

EFFECT OF MICROFOCUSED ULTRASOUND APPLICATION WITH THE PEN TIP, AN ANATOMICAL APPROACH TARGETED FOR FACIAL ANCHORING: PRECISION AND SAFETY IN NON-SURGICAL REJUVENATION

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Article Info

Article Received: 14 Sept 2025,
Article Revised: 02 October 2025,
Published on: 15 October 2025.



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How to cite this Article:

Dra Daniela Baptistini Moleiro, (2025).
EFFECT OF MICROFOCUSED
ULTRASOUND APPLICATION WITH
THE PEN TIP, AN ANATOMICAL
APPROACH TARGETED FOR
FACIAL ANCHORING: PRECISION
AND SAFETY IN NON-SURGICAL
REJUVENATION. World Journal of
Internal Medicine and Surgery, 2(8), 22–
31.

<https://doi.org/10.5281/zenodo.17405934>

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ABSTRACT

The demand for non-invasive, low-cost treatments for facial rejuvenation and lifting has increased significantly in recent decades. Portable microfocused ultrasound with a pen tip, using "point-to-point" microthermocoagulation technology, is a technology capable of thermally stimulating different tissue depths, including the superficial musculoaponeurotic system (SMAS) and the deep and superficial dermis at different depths, generating SMAS contraction and restoring dermal reorganization, primarily associated with collagen synthesis through HSP47 activation, with a tissue anchoring effect and skin firmness. In this study, we used the protocol previously validated by the authors, which facilitates tip selection based on the anatomical tissue depth and subcutaneous fat thickness. The technique is based on measuring tissue thickness by manual clamping adipometry, using an adipometer in strategic anatomical regions, such as the submental region (double chin), the lower third of the face, and the upper eyelid. Skinfold thickness is interpreted as a 50% reference point for selecting the ideal tip, correlating it with the necessary and safe depth of action for intentional layered application. The therapeutic approach improved the firmness and tissue support of the dermis, particularly in the subocular region, temples, and nasolabial fold. Therefore, it can be concluded that the use of microfocused ultrasound with the point-by-point technique and following the depth chart in the facial region is a safe and effective therapeutic approach for treating skin aging, as it improves tissue support and restores the tissue matrix, which also contributes to improving skin laxity. More importantly, intentional compaction of loose tissue and a natural facial contour were observed.

KEYWORDS: Microfocused ultrasound, adipometry, SMAS, facial aesthetics, clinical planning, dermatology, aesthetic technologies, cadaveric facial dissection.

1-INTRODUCTION

Due to numerous reports of complications and complications after surgical interventions and invasive procedures for treating sagging skin and rejuvenation, the demand for non-invasive procedures with shorter recovery times has become a cornerstone

of aesthetic treatments, treatments that also involve fewer complications. Recent scientific literature reports a number of cases of complications, including facial nerve injuries (Jacono, 2019; Moleiro, 2025).

Microfocused ultrasound is a technology with proven efficacy in aesthetic clinical practice and widely used in the treatment of facial sagging.

Its action occurs through the generation of focused heat at different tissue depths, promoting controlled thermal coagulation, tissue retraction, and stimulation of neocollagenesis (Alam, 2010; Moleiro, 2025). Despite its proven effectiveness, in daily practice, we observe the indiscriminate application of standardized protocols, in which tips with depths of 4.5 mm, 3.0 mm, and 1.5 mm are systematically used, regardless of the individual anatomical characteristics of the patients (Wanitphakdeedecha, 2011; fabi, 2014; Moleiro, 2025). These standardized approaches ignore significant variations in facial tissue thickness between individuals, especially regarding the density and depth of adipose compartments. Patients with thinner facial structures, low subcutaneous volume, or a genetic predisposition to thinner fat may experience unfavorable results when undergoing deep microfocused ultrasound without prior evaluation. In these situations, hypodermic debulking is frequently observed, contributing to facial volume loss and the appearance of residual sagging due to volumetric deflation. This is not attributed to a technological failure, but rather to the compromise of facial anatomical support exposed to the technology's thermal energy (Beer, 2019; Bertossi, 2015).

