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Evaluation Study

Quantum Molecular Resonance scalpel QMR and its potential applications in Aesthetic Phlebology

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ABSTRACT

Officially recognized internationally, sclerotherapy is the primary treatment for varicose veins, spider veins, and telangiectasias. Electromicrocoagulation is also used to treat red and blue capillaries. This work aims to evaluate the effectiveness of a novel microelectrotherapy strategy in reducing complications associated with thermal damage. Advances in bioelectronic engineering have led to new treatment options through Quantum Molecular Resonance (QMR), a novel strategy applied in regenerative medicine for organ and tissue regeneration by adult stem cell activation, in physiotherapy due to its strong anti-inflammatory and regenerative effects, in neurosurgery and other surgical fields for its potential in developing a "low-temperature QMR electric scalpel". This new type of electric scalpel can also be used in phlebology to treat dermal capillaries and varicosities, thanks to its adjustable power and precise timing, which help reduce thermal damage. The use of microcoagulation with a QMR-based bioelectronic scalpel has shown promising results, significantly reducing skin thermal heating during the treatment of capillaries, varicosities, and telangiectasias. When combined with microsclerotherapy, it reduces the risk of inflammatory responses and pigmentation, giving rise to a new technique called "QMR microscleroresonance", which represents a promising advancement in Aesthetic Phlebology.

INTRODUCTION

The use of electric current on biological tissues produces a range of effects that are routinely applied in medicine. Depending on its characteristics, the current is used to achieve specific actions for diagnostic, therapeutic, or rehabilitative purposes. Whenever an electrical device supplies energy to biological tissue, much of it is dissipated as heat, which is better defined as "molecular kinetic energy," essentially translating into an increase in temperature.

In the human body, temperatures exceeding 43°C or 45°C trigger connective tissue and cellular alterations, leading to cell death and tissue necrosis, known as thermal damage. To protect tissues from aging and promote cellular regeneration, the current challenge lies in utilizing a form of electrical energy that can activate cellular functions without causing thermal damage. The goal is to harness the interaction of energy with biological tissues while avoiding any temperature increase. In this context, Quantum Molecular Resonance (QMR) technology has found application in regenerative medicine, physiotherapy, neurosurgery, and aesthetic medicine.

Electrosurgery refers to the use of high-frequency alternating electric current to heat tissue. It employs high-frequency current (HFC) to cut and coagulate biological tissue by exploiting the thermal effect of electric current, which is concentrated primarily where the conductor’s cross-section is minimal: hence the name electrocautery (1, 2).

The success of an electrosurgical unit lies in its ability to simultaneously cut tissue and coagulate bleeding vessels by raising the temperature above 100°C. This, on the one hand, destroys cells closing the injured vessel by water evaporation and protein denaturation.

The most advanced electrosurgical units operate within the radiofrequency spectrum (3-5), realising cleaner and more precise incisions by concentrating higher current density in very small electromaniples, using lower energy for better tissue separation. This surgical diathermy can also be timed; it is used primarily for dermatological treatments, but it carries the same risks of thermal damage.

Three types of electrosurgery are primarily employed in modern surgical practice: ultrasound, which uses mechanical vibrations to break hydrogen, enabling vessel coagulation and cavitation-based cutting;

radiofrequency (or rather, high-frequency, above 200 kHz), which is effective and user-friendly, but operates at high temperatures, risking skin damage (6, 7). In any case, high temperatures always carry the risk of skin necrosis, keloids, and scarring.

Quantum Molecular Resonance scalpel uses a series of high-frequency electrical waves that interact with tissue without producing heat, acting at the molecular level in a less invasive manner (8).

Electrosurgery has brought enormous benefits to surgical procedures, particularly through the simultaneous combination of cutting and clotting, which reduces bleeding, a complication that remains one of the most significant in surgery. However, the risk of thermal damage from elevated skin temperature persists and must be controlled to avoid skin lesions, scarring, keloids, and pigmentation disorders.

More recently, bioelectronic technology has introduced the new QMR strategy, which uses electrical currents to induce molecular resonance within tissue, enabling both cutting and coagulation with minimal heat production and greatly reduced thermal risk.

