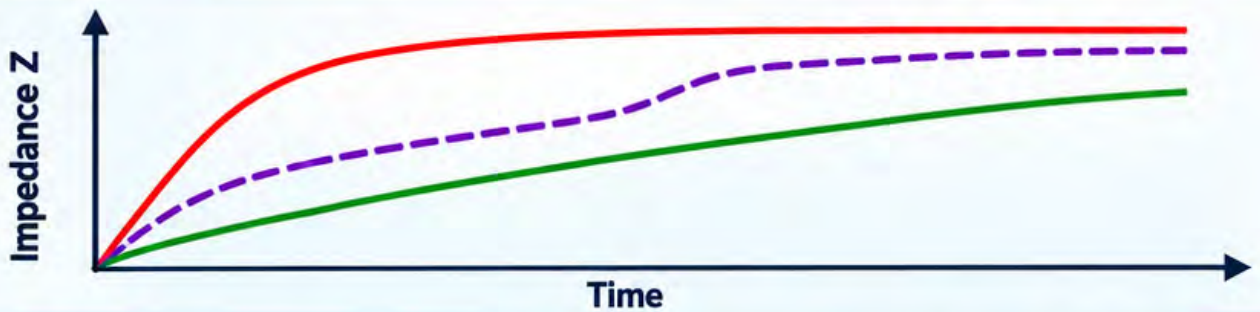
Compression + captured tissue



Effective contact depends on grasp and tissue compression → impedance changes as tissue coagulates.

Impedance during activation

Each instrument shows a different impedance response due to contact area and tissue effect.



- **Fine knife tip** (small contact area)
- **Broad electrode tip** (large contact area)
- **Haemostatic forceps** (compression + captured tissue)

Current density = current ÷ contact area

Smaller contact area concentrates current and usually makes impedance rise faster as tissue desiccates.