Subcutaneous tissue plays a fundamental role in supporting the skin and maintaining facial contours. Unplanned destruction of adipose compartments can result in undesirable aesthetic changes, such as deep furrows, tissue sagging, and the appearance of premature aging (Rohrich, 2007). This condition reinforces the importance of a personalized approach, based on the assessment of actual tissue thickness, for the safe selection of the microfocused ultrasound application depth.

Understanding the superficial musculoaponeurotic system (SMAS) (Surek, 2019) is extremely important. The SMAS has been considered a fundamental pillar of facial rejuvenation, where volumization and facial lifting can be achieved through non-surgical treatment techniques (Beer, 2019; Bertossi, 2015).

In this context, this study describes a clinical methodology for individualized planning of microfocused and macrofocused ultrasound application on the face, based on skinfold thickness measurements using a clinical adipometer (Moleiro, 2025). The technique consists of measuring tissue thickness in strategic areas, such as the submental region, the lower third of the face, and the upper eyelid region, using 50% of the measured value as the technical criterion for defining the ideal tip. The

proposed methodology was validated with imaging ultrasound, allowing correlation between clinical reasoning based on adipometry and the actual visualization of anatomical structures, such as the SMAS, the deep dermis, and the superficial dermis (Moleiro, 2025). As a result, a practical reference table was developed for clinical use to guide aesthetic and healthcare professionals in choosing the personalized injection depth, promoting greater safety and predictability in results and individual customization, encompassing three facial profile classifications (Moleiro, 2025).

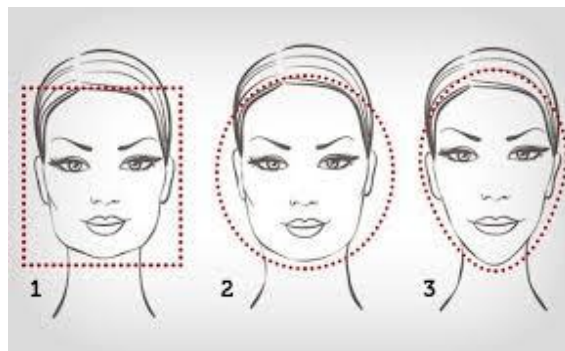


Figure 1: Facial profile.

"Point-to-Point" Technology

Microfocused ultrasound technology aims to deliver targeted energy to single points, capable of producing a microthermal lesion in the target tissue. The equipment used in this article allows this energy delivery at no additional cost and with unlimited shots. The VISAGE® device, developed and manufactured by the Brazilian Medical Equipment Industry – IBRAMED, can be used. This device can reach different depths in the target tissue. In this study, three types of applications were used, with distances of 4.5, 3.0, and 1.5 mm, which can deliver the desired energy from the musculoaponeurotic system (SMAS) layer to the papillary and reticular dermis layer, considered more superficial. Point-to-point energy emission, in this case, originates from a metal concavity at the tip and emits one shot at a time. The applicator requires dexterity in moving the device through the tissue, allowing the heat to be correctly directed to the tissue layers. With the lifting effect, the "point-to-point" application method offers anatomical benefits to the tissues and anchoring structures. The entire process is only possible due to precise mathematical calculations. With technological innovation and professional autonomy regarding application strategies, new and interesting therapeutic approaches emerge that benefit from microfocused ultrasound and expand into different areas of facial treatment.

Anatomy of the SMAS

The SMAS can be didactically separated into upper and lower facial components, this division being related to the position of the zygomaticocutaneous ligaments. With this definition of upper and lower, it is possible to obtain an imaginary line described by the authors as the malar equator (Samb, 2017; Cotofana, 2019; Surek, 2016).