MATERIALS AND METHODS

Any form of energy is transmitted from a source to a "user" in discrete packets called "quanta", whose energy value is proportional to the frequency of the source. In physics, "quantum of energy" refers to a discrete and indivisible elementary quantity of a given force field. Quantum Molecular Resonance (QMR) is a newly patented Italian technique that transmits energy quanta capable of breaking molecular bonds without increasing the kinetic energy of the atoms, and therefore without raising the temperature beyond the physiological thermal range. This technique has demonstrated regenerative properties on biological tissues (9), along with anti-inflammatory and anti-edema effects (10) attributable to the use of "quanta" with energy levels very close to those of certain molecular bonds typical of biological structures, which enter into resonance and subsequently dissociate. These effects are achieved through the use of electrical energy delivered by alternating electric fields with high frequencies (between 4 MHz and 64 MHz) and low intensity, with a frequency spectrum that enables energy to interact directly at the molecular level, without generating heat during interactions with biological tissues. The procedure is therefore performed at temperatures below 45°C, within the physiological thermal range. This type of energy has been used in surgery for several years using a QMR electrosurgical unit that enables atraumatic cuts and gentle coagulation. The energy expressed is exactly equal to the energy of intermolecular bonds. The molecular resonance generator operates using a unique, patented combination of four frequencies in the 4-16 MHz range, known as the Cells Keeping Spectrum (CKS), which induces resonance of molecular bonds. As a result, the amplitude of the oscillations increases immediately, leading to the rupture of the cell membrane and the cutting of tissue. The breaking of intermolecular bonds occurs through the effect of resonance (10, 11), generating a cutting temperature that does not exceed 45–50°C. This significantly reduces the risk of thermal damage, preventing carbonization at the edges of the incision (Fig. 1, 2).

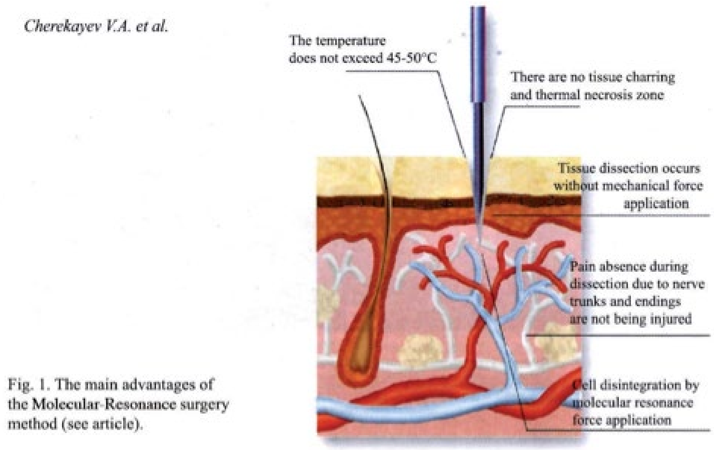


Fig. 1. *The figure illustrates the advantages of QMR microsurgery, which improves the cutting line and reduces incision edge charring (Courtesy Telea).*

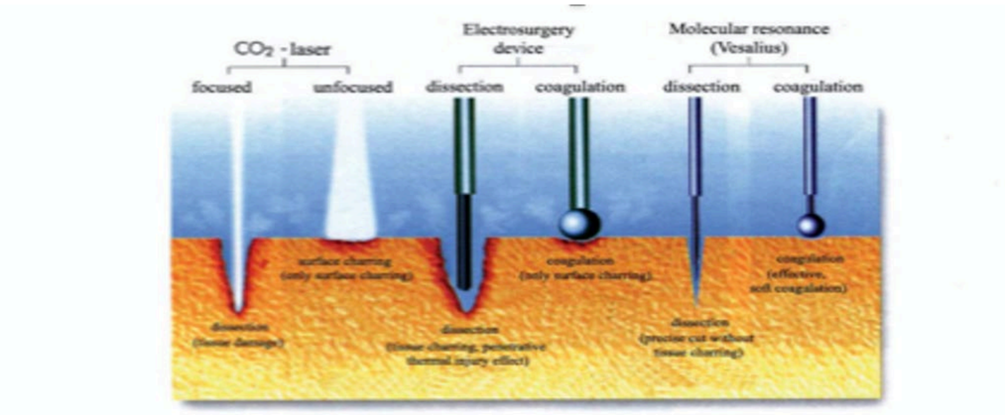


Fig. 2. *The figure shows the lower thermal risk of QMR compared to laser and electrosurgery (Courtesy Telea).*