Return-electrode contact protects the patient

Full contact on an appropriate skin site

A compatible electrode disperses the returning current

Contact monitoring supports circuit safety

The monitored functions depend on the pad and generator configuration

A pad alarm requires inspection

The team checks adhesion, skin contact, cable and connector

A contact monitor cannot detect every cause of unintended injury

APC is monopolar electrosurgery

Ionized argon

The gas conducts current between probe and tissue

Return electrode

A dispersive electrode completes the patient circuit

APC modes

VIO 3 + APC 3: FORCED, PULSED or PRECISE APC

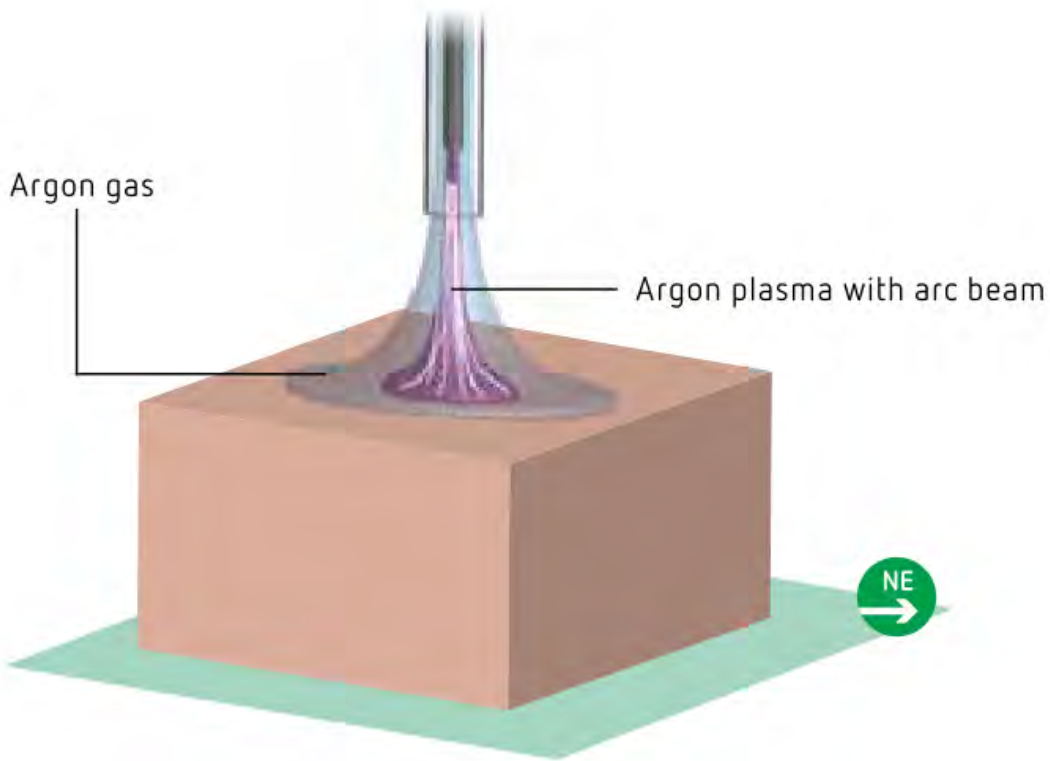


Figure: Erbe Basic knowledge in plasma surgery, p.2

How tissue composition changes impedance

Dissolved ions in tissue fluid carry most of the electrical current

Tissue property	Electrical behaviour	Effect on cutting / coagulation
Water + ions	Lower impedance	Conducts current; rapid heating can vaporize water
Fat (vs muscle)	Higher impedance	The cutting response changes with the tissue
Desiccation	Impedance rises as water is lost	Current may fall; cutting can stall

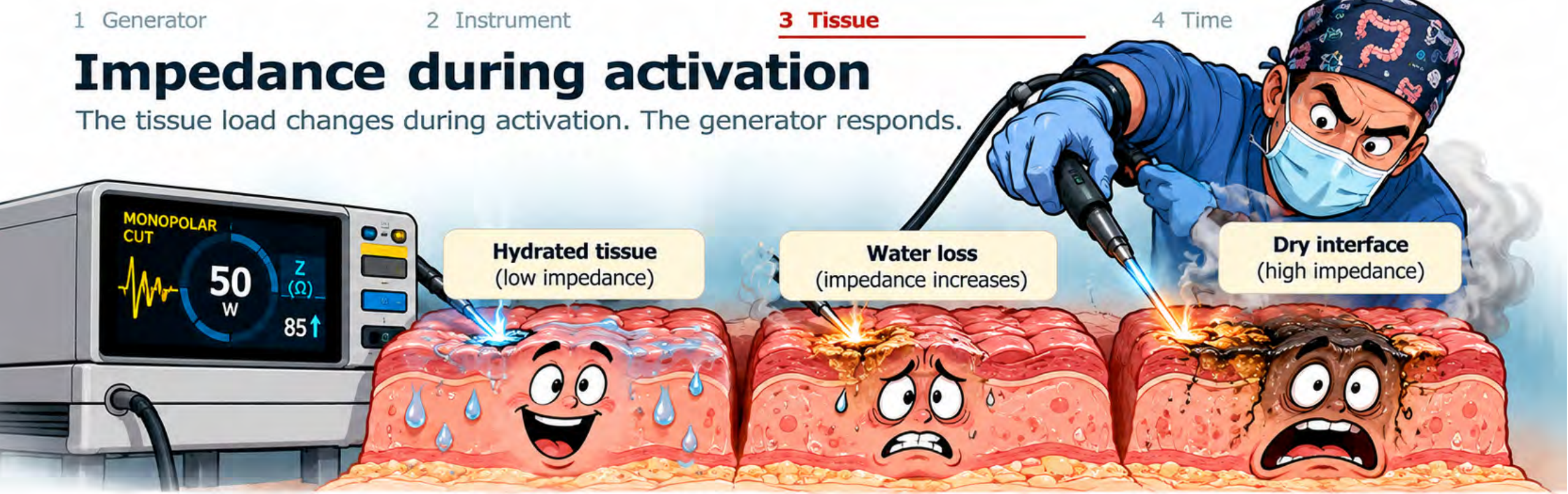
Saline conducts: it can redistribute current and remove heat.