The importance of anatomical knowledge of the SMAS in the application of microfocused ultrasound

The main objective of microfocused ultrasound technology is to achieve a non-surgical lifting effect through the retraction and anchoring of the SMAS (Superficial Musculo-Aponeurotic System). Studies such as that by João Pantojo Neto and Fabio César Prosdócimi (Moleiro; Ruiz et al. 2025), who performed anatomical dissections on fresh cadavers, confirm the complexity and continuity of the SMAS in facial regions—including the nasolabial fold, infraorbital fold, cheek, angle of the mouth, and nasal ala—revealing fibromuscular structures with dense collagen and elastic fibers of varying calibers.

This morphofunctional basis corroborates the precise use of microfocused ultrasound, as approximately 70% of the retraction promoted by the equipment is directly related to the repositioning of the SMAS, and not just the stimulation of superficial collagen. Therefore, knowing the anatomical areas and the exact depth of application is essential to correctly anchor the tissues, generate the desired lifting effect, and ensure the safety of the procedure. The SMAS, involving muscles such as the orbicularis oculi, platysma, and occipitofrontalis, functions as an anatomical bridge between facial expressions and skin architecture. Therefore, when tensioned by technologies such as microfocused ultrasound, it provides improved facial contours, gravitationally lifted ptosis, and compacted loose tissue, with a true anti-aging effect.

Use of the Adipometer in Advanced Aesthetics: Anatomical Basis and Integration with Microfocused Ultrasound

The adipometer is an anthropometric assessment instrument used to measure the thickness of the skinfold, composed of skin and subcutaneous adipose tissue. When performing the fold, the practitioner pinches the superficial layer of the skin along with the adipose tissue, preserving the deeper layers, such as the muscle fascia, the superficial musculoaponeurotic system (SMAS), and the internal fibrous septa (Durnin & Womersley, 1974; Jackson & Pollock, 1985).

The tissue compressed in the adipometric fold includes:

Epidermis and dermis (skin structures);

Hypodermis, especially the superficial and intermediate fat lobules.

Tissues that are not pinched (i.e., preserved during the measurement) include:

The SMAS (when on the face);

Deep muscle tissue;

Deeper vascular and nervous structures, which are not involved in the fold.



Figure 2 and 3: Practical use of the adipometer.



Figure 4: Practical use of the adipometer

This anatomical understanding is essential for establishing precise clinical reasoning when selecting surgical tips and depths when using microfocused or focused ultrasound (HIFU). By correlating the thickness of the fold with the available tips (e.g., 1.5 mm, 3.0 mm, 4.5 mm), it is possible to direct the ultrasound energy to the desired plane, whether dermal, subcutaneous, or SMAS, with greater safety and specificity, respecting the anatomical structure and physiological volume individually in each anatomical region of the face (Moleiro, 2025).

The combination of adipometry and focused ultrasound offers three fundamental clinical advantages:

A personalized protocol according to tissue thickness, promoting more effective results;

It avoids unwanted deflation, especially in areas of facial or body support, preventing side effects such as premature structural aging or post-treatment depressions;

It promotes safety by respecting anatomical risk areas and avoiding the application of energy at depths incompatible with the individual's body type.

Furthermore, the use of adipometric fold thickness as a clinical reasoning tool is in line with the current trend toward evidence-based aesthetics and functional anatomy, favoring individualized and preventive treatments (Rzany & Wanitphakdeedecha, 2020).

2. MATERIALS AND METHODS

Conventional clinical practice in the application of micro- and macro-focused ultrasound is still largely based on standardized protocols, with the frequent use of the 4.5 mm tip as the first therapeutic injection. This depth is associated with thermal contraction of the superficial musculoaponeurotic system (SMAS) and is considered ideal for promoting lifting and an immediate tightening effect (1). However, the indiscriminate adoption of this approach, without considering individual tissue thickness, can compromise the anatomical safety and efficacy of the procedure.

Faces with less subcutaneous tissue or more delicate anatomical features may not have sufficient thickness to justify the use of the 4.5 mm tip, which can cause the ultrasound to penetrate deeper than intended, even reaching muscle or bone structures. This can result in exacerbated discomfort, undesirable anatomical changes, or even lack of clinical results. Therefore, this study adopted a descriptive, cross-sectional, and technical validation approach to propose and evaluate a customized methodology for planning the application of microfocused ultrasound to the face. The proposal is based on measuring skinfold thickness using a clinical adipometer (Sanny® scientific adipometer, 0.1 mm accuracy) and calculating 50% of the measured value, considering that pinching involves two layers of subcutaneous tissue, as the clinical criterion for defining the ideal tip depth.