Coagulation QMR occurs through the denaturation of fibrinogen at 63 °C, avoiding the use of higher temperatures typically employed in conventional methods. This process helps reduce the formation of scar or keloid tissue, offering clear aesthetic advantages and significantly decreasing postoperative swelling and pain. These properties have led to the adoption of the device in delicate surgical fields such as oromaxillofacial surgery, neurosurgery, urology, gynecology, and oncologic dermatologic surgery (12–17), as well as in tissue engineering applied to organ regeneration. In the latter case, the ability to create microchannels without thermal damage has enabled the development of ideal environments for stem cell regeneration, thus promoting organ regenerative processes (18, 19). The distinctive value of QMR technology lies in its ability to cut biological tissues without causing thermal damage. In the field of tissue engineering applied to organ regeneration, this feature enables the creation of a dense matrix of micropores across the entire scaffold (over 1000 pores/cm²), resulting in a three-dimensional structure that is optimal for cell attachment. This promotes recellularization and subsequent tissue regeneration by closely mimicking the body's natural physiology. The scaffold produced through this technique is then seeded with mesenchymal stem cells (MSCs) and implanted in vivo to restore full tissue functionality or to replace a damaged organ (Fig. 3, 4).

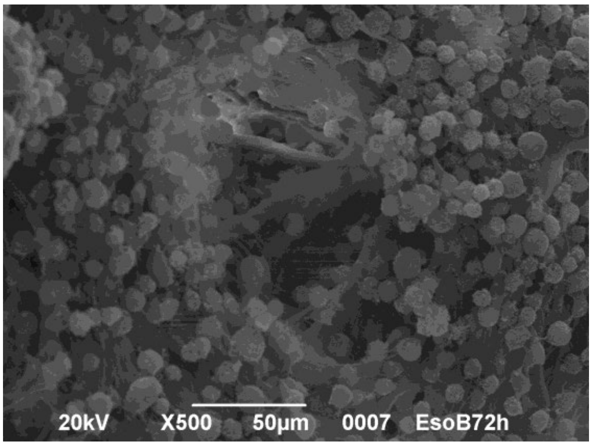


Fig. 3. *Digital microscope image of a microperforated surface with QMR (Courtesy Telea).*

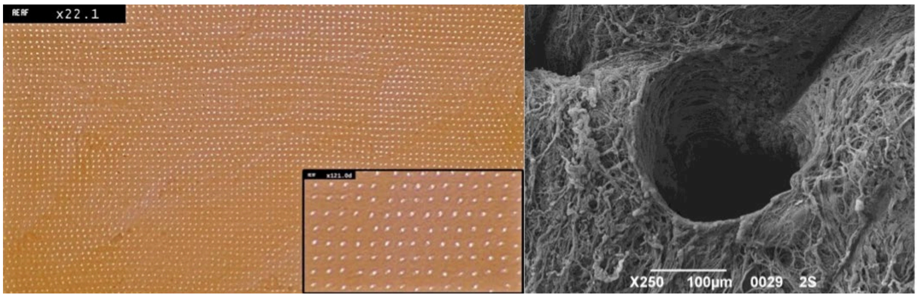


Fig. 4. *SEM image of a single hole. Note how the protein structure around the hole is perfectly intact (Courtesy Telea).*

The entire seeding process was made possible thanks to a bioreactor with a unique motion that easily inserted cells not only onto the surface but also inside the micropores, thus achieving a three-dimensional seeding effect. The stem cells enter the channels, where they find an optimal environment within the extracellular matrix (which remains unaffected by the micropore-building process due to the lack of thermal damage), providing a suitable environment for proper protein expression. This allows for proper signal exchanges to differentiate the cells into the same tissue type into which they are seeded (Fig. 5).