A fluid lift separates tissue layers; it also conducts electricity.

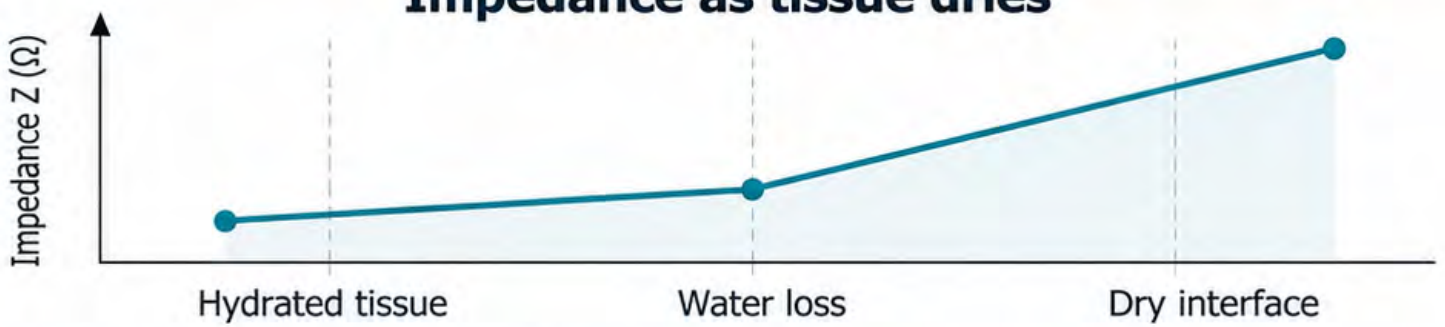
Tissue properties: Erbe Principles; ESGE 2010. Saline cushion: Erbe ENDO CUT Q.

Impedance during activation

The tissue load changes during activation. The generator responds.



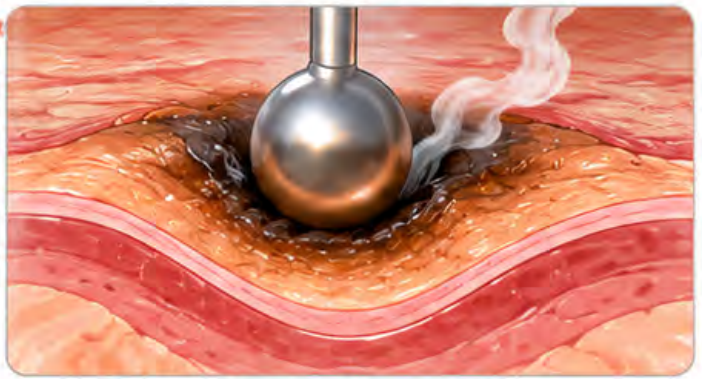
Impedance as tissue dries



Conceptual trend during water loss. No measured values or time scale.

The generator measures the load and adjusts output according to the mode.

