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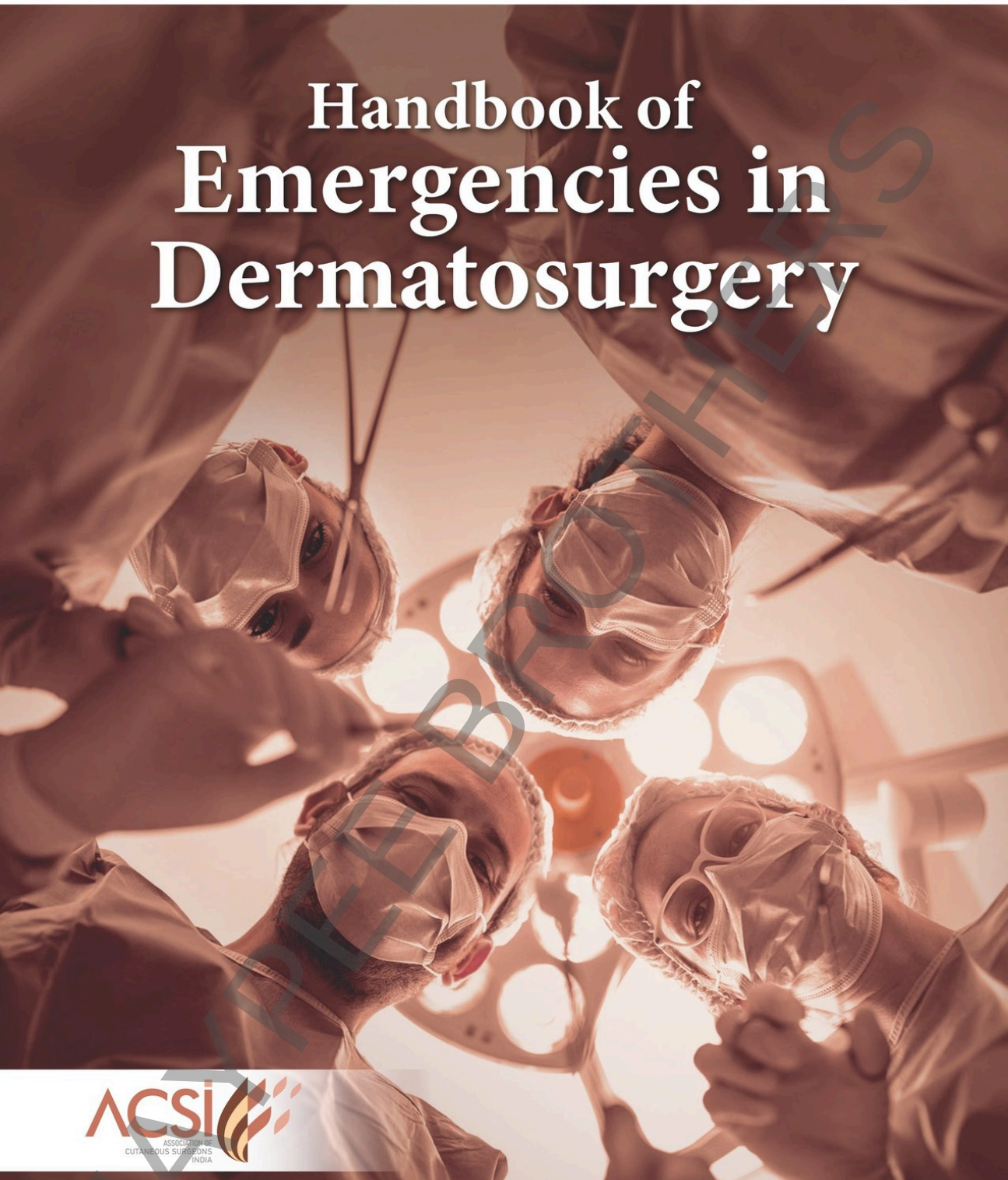
Handbook of Emergencies in Dermatosurgery



ACSI
ASSOCIATION OF CUTANEOUS SURGEONS INDIA

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CHAPTER 21

Emergencies during Non-laser Energy-Based Devices

Shehnaz Arsiwala, Nazneen Arsiwala

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INTRODUCTION

Energy-based devices such as radiofrequency (RF) and high-intensity focused ultrasound (HIFU) therapies for face lifting, tightening, and shaping have gained popularity in last few years due to safe and noninvasive technique. While these treatments have to be performed by qualified trained physician. It is often delegated to technical or nursing staff or also used by nonqualified personnel increasing potential risks of faulty treatments and instead risk for complications.