Fig. 5. *Portion of regenerated esophagus six months after surgery (Courtesy Telea).*

METHOD

This typical feature of atraumatic cutting and gentle coagulation, offered by the QMR, can also be applied in phlebology to treat dermal capillaries and reticular varicosities in the malleolar region, thereby preventing thermal damage and pigmentation. Twenty patients requiring microsclerotherapy and microcoagulation were treated with QMR (Quantum Molecular Resonance) microsclerotherapy. Patients were selected based on the absence of phlebitis and high-pressure saphenous varices, the absence of previous varicose ulcers and malleolar hyposclerosis, and the absence of venous and lymphatic edema, lymphedema, or lipoedema. Patients with low-pressure reticular varicose veins and short reflux or hyperinflow malleolar capillaries were selected, with CEAP classification of type As-C1.

After careful evaluation using color Doppler ultrasound and vascular mapping to avoid complications in high-risk areas such as the malleolar regions, microsclerotherapy with polidocanol was used in the varicosities (20), with a 31G needle (21-23) at a concentration of 0.25% diluted with saline solution 8:2, and 0.05 ml of air was first injected to clear the vessel and reduce the effects of pigmentation or overdose (24, 25).

For dermal red capillaries, single-point microcoagulations were performed using a QMR electric scalpel, timed to the hundredth of a second (Vesalius Smart by Telea®). This allows atraumatic microincisions with gentle coagulation at low temperatures, reducing the risk of thermal damage. Microsclerotherapy was used for subcutaneous varicosities, while timed microcoagulation with the QMR scalpel was applied to microperforating veins or blue and red capillaries, in a manner similar to other timed microcoagulation techniques. Using shielded microneedles connected to the scalpel handpiece, a blended cutting/timed coagulation mode was used without the use of local anesthetic or pre-cooling in the capillaries. In perforating capillaries, deep microcoagulation was performed in untimed coagulation mode with the same microneedle. The procedure involves skin preparation with a non-alcoholic antiseptic solution. No local or topical anesthesia is used. The sterile disposable microneedle is inserted into the handpiece and connected to the monopolar generator (Fig. 6, 7).

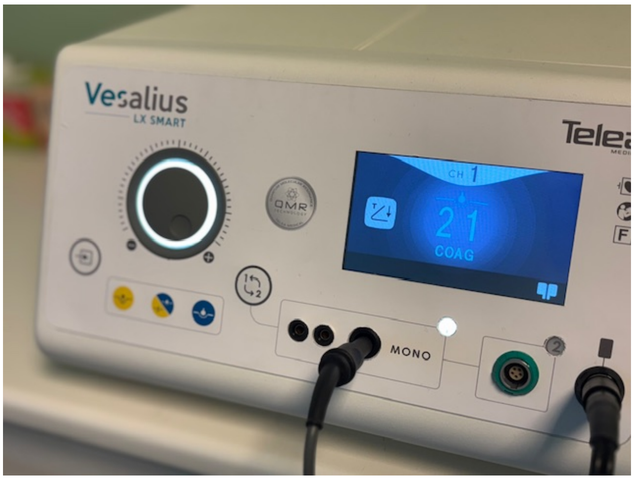


Fig.6. *Non-timed microcoagulation for perforating veins – average baseline power at level 21 (Bacci Archive).*

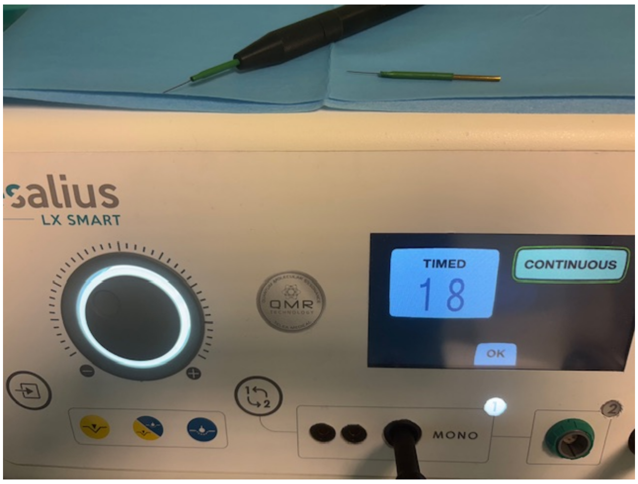


Fig.7. *Timed microcoagulation for capillaries and varicose veins in blended mode with vertical micropuncture technique – Average base power with level 15 and timing of 0.18 seconds, while with the horizontal intravascular technique, the non-blended mode is used, coagulation only with average base power with value 22 and timing of 0.40 seconds (Bacci Archive).*