During desiccation

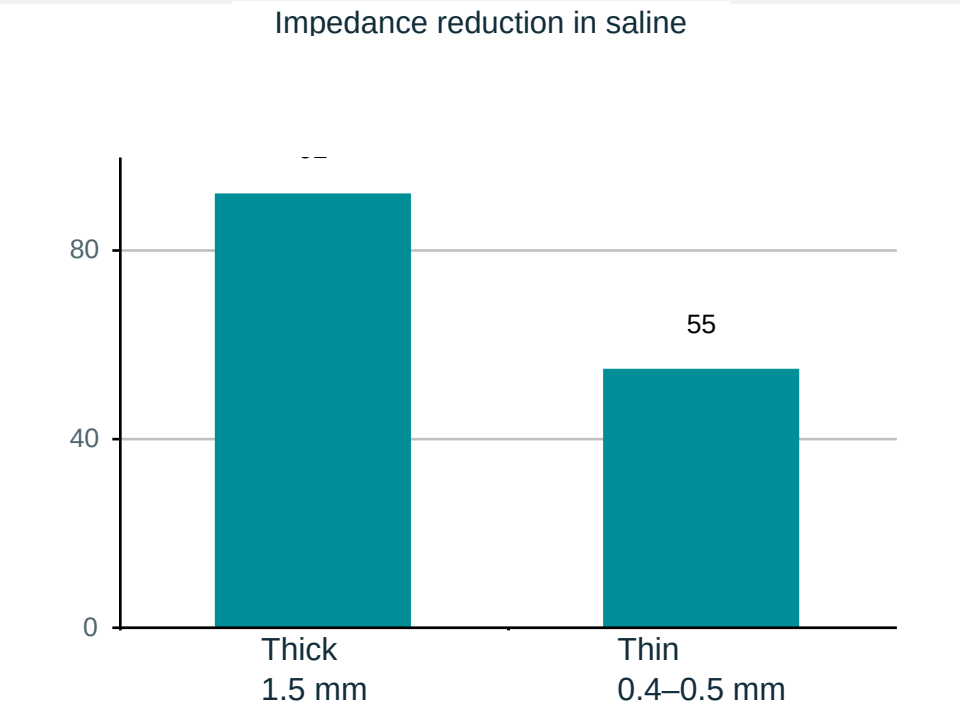


Impedance rises. Current delivery and the tissue effect can change.

Gas, water and saline

The medium and electrode size interact

Medium	Electrical consequence
Gas	Poor conductor until ionized. Arcs can bridge a small gap.
Low-ion water	Conductivity depends on dissolved ions and mixing.
Saline	Conductive fluid redistributes current and heat.



Saline affected the thick knife more than the thin knives in this model.

Ex vivo porcine tissue, 252 incisions. Clinical safety requires separate evidence.

Capogreco et al., Scientific Reports 2026. doi:10.1038/s41598-026-59589-2

Time: cumulative exposure and thermal injury

Activation duration and repetition are the fourth contributor.

Prolonged or repeated exposure increases risk

Low voltage and a modest watt setting do not guarantee shallow treatment

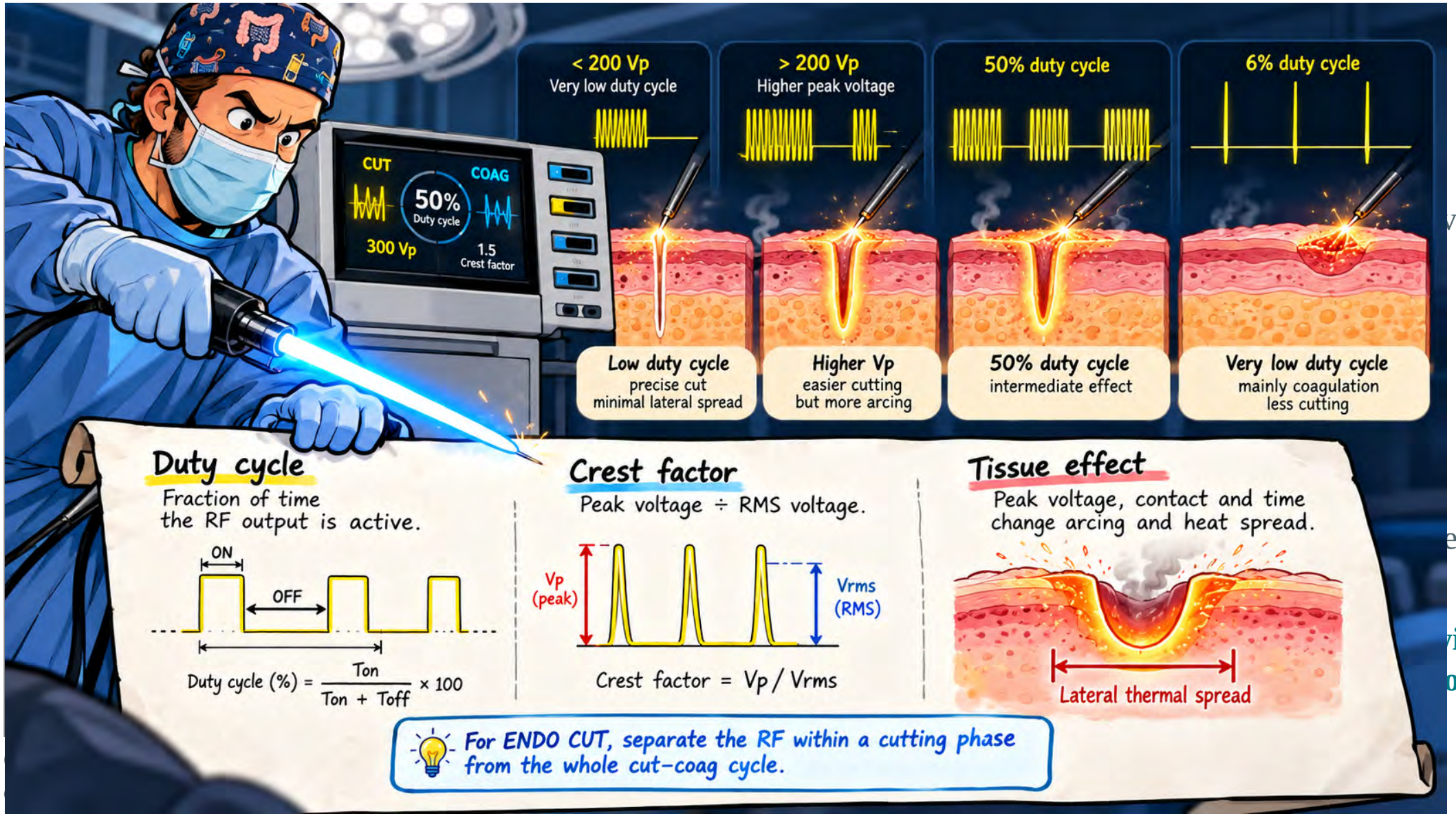
Unintended contact can injure another site