Radiofrequency therapy utilizes nonionizing electromagnetic radiation which is chromophore—independent and works on principle of impedance where the energy has better penetration to the dermis and hypodermis as compared to light-based technologies which are chromophore dependent. The use of RF overcomes some of light-based disadvantages offering enhanced tissue penetration independent of skin color. Clinical treatment systems using RF energy were proven in the last decade to be safe and effective for both nonablative skin tightening of the face and body, and fractional RF skin resurfacing for skin.[1]

The RF devices can be monopolar, bipolar, tripolar, or multipolar, each having its variable depth of penetration due to depth of current flow, each type of RF device has its own advantages and disadvantages. RF devices that deliver energy with microneedles and nonneedle fractional resurfacing are very popular for acne scars and improvement of skin texture and open pores.

MONOPOLAR RADIOFREQUENCY TECHNOLOGIES[1]

Single electrode is controlled by one RF generator enabling energy flow through the body by a grounding pad, the subsequent penetration is deeper than bipolar. Monopolar (MP) energy delivery results in high temperature near the electrode, requiring intense epidermal cooling, and uncontrolled energy spreading toward the grounding pad. It may be painful since higher power is required to "push" the RF from the single electrode into the skin. Disadvantages include pain and risk of epidermal burns.

BIPOLAR RADIOFREQUENCY TECHNOLOGIES[1]

One RF generator controls two electrodes, there is only superficial penetration since the energy flows along the shortest path, between the two electrodes. It requires active cooling of electrodes to prevent epidermal burns. Complications include epidermal burns if cooling is inadequate.

MULTIPOLAR RADIO-FREQUENCY TECHNOLOGIES[1,2]

One RF generator controls 3–5 electrodes, there is only superficial penetration since the energy flows along the shortest path, between the three and five electrodes (similar to bipolar RF). No cooling is needed because the energy is split between two or more receiving electrodes. Minimal risk of complications

MULTISOURCE: PHASE CONTROLLED RADIOFREQUENCY[3-5]

Achieves deep delivery of RF energy into the skin through a focused and contained deep energy flow and a minimal surface energy flow thus eliminates the need for intense cooling. This makes the RF tightening totally safe and painless.

Personalized parameters based on multiple unique automatic skin sensing feedback mechanisms enable precise treatment.

Skin impedance depends on patients' condition during procedure causing unpredictable electrical heating in dermis leading to unwanted adverse effects.[4]

Important factors which define safe use of radiofrequency tightening:

- Ultrasonic gel is mandatory to protect epidermis
- Room temperature ultrasonic gel, not to be cooled
- No anesthesia
- Can perhydrate with sheet mask for better impedance
- Multipass technology sensor operated, fast hand movements, graded heating, not to cross 42–43°
- Popular erythema or edema as endpoint

Risks during treatment which can lead to complications during RF tightening include:

- Insufficient gel
- Slow hand movements, static shots, and poor motion technique
- Treating on damp skin
- Lifting on hand piece or break in continuous skin contact
- Overheating leading to visible blistering
- Pain while treatment which is unbearable.
- Active infection in treatment area
- Presence of metals on or inside body—area of treatment

COMPLICATIONS OF RADIOFREQUENCY TIGHTENING[5,6]

Adverse effects of RF tightening are very low, especially with the newer generation technologies such as optimal epidermal cooling and vibratory tips and sensor control.

Pain or heat sensation during treatment—this is transient and equivalent to volumetric bulk heating in treatment area and it is generally not persistent.

Edema and erythema are normal end point of a good RF cycle and settle in minutes to an hour; persistent erythema and edema can be seen with sensitive skin types and high energy levels and prolonged overheating.

Skin burns—first- or second-degree burns can occur with RF tightening if skin is overheated and temperature is not monitored, mostly due to epidermal damage.

Scars and pigmentation—RF can cause scarring if tissue temperature is not respected and results in vesicles or blisters; in dark skin types, this can also lead to hyperpigmentation on resolution.