Measurements were taken at three strategic anatomical points: the submental region (double chin), the lower third of the face (mandibular line), and the upper eyelid region. At each point, bilateral skin clamping was performed with the patient at rest, maintaining a standardized caliper angle and pressure. The average of the measured folds was used to calculate 50% of the tissue thickness. The resulting value was correlated with the operating depth of the ultrasound equipment's tips.



Figure 5: Measurement of the adipometry fold of the upper face.

To validate the methodology, an ultrasound imaging system (Samsung Medison HS40®, 7.5-12 MHz multifrequency linear transducer) was used, which allowed real-time visualization of the dermal, subcutaneous, and SMAS layers. Ultrasound analysis was performed on the same clamped areas, recording the actual depth of each anatomical layer.



Figure 6: Photo of the capture of the ultrasound image areas in the comparison and validation of the use of adipometry fold with the depth of the structural and anatomical areas.



Figure 7 and 8: Research photo of anatomical areas measuring the depth and thickness of tissues with ultrasound imaging, mapping areas of SMAS, subcutaneous, deep and superficial dermis.

The comparison between clinical reasoning based on adipometry (50% of the skinfold thickness) and ultrasound findings allowed us to validate the method's accuracy in selecting the ideal tip. Based on these data, a reference table was created with the average skinfold values and their respective indicated depths, including safety zones for clinical application. This table aims to assist aesthetic and healthcare professionals in the safe and personalized planning of microfocused ultrasound applications, based on objective and accessible data, reducing risks and optimizing results (Moleiro, 2025).

To further explore the clinical justification for the application of microfocused or focused ultrasound (HIFU – High-Intensity Focused Ultrasound) in facial harmonization, we performed anatomical analyses in the laboratory on fresh cadaveric specimens, with an emphasis on the facial region. During the dissection procedure in the cadaver laboratory, we observed the reflection of successive layers of tissue: skin, superficial fat, and deep fat, leading to direct exposure of the Superficial Musculo-Aponeurotic System (SMAS).

Visual identification and analysis of the layers allowed us to verify tissue thickness and quality in different facial areas, as well as structural changes related to aging, such as sliding of the adipose compartments, ligamentous laxity, and loss of SMAS tone. This analysis reinforces the strategic and safe choice of microfocused ultrasound action plans, which aim to provide controlled thermal stimulation to promote retraction and non-surgical lifting.

Microfocused ultrasound works by deposition of thermal coagulation points (TCPs), concentrating energy at specific depths (1.5 mm, 3.0 mm, and 4.5 mm), depending on the tip used. The temperature reached at the focal points can range from 65°C to 70°C, which is sufficient to cause selective collagen denaturation, followed by neocollagenesis and tissue retraction, without compromising the superficial layers (Moleiro, 2025). The 4.5 mm plane is generally used for SMAS and is primarily responsible for the lasting effect of the facelift. The 3.0 mm and 1.5 mm planes act on superficial fat and the deep dermis, respectively, improving skin texture and firmness (Moleiro, 2025). Correct anatomical identification of these planes during dissection reinforces the importance of technical precision in tip selection based on tissue thickness assessed clinically, for example, through digital adipometry.

Therefore, the combination of practical anatomical knowledge (through dissection), personalized clinical assessment, and the use of microfocused ultrasound at anatomically appropriate depths forms the basis for

safe and effective non-surgical facelift protocols. Selective plane stimulation structural, such as SMAS, guarantees natural facial support and traction, with progressive and long-lasting results (Moleiro, 2025).



Figure 9: Anatomical dissection of a cadaveric specimen demonstrating the SMAS, adipose compartments, and muscular plane (Moleiro, 2025).