The active tip, insulation, clips and endoscope need attention

Pain after thermal resection needs assessment

Deep mural injury may present as coagulation syndrome or delayed perforation

Duty cycle and crest factor



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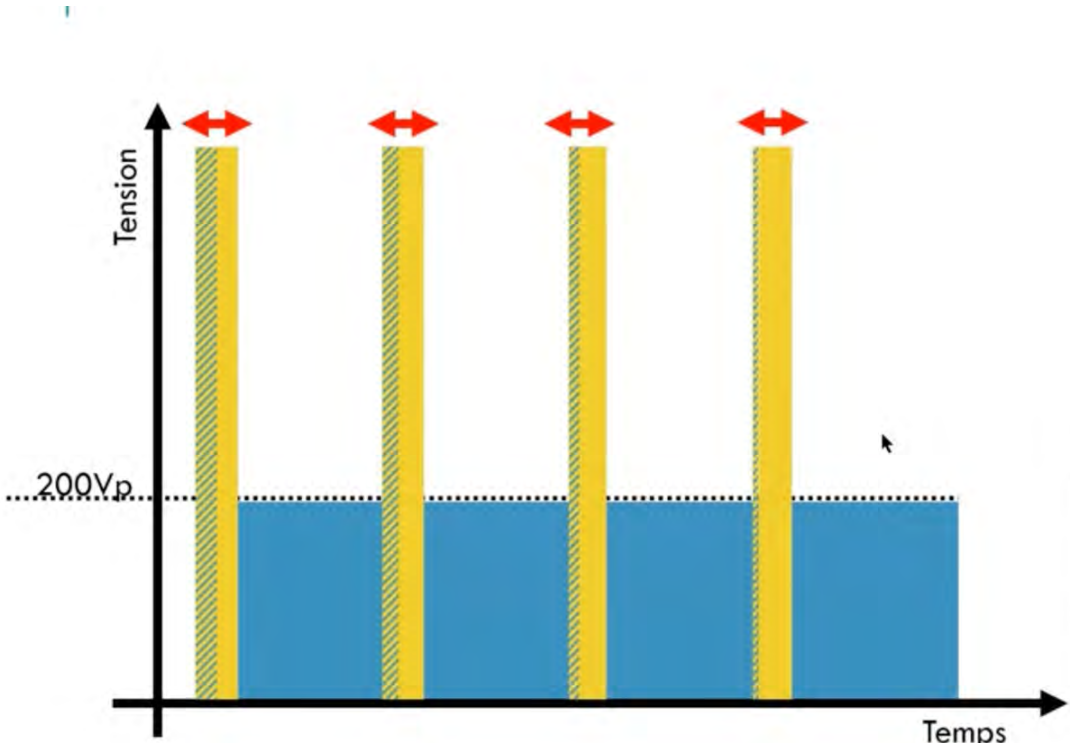
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ENDO CUT: duration of each cutting phase