The generator is set to blended cutting/coagulation mode with a base power level of 15, with power and timing adjusted every 0.18 seconds, depending on skin resistance. The needle is inserted vertically through the skin into the capillary to create microcoagulations, which are activated by pressing the foot pedal. For microperforating vessels, the microneedle is inserted perpendicularly into the vessel using the non-timed coagulation mode. In straight capillaries, the microneedle can be inserted into the vessel to coagulate from the inside, but avoiding the cutting action that could damage the vessel and skin, causing small hemorrhages and pigmentation. In this case, only the coagulation mode is used, with a base timing of 0.40 seconds and increased power settings at levels 22/29, depending on skin and vessel resistance (Fig. 8). The risk of allergic reactions, thrombophlebitis, embolism, or nerve damage is virtually zero due to the low heat production.

Fig.8. *Timed QMR microscleroresonance (Bacci Archive).*

RESULTS

For better data collection, a 2cm x 2cm treatment square was identified on the treatment area. Then, using a Flashpoint F2 Jules Richard class 2 laser thermometer, the temperature was taken before treatment, immediately after treatment, and 2 minutes after treatment (Fig. 9-12).

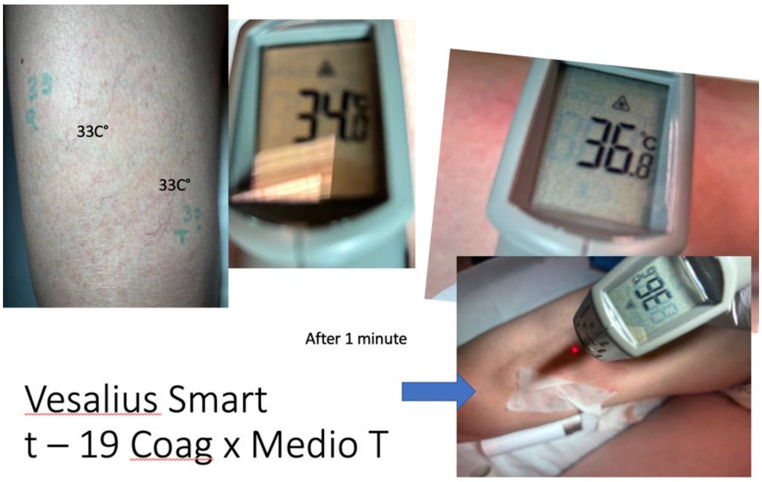


Fig. 9. *Dermal microcapillaries – excellent indication for QMR microscleroresonance (Bacci Archive).*

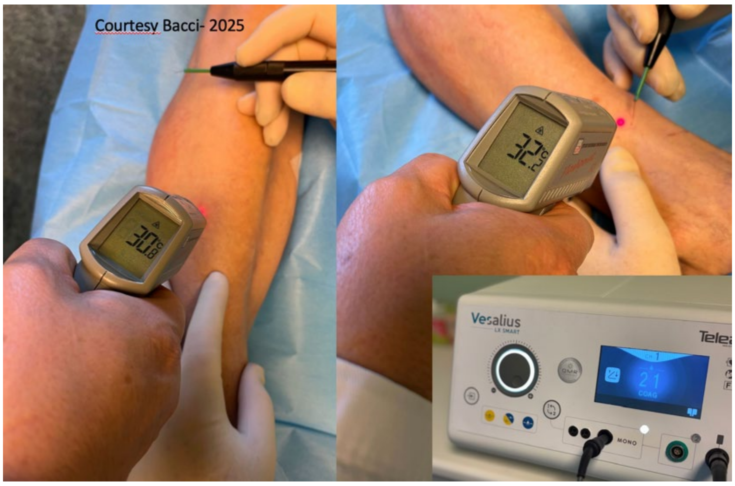


Fig. 10. *Venous microperforating treatment (non-timed QMR coagulation) – temperature increase of 2.2°C (Bacci Archive).*