Clear visualization of the overlapping superficial and deep fat pockets and the separation between the subcutaneous and musculoaponeurotic planes.

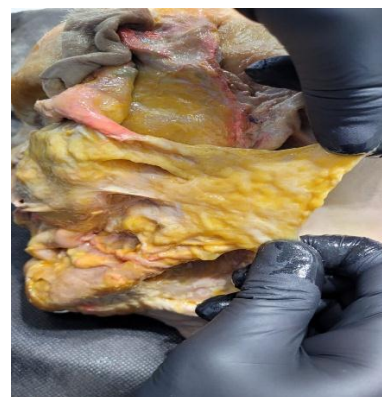


Figure 10: Sagittal section demonstrating multiple facial fat compartments and the SMAS plane.

The distribution of laminar structures and the continuity of fibroadipose tissue are highlighted, highlighting the importance of adipometry planning for clinical safety in deep injections.

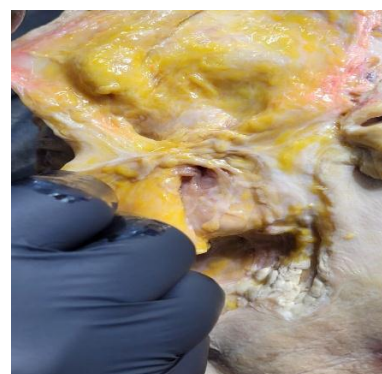


Figure 11: Reflection of subcutaneous tissue, highlighting the transition between fat and SMAS.

Demonstrates the three-dimensional anatomy involved in facial support and reinforces the importance of maintaining optimal depth to prevent facial depression.



Figure 12: Top-down view of SMAS thickness in the lateral region.

This image illustrates the clinical application of three-dimensional anatomical knowledge in planning the tip to be applied, especially in areas of critical thickness.



Image 13: Photograph of a dissected anatomical specimen from the lower third of the face, with arrows indicating the SMAS, fat compartments, and muscles. Ideally, in lateral or sagittal view.

In the upper eyelid region, anatomical sensitivity is even greater. The measured skinfold thickness ranged from 3 mm to 7 mm, and in all cases, the recommended probe was the shallowest (1.5 mm), with energy and shot density adjustments. Ultrasound revealed the proximity of the orbicularis oculi muscle and the need for extreme caution to avoid structural damage or functional alterations.

Images obtained through anatomical dissection of fresh cadavers demonstrated the natural variation in SMAS depth between individuals and reinforced the lack of a fixed standard for defining the ideal probe. Visual and photographic analysis of the anatomical planes confirmed the positioning of the structures measured clinically and by imaging, validating the use of adipometry as a safe and accessible clinical tool for microfocused ultrasound treatment planning. Triangulation of adipometry, ultrasound, and anatomical data from the dissected specimen allowed the development of a clinical reference table, combining skinfold ranges by anatomical region and recommended probes with safe depth zones for therapeutic intervention. This table was developed as a clinical support tool for the assertive selection of a focused ultrasound probe, whether microfocused (focusing on superficial layers) or macrofocused (penetrating deeper planes to interact with subcutaneous tissue) (Moleiro, 2025).

Selection is based on an assessment of the anatomical skin fold, facial or body, which considers the thickness of the pinchable tissue (skin and subcutaneous tissue) and the analysis of sagging or fat accumulation in the region.

Skinfold Thickness (100%)	Tip Selection (50%)
Above 3.0 mm	1.5 mm
Above 4.0 mm	2.0 mm
Above 6.0 mm	3.0 mm
Above 9.0 mm	4.5 mm

Description of the Clinical Reasoning Table for Choosing a Microfocused Ultrasound Tip

The proposed methodology proved to be viable, safe, and effective.

Recommendation for adopting the medical record as a personalized clinical guide.