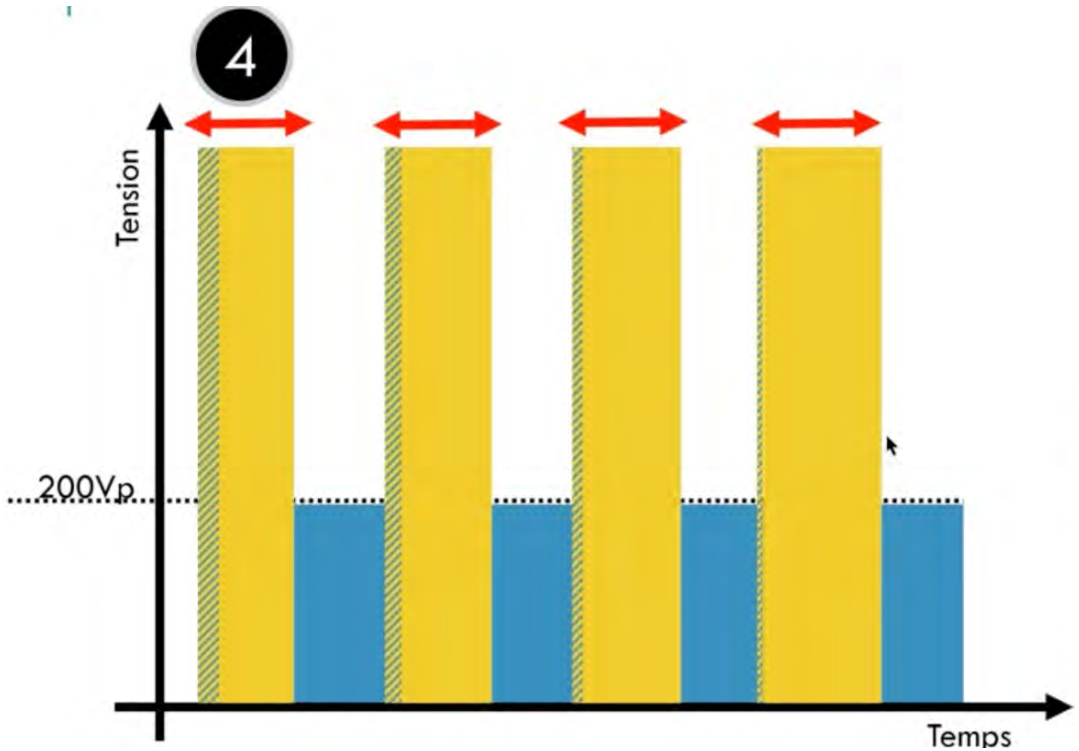


A longer cutting phase can increase the length of an individual cutting step

Short cutting phase



Long cutting phase



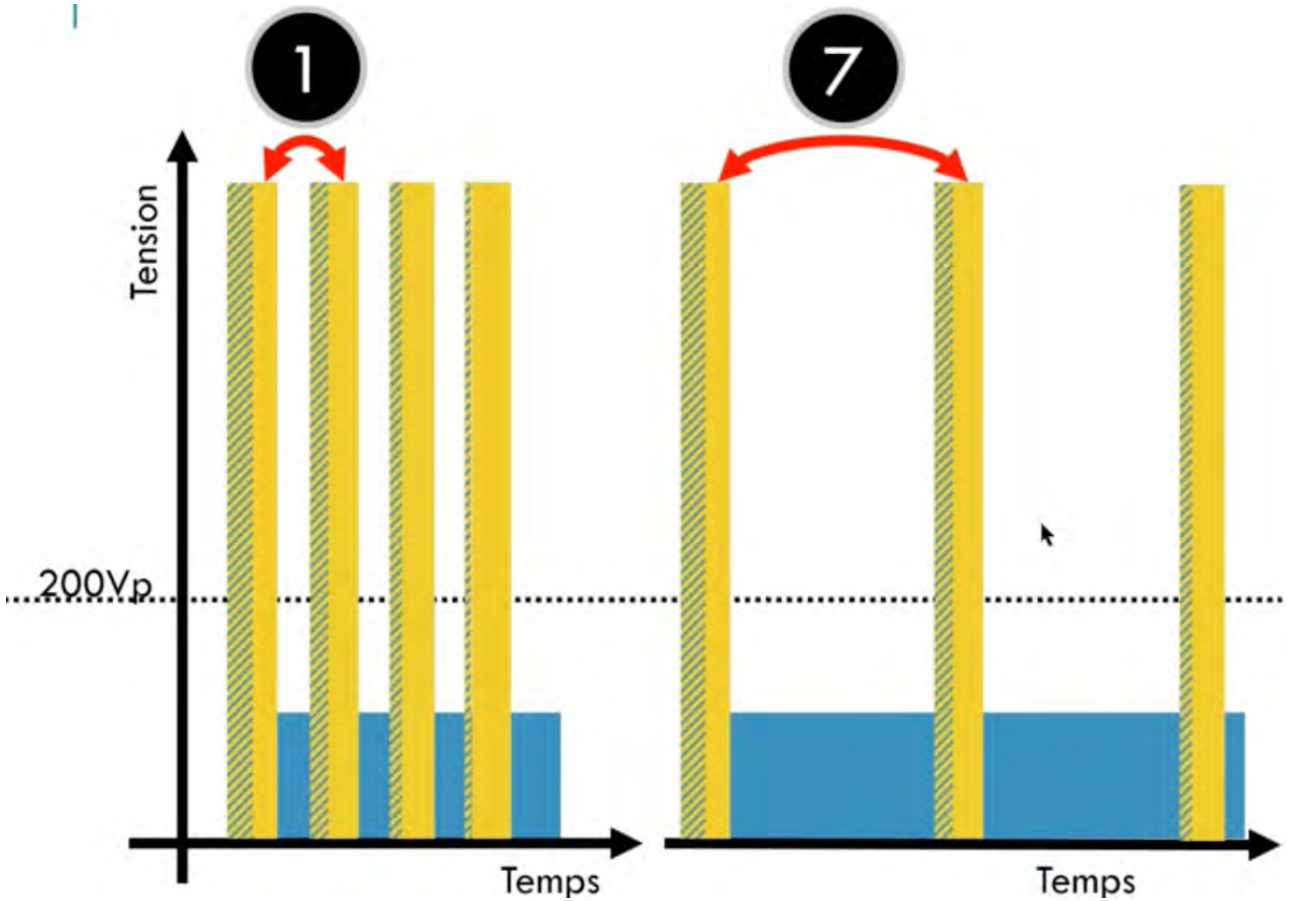
Duration changes the cutting phase. Interval sets the cycle time.

Supplied schematics, not calibrated traces. VIO 3 cut duration: 4 levels.

ENDO CUT: interval controls the pace

Cut interval runs from the start of one cutting phase to the start of the next





Shorter interval

Cutting phases recur more frequently.

Longer interval

More time between successive cutting phases.

Read it correctly

The interval includes the cut itself. It is not only the pause.

Supplied schematic, not a calibrated trace. VIO 3 cut interval: 10 levels.