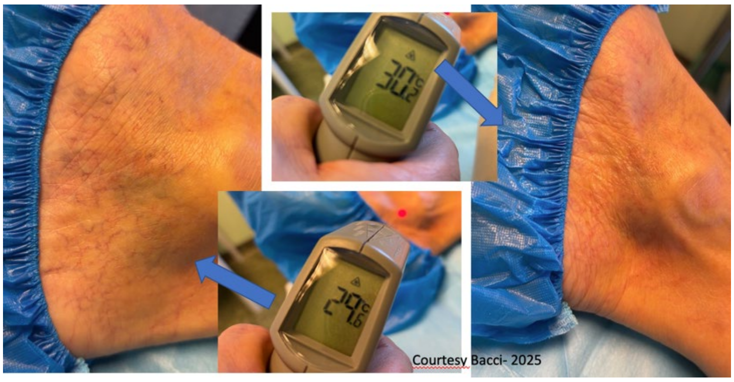
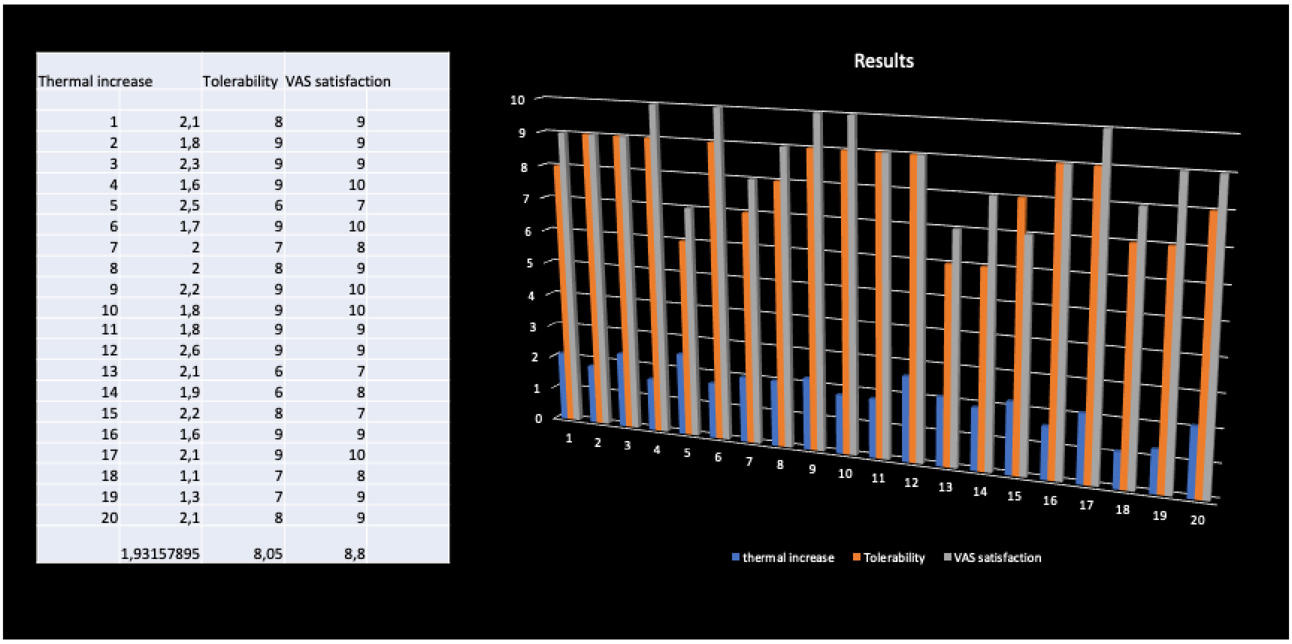


Fig. 11. *Malleolar dermal capillaries (QMR timed and blended coagulation) – temperature increase of 0.6°C (Bacci Archive).*

Fig. 12. *Treatment of blue and dermal capillaries after six days from QMR (Bacci Archive).*

The QMR scalpel induced an average temperature increase of 1.9 degrees Celsius with no immediate or delayed side effects, thanks to the reduced thermal trauma and the precision of the cut/coagulation process, which facilitates accelerated healing processes with controlled scarring without visible signs after 10 days.