Anatomical Region	Measured Skinfold (mm)	Estimated Depth (50%) (mm)	Recommended Tip (mm)	Technical Notes
Submental (Double Chin)	10 mm	5 mm	4.5 mm	Ideal for SMAS targeting in patients with cervical fat
Submental (Double Chin)	9 mm 6mm	4.5 mm 3mm	3.0 mm	When SMAS is more superficial or in a thin face
Mandibular Line (lower third)	9 mm 12mm	4.5 mm 6mm	4.5 mm	Evaluate lateral face thickness in men or women
Mandibular Line	5 mm 7mm	2.5 to 3.5 mm	3.0 mm	Thin face: adjust energy to avoid volume loss
Upper Eyelid	4 mm 6mm	2 mm 3 mm	1.5 mm	Superficial action with lower energy
Upper Eyelid	< 4	< 2 mm	1.5 mm with adjustment	Use reduced energy density for shots

Through anatomical studies performed on fresh cadavers, we developed a valid and innovative clinical methodology for individualized planning of micro- and macro-focused ultrasound applications on the face. The technique is based on measuring tissue thickness by manual clamping adipometry, using a caliper in strategic anatomical regions, such as the submental region (double chin), the lower third of the face, and the upper eyelid. Skinfold thickness is interpreted as 50% of the measurement as a reference for selecting the ideal tip (cartridge), correlating it with the required depth of action.

We validated the methodology through real-time ultrasound examinations, which allowed us to establish a correlation between soft tissue thickness and anatomical planes of energy action, such as the SMAS, the deep dermis, and the superficial dermis. Based on combined adipometry and ultrasound analysis, we developed a clinical reference chart to guide aesthetic healthcare professionals in the safe and personalized selection of pen tips, promoting greater predictability of results, therapeutic personalization, and clinical safety.

3. CLINICAL RESULTS: APPLICATION TECHNIQUES "POINT BY POINT"

The application of microfocused ultrasound using a pen-type transducer should be conducted with strict adherence to safety criteria and patient individuality. Initially, it is essential to assess cutaneous sensitivity as well as the local adipometry of each facial region in

order to determine appropriate energy limits and to prevent excessive discomfort or potential tissue injury. The sequence of application must follow a pattern progressing from the deepest to the most superficial layers, ensuring effective stimulation of the SMAS, subcutaneous tissues, and dermis.

A uniform distribution based on facial anatomy and the specific needs of each patient should be maintained throughout the procedure. The number of shots indicated in the protocol refers to the total count of focal shots delivered with the transducers, considering each treated point individually. Adjustments in the number of shots should be made according to the anatomical region, skin thickness, and patient tolerance, ensuring procedural uniformity and safety.

During application, the transducer should be positioned perpendicularly at a 90° angle to the skin surface to avoid excessive overlap in sensitive areas or regions with thinner dermal layers. The patient's response should be continuously monitored, allowing for energy parameter adjustments when necessary. The point-by-point technique provides precise energy delivery, promoting uniform and safe outcomes. Its success depends on respecting patient individuality and facial anatomy, thereby optimizing clinical effects and minimizing discomfort.

Area	Number of shots (per hemiface)	Depths (from deepest to most superficial)
Upper third	700	3.0 mm → 1.5 mm
Middle and lower third	3,800	4.5 mm → 3.0 mm → 1.5 mm
Submental region (double chin)	2,800	4.5 mm → 3.0 mm → 1.5 mm
Neck	3,500	4.5 mm → 3.0 mm → 1.5 mm

General application guidelines for all areas and depths

1. Assess the patient’s local adipometry to determine the appropriate transducer cartridges.
2. Application may be performed up to **three times on the same area**, according to clinical indication, individual assessment, and treatment objectives, considering patient tolerance and sensitivity.
3. Respect the sensitivity limits and the specific anatomical characteristics of each facial region.

Photographic analysis demonstrated improvements in skin texture and quality. Overall, an increase in tissue support was observed, resulting in the smoothing of the nasolabial fold and deep wrinkles in the forehead region.