Management of Complications

Pain can be managed by lowering energy levels; however in order to maintain adequate heating, number of passes may have to be increased, it is mandatory to measure temperature using a temperature

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gun after every 1–2 passes to ensure that consistent thermal balance is maintained. Surface anesthesia is to be avoided as patient feedback is important for degree of heating.

Edema and erythema if persistent can be treated with mild topical steroids if needed. If any active pustule acne is present topical antibiotics may be prescribed. Scarring has to be managed with steroid, anticritical combinations, sun protection, and interventions where needed.

Microneedle radiofrequency (MNRF)[7-10] is a novel method that allows nonthermal penetration of the epidermis followed by RF coagulation in selected depth of the dermis surrounded by zone of noncoagulative volumetric heating using smooth motion, extra sharp microneedles each having a diameter of 300 µm and tapered at the edge.

The first-generation MNRF delivery technology used insulated needles and microneedles allowed the heating of small volume of dermal tissue with energy flow at the needle tip while the rest of the needle was insulated.

Microneedle radiofrequency enables nonheat penetration of epidermis, higher penetration of dermis with bulk heating up to 3.5–5 mm depending on needle depth. This causes less down time, less erythema and edema. There is additional benefit of mechanical scar disruption and less pain. A physician can also deliver ability to deliver transepidermal drugs after treating with MNRF.

Since MNRF is not chromophore dependent, it has gained most popularity for treating various scars and conditions in skin of color due to low incidence of post-inflammatory hyperpigmentation after MNRF which is significant for Indian skin types compared to laser devices which are chromophore dependent **(Fig. 1)**. Difference in physical effects of light and RF, fractional lasers-damage to the dermoepidermal junction and dropping of melanin to the dermis. The smooth-motion, extra-sharp microneedle is less traumatic to the epidermis and epidermal dermal junction leading to a decreased chance of PIH in microneedle RF treatments.

The reduced pain experience in microneedle RF treatment may be related to sharpness of the needles and the unique smooth needle motorized insertion. The earlier systems inserted needles mechanically using a spring and the latest generation systems use electronically controlled



Fig. 1: Hyperpigmented microneedle footprints after microneedle radiofrequency (MNRF).

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motorized systems which inserts needles gradually. Second important differentiating feature involves the needle quality basically the sharpness and coating material.

The RF systems enable use of insulated, partially insulated, and noninsulated needles which have their own benefits and risks.

- *Insulated needles:*[9,10]
  - Limited by the small volume of heat produced through the small noninsulated part near the tip
  - Significant microbleeding through the treatment
  - Reduced clinically efficacy and need for treating various depths
  - In contrast to the insulated needles that emit RF through a small area near their tip
- *Noninsulated needles:*[9,10]
  - Noninsulated gold-plated needle emits RF through the whole length allowing heating of 3× the volume.
  - While MNRF is delivered when the needle is inserted to its maximal penetration and dermal impedance is lower than epidermal impedance, the RF will flow through the dermis with no epidermal coagulation and higher bulk heating.
  - Gold plating allows better RF conductivity than stainless needles and thus better treatment efficacy
  - RF emission through the whole needle provides a coagulation effect eliminating microbleeding improving the patient experience. The effect of energy density on the level of coagulated tissue another aspect that was evaluated in this work was the effect of the needle's depths on the level of ablation.
  - When performing a clinical treatment, there is a great significance to the physician ability to keep the clinical effect constant or with minimal on the entire treatment area, regardless of the differences in treatment location, parameters, and other conditions.
  - The hypothesis form the studies was that reducing the needle depth while keeping the rest of the parameters unchanged, will result in higher energy density due to the decrease in needles surface area, what will lead to an increase in the diameter of coagulated tissue.
- *Important factors which define safe use of MNRF:*
  - Adequate priming and sun protection
  - Good surface anesthesia
  - Adequate parameters—heating depth, heating duration
  - Noninsulated needle requires single pass
  - Insulated needles need multiple passes at different depths
  - No active viral or bacterial infections
  - No metals near on in treatment site
  - Nonsensitive skin

Risks during treatment which can lead to complications of MNRF:

- Adequate priming and sun protection
- Sensitive to surface anesthetic—contact irritation preexisting

Active infections—bacterial or viral:

- Nonprimed skin and sensitive skin
- Excessive pain

COMPLICATIONS OF MICRONEEDLE RADIOFREQUENCY[11-16]

- *Pain:* It is a common feature of MNRF, a good surface or block anesthesia is needed. Pain is more when noninsulated needles are used as energy depth due to multiple passes needed to cover different scar depths, comparatively pain is lesser with insulated needles as treatment entails single pass only.