The average temperature changes recorded were in the order of 1.9 degrees C, thus a negligible temperature increase using the QMR scalpel. The method demonstrated high tolerability, justifying the avoidance of local anesthesia techniques, with patients' average VAS scores of 8.5 (level 1 to 10) for treatment tolerability and an average VAS score of 8.8 for patient satisfaction after treatment (Fig. 13).



Thermal increase		Tolerability	VAS satisfaction
1	2,1	8	9
2	1,8	9	9
3	2,3	9	9
4	1,6	9	10
5	2,5	6	7
6	1,7	9	10
7	2	7	8
8	2	8	9
9	2,2	9	10
10	1,8	9	10
11	1,8	9	9
12	2,6	9	9
13	2,1	6	7
14	1,9	6	8
15	2,2	8	7
16	1,6	9	9
17	2,1	9	10
18	1,1	7	8
19	1,3	7	9
20	2,1	8	9
	1,93157895	8,05	8,8

Fig. 13. *On the left, the thermal increase schema and the VAS about tolerability and patient satisfaction, on the right, the summary graph with an average of 1.9°C for thermal increase, VAS of 8.0.5 for tolerability, and 8.8 for satisfaction (Bacci Archive).*

The treated patients were monitored after six weeks of treatment, with no evidence of pain, edema, pigmentation, eschar, or relapse.

DISCUSSION

Telangiectasias are visible microvascular formations located at the superficial dermal and subdermal level that open due to increased pressure from the superficial or deep venous systems. They are caused by both reflux from above and impaired drainage, as well as vascular anomalies. Vasodilatory stimuli also originate from the sympathetic nervous system, catecholamines, insulin, thyroid and adrenal hormones, as well as secondary effects of pharmacological therapies, such as hypotensive agents. Increased visibility of dermal capillaries can also be triggered by direct or indirect inflammatory stimuli, often following medical or physiotherapy treatments, including sclerotherapy itself, which uses pharmacological agents to alter the endothelium and progressively reduce varicose veins or capillaries. Overdosing and abnormal individual inflammatory responses may open arteriovenular microanastomoses, leading to matting or pigmentation. Therefore, the minimum amount of sclerosant with the lowest concentration is used to achieve the desired clinical or aesthetic outcome.

Extravasation necrosis is one of the main drawbacks associated with the use of sclerosants. Neovascularization (matting) and therapeutic failures likely occur with the same frequency with all types of sclerosants of the same potency. In fact, hyperpigmentation is reported as a side effect in up to 30% of patients (26). Allergies and anaphylaxis range from 0.01% to 0.9%. Deep vein thrombosis and pulmonary embolism are rare and occur more often in non-ambulatory patients who receive inappropriate compression or present with hypercoagulable states. The literature reports five cases of anaphylactic shock with fatal outcomes (27). Laser technology has enabled more selective and better-tolerated therapies, with greater success in managing rosacea and microvaricosities of the lower limbs, even in combination with sclerotherapy. However, outcomes and side effects depend on the laser source, wavelength, fluence, pulse duration and amplitude, skin cooling, as well as the diameter and color of the target vessel (28, 29).

Laser may cause dyschromia and scarring, while electrocoagulation leads to tissue necrosis due to dermal damage. For this reason, microsclerotherapy with timed electrocoagulators was introduced, which reduces side effects, although it can cause pigmentation and small eschars due to increased heat. Incomplete and short-lived results have also been observed, which can be corrected by increasing the application time or the power of the microcoagulation, although doing so increases the risk of thermal damage (30, 31).