In addition, significant improvement was observed in the upper eyelid, likely due to the treatment applied to the area between the frontal and temporal bones, extending to the scalp. Another area that benefited from this application was the upper eyelids and fine wrinkles around the lateral eye area. Regarding tissue vitality, the entire face showed visible improvement, with special emphasis on the mid and subocular regions, which clinically translated into a rejuvenated appearance and reduced sagging, commonly associated with a tired appearance.



Figure 14: patient A.M 61 years.



Figure 15: patient P.M 43 years.



Figure 16: patient E.P 51 years.



Figure 17: patient A.B 40 years.



Figure 18: patient T.F 69 years.

4-DISCUSSION

Microfocused ultrasound technology, which targets the Superficial Musculoaponeurotic System (SMAS), leading to significant tissue contraction that results in a lifting effect, has proven to be an effective, safe, and cost-effective technique. Given these characteristics and its biological mechanism of heat-induced coagulative microinjury, this technology is applicable to various areas of the body, especially the face.

Our methodology proved to be effective and efficient after in vivo analyses on fresh cadavers. The objective of this study was to evaluate the effects of microfocused ultrasound using point-to-point and scanning application modes as part of a therapeutic strategy for the treatment of age-related facial changes.

The results revealed notable improvements in facial tissue support. In the forehead and eyebrow regions, an observable lifting effect was achieved through structural reinforcement, contributing to a better appearance of the eyelids and overall facial lift. These aspects were evaluated and confirmed by Moleiro et al. (Moleiro, 2025) in previous studies. Microfocused ultrasound energy has distinct properties that promote tissue support through dermal matrix replacement. This is directly linked to its ability to deliver targeted energy at different depths. In the case of treatment in deeper layers, such as SMAS, it is clear that the induced microinjury results in a facial lift, with a significant improvement in overall muscle support, which significantly improves the appearance of the final result.

At shallower depths, the treatment acts on the papillary and reticular dermis, primarily stimulating dermal regeneration and collagen synthesis. This process not only strengthens tissue structure but also improves skin elasticity, hydration, and overall vitality.

The main mechanism of action of microfocused ultrasound involves the precise and intense application of energy in a short period of time (20 to 50 milliseconds), reaching various depths and effectively inducing thermal microlesions in three main layers: the musculoaponeurotic layer, the papillary dermis, and the reticular dermis, up to approximately 5 mm in depth. Once these microlesions are established, the tissue repair process begins, progressing through the phases of inflammation, proliferation, and remodeling, with the primary goal of dermal reconstruction through collagen synthesis. For treatments that induce internal lesions, it has the advantage of not causing changes to the epidermis. Therefore, the patient does not require special care after application, and no

morphological changes, irritation, or erythema are visible in the superficial layer (Rzany, 2020; 2015).

Previous research reports that fibroplasty is activated by the activation of the expression of the HSP47 protein, which is responsible for the quality of collagen cross-linking. The results of the clinical cases presented in this study demonstrate the effectiveness of the method and equipment, due to significant changes after one month of treatment.

We conclude that microfocused ultrasound is effective in promoting facial rejuvenation, with notable improvements, especially in the subocular region, nasolabial folds, and temples. This allows for painless and non-invasive therapeutic improvement of the facial contour, using the fold measurement methodology and the correct selection of the pen tip.

5-CONCLUSION

Through the evaluation protocol, which measured tissue thickness by manual adipometry and used the proposed table with a 50% reference point for selecting the ideal tip, correlating it with the required depth of action and for intentional layering, the therapeutic approach improved the firmness and tissue support of the dermis, especially in the subocular region, temples, and nasolabial fold. Thus, it can be concluded that the use of microfocused ultrasound with the point-by-point technique and following the depth chart in the facial region is a safe and effective therapeutic approach for the safe treatment of skin aging, as it improves tissue support and restores the tissue matrix, which also contributes to the improvement of skin laxity. More importantly, intentional compaction of loose tissues and a natural facial contour were observed.

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Application of Micro and Macrofocused Ultrasound: Validation with Imaging Ultrasound
IOSR Journal of Pharmacy (e-ISSN: 2250-3013, (p)-ISSN: 2319-4219, August 2025; 15(8): 01-15.