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- Contact sensitivity to surface esthetic—in predisposed sensitive skin types, surface anesthetic cream can cause erythema and edema as end point, if this is followed by MNRF it may alter the tissue response due to change in impedance.
- Pinpoint bleeding during treatment can be seen with noninsulated needles, they are not concerning and resolve well.
- *Infection:* Inadequate post-treatment care or focus of infection at treatment site may result in active bacterial infections, and in previously exposed patients, there may be a herpes simplex flare post-treatment. Acne flare can also be seen if few cases with pustular lesions or superinfection.
- Microneedle footprints—though normal footprints fade off in 3–5 days, persistent footprints are seen sometimes, and probable reasons may be treating damp surface, high energy treatment, hasty withdrawal of microneedles while energy is being delivered, poor priming and/or inadequate post-treatment sun protection.
- Hyperpigmentation—though the technology is color blind, if there is high energy and epidermal burn happens, it can result in persistent postinflammatory hyperpigmentation.
- Scarring—in rare cases, scars may result from epidermal burns or infection cases.
- Electric shock—if wet skin is treated or patients with metal implants are treated.

Management of Complications with Microneedle Radiofrequency

Pain and burning is transient and decreases within an hour of treatment, can be minimized with good surface anesthetic or block anesthesia or vibration device.

Contact sensitivity to surface anesthetic can be treated by topical steroid for 2–3 days post-therapy.

Infection can be managed with oral and topical antibiotics if bacterial or acyclovir if herpetic.

Microneedle footprints can be treated with sun protection, lightening agents, oral antioxidants, and Q-switched lasers if persistent.

Hyperpigmentation can be treated with sun protection, lightening agents, oral antioxidants, and Q-switched lasers if persistent.

Scarring can be treated with antiscar agents and topical retinoids, regenerative therapies fractional carbon dioxide lasers if indicated.

High-intensity focused ultrasound[16-21] is a relatively new cosmetic treatment for skin tightening, lifting, face shaping, and focal fat reduction. It is noninvasive and painless and hence popular replacement for surgical face lifts. HIFU uses ultrasound energy to stimulate neo collagen resulting in firmer and tightened skin. HIFU uses focused ultrasound energy to target the layers of skin just below the surface. The ultrasound energy causes the tissue to heat up rapidly. Once the cells in the targeted area reach a certain temperature, they experience cellular damage. While this may seem counterintuitive, the damage actually stimulates the cells to produce more collagen a protein that provides structure to the skin. The increase in collagen results in wrinkle reduction and action on superficial musculoaponeurotic system (SMAS) lifts the lines. Since the high-frequency ultrasound beams are focused on a specific tissue site below the skin's surface, there is no damage to the epidermis or collateral damage to adnexal structures.

High-intensity focused ultrasound works on principle of hyperthermia lifting therapy where creating skin coagulation on the target layer of skin tissue by 65–75°C of HIFU energy. No damages on surrounding area and skin surface are seen. The ultrasonic

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energy can be delivered as microfocused or macrofocused technique using specific cartridges [micro- and macrofocused ultrasound (MMFU)]. The HIFU systems deliver energy in megahertz (MHz) and there are various modes of delivery of energy as thermal coagulation points (TCPs) by the dot method (interrupted) or linear method (continuous).

Micro- and macro-focused ultrasound technology that uses thermal energy to make 25 stitches in a 25-mm treatment length. Maximizes the lifting effect by inducing collagen regeneration with concentrated heating. There is local heating with collagen denaturation. Micropulse technology in linear mode that delivers 417 TCP over a treatment length of 25 mm, this delivers energy over the treatment area and allows for denser heating. Thus, it covers a larger area and delivers dense heating, effectively reducing the volume. This results in dense heating, focal fat burning, and volume reduction.