Four contributors to remember

Gener

Mode a

Instru

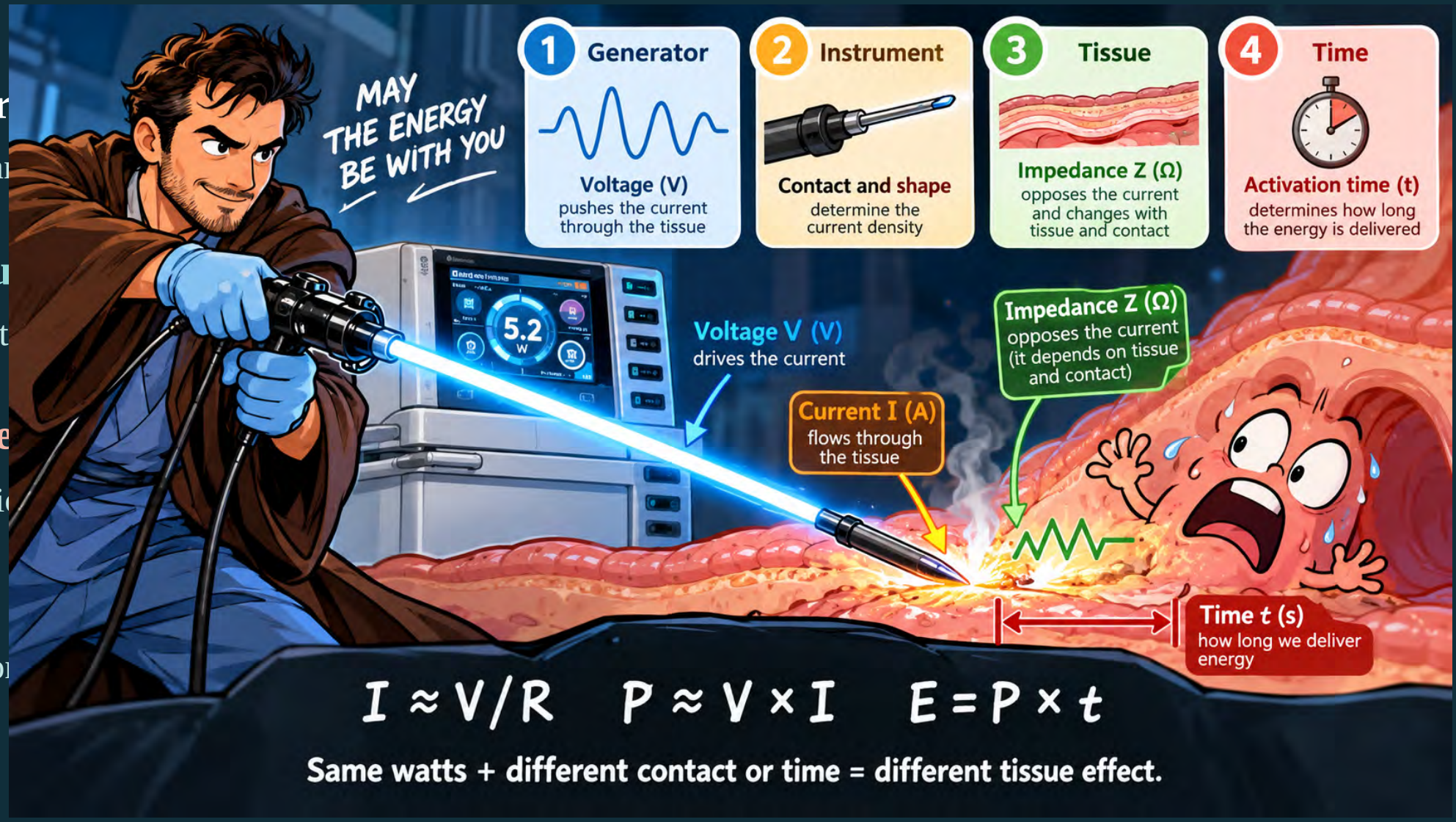
Geomet

Tissue

Hydrati

Time

Duratio







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