The use of Quantum Molecular Resonance microcoagulation is justified by the characteristics of the instrumentation, which performs atraumatic cutting and gentle coagulation with minimal thermal damage. For this reason, it is adopted in neurosurgery and regenerative medicine for its ability to reduce inflammation and regenerate tissue by activating the stem cell line. Electromagnetic fields play a crucial role in cellular function by interfering with cellular pathways and tissue physiology. Quantum Molecular Resonance (QMR) produces waves with a specific shape at high frequencies (4MHz - 64 MHz) and low intensity through electric fields. This effect on mesenchymal stromal cells (MSCs) results in greater transcriptional changes in treated cells, without altering their morphology, phenotype, or ability to undergo multilineage differentiation. This is especially true given a significant increase in the expression of the MMP1, PLAT, and ARHGAP22 genes, which are involved in extracellular matrix (ECM) remodeling (32, 33).

Radiofrequency is based on electromagnetic energy generated by medical devices that transmit energy capable of penetrating the full thickness of the dermis and traveling through the fibrous septa of the hypodermis to the superficial muscular fascia. As it passes through the tissues, the electromagnetic energy encounters resistance that converts into thermal energy, which increases with depth. When tissue temperature exceeds 40°C, collagen denaturation and fibroblast stimulation begin, enhancing the synthesis of collagen and elastin, water draw, and dermal hyaluronic acid. These effects are also utilized in aesthetic medicine, as the collagen molecule becomes shorter and thicker, thereby increasing dermal firmness with an apparent increase in tone and tension, often resulting in an aesthetically satisfactory outcome, despite reflecting a non-physiological tissue compaction. Exceeding 45°C, thermal damage may occur, triggering inflammation that requires both a repair and a subsequent tissue regeneration process. What makes QMR technology innovative is its ability to act on biological tissue without inducing a temperature increase in the tissue itself. This physiologically stimulates the regenerative capacities of cells and biological tissues, replacing the repair process with stem cell-based regeneration.

Compared to the use of traditional radiofrequency scalpels, which operate at higher temperatures and cause thermal alterations in the skin, the use of the QMR Quantum Molecular Resonance scalpel offers gentler treatments with less thermal damage and improved healing outcomes (34, 35).

CONCLUSION

Capillaries and telangiectasias are truly aesthetic conditions that must be diagnosed and classified before choosing the best treatment. Phlebology identifies microsclerotherapy as the primary therapeutic approach. The purpose of this study is to observe the benefits of microsclerotherapy combined with Quantum Molecular Resonance microcoagulation, reducing the side effects of both methods and maximizing their synergistic benefits.

The demonstrated anti-inflammatory and regenerative effects of Quantum Molecular Resonance (QMR) in gynecology, orthopedics, rehabilitation, and tissue engineering supported interest in a method that does not induce tissue hyperthermia by transferring energy directly on molecular bonds, altering their energetic state to activate essential regenerative processes. As a non-invasive technique capable of acting on biological tissue without raising tissue temperature, Quantum Molecular Resonance (QMR) is well-suited for regenerative medicine and aesthetic pathologies treatments, particularly in anti-aging treatments. The precision of the incision and the reduced surgical trauma with the QMR scalpel offer clear clinical advantages over electromedical devices and multi-wavelength lasers in dermatology, neurosurgery and oro-maxillofacial surgery.

Some observations have demonstrated excellent results with microsclerotherapy for reticular varicose veins, while QMR microresonance has demonstrated superior outcomes in the treatment of red dermal telangiectasias. The combination of these techniques reduces the risk of matting and pigmentation by limiting the concentration and diffusion of the sclerosant due to vessel occlusion.

The use of microelectrotherapy with a Quantum Molecular Resonance (QMR) bioelectronic scalpel has demonstrated positive results, significantly reducing skin thermal heating in the treatment of capillaries and telangiectasias. Its combination with microsclerotherapy reduces the risk of inflammatory responses and pigmentation, resulting in the development of "QMR microscleroresonance" that presents itself as an interesting new approach in aesthetic phlebology.

Conflicts of Interest

Gianantonio Pozzato and Alessandro Pozzato are employees of Telea Electronic Engineering S.r.l., Sandrigo (VI), Italy, the company that owns the rights to use QMR technology for regenerative medicine purposes. Telea Electronic Engineering S.r.l. provided unconditioned funding but had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results. All the other authors declare no conflicts of interest.

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