Important factors which define safe use of HIFU:

- Mark the area to be treated in order to treat symmetrically
- *Blow and hold air*: Air does not conduct ultrasound so protects the gums and teeth **(Fig. 2)**
- Can stuffing sterile gauze—if metal fillings
- Watch for any major discomfort, sharp pain, or shooting pain around nerve areas
- Tooth implants are not metals and safe for HIFU.
- Avoid no-go zones
- Keenly observe endpoints—erythematous papules



Fig. 2: Air blowing in cheek while treatment to prevent gum damage.[17]

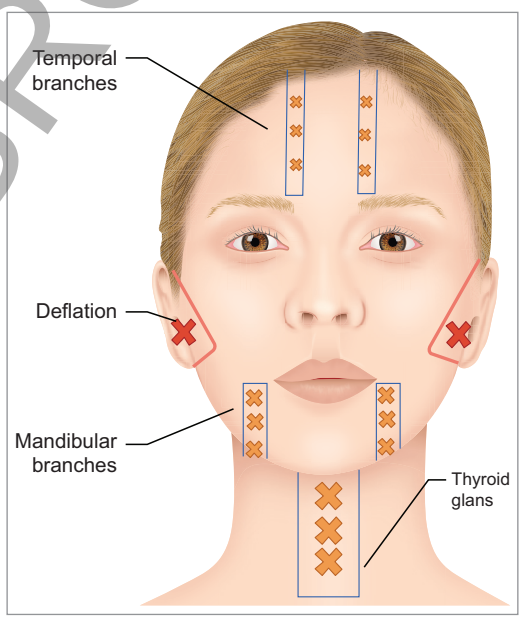

Fig. 3: Risk areas for treating with high-intensity focused ultrasound (HIFU).

*Risks during treatment which can lead to complications of HIFU **(Fig. 3)**:*

- Treating no go areas, treating over areas where nerves are superficial **(Fig. 4)**.
- Treating over gland area—parotid and thyroid gland
- Damage to gums, teeth, and dental implants
- Overheating, vesicles, blister formation due to epidermal damage
- Treating in areas of metal implants, presence of metal in the site of treatment

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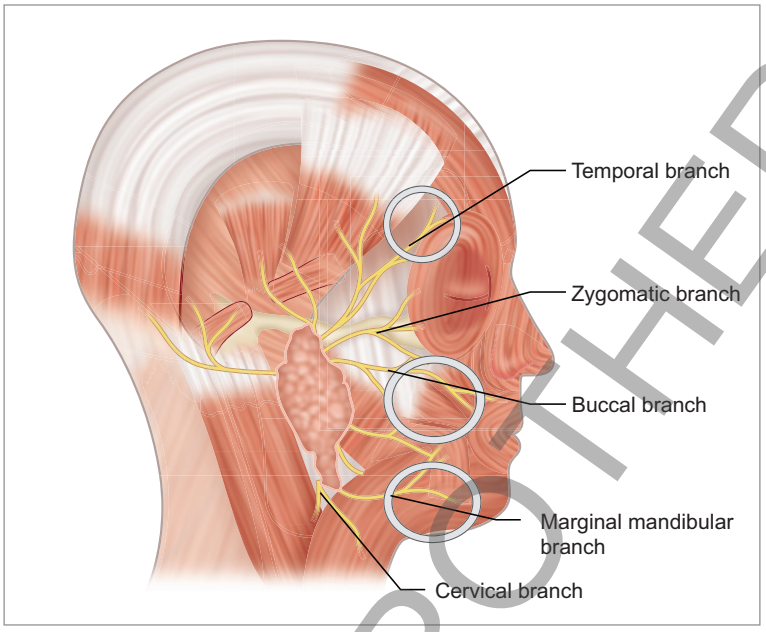

Fig. 4: Danger areas where facial nerves are superficial.

Clinical Study Result: Danger areas for HIFU where nerve branches became superficial → distal temporal, lower buccal, and upper mandibular branches over the masseter muscle and marginal mandibular

- Asymmetrical sonic delivery or failure to document asymmetry

COMPLICATIONS OF HIGH-INTENSITY FOCUSED ULTRASOUND (BOX 1)

These are potentially avoidable if the treatment is conducted by a qualified physician who is experienced. The complications are divided into common and uncommon.

During treatment pain, discomfort, mild edema, erythema, papules are considered normal.

Complications from high-intensity focused ultrasound[17,19,22]

Pain and discomfort: Transient pain while treatment is felt like a stinging sensation, pain at bony points can be discomforting. It is seen when a cartridge with faster delivery like a 7 or 5.5 MHz is used, pain builds up as skin is heated and more toward the end of treatment. The pain subsides on stopping treatment, there may be a sore feeling for few days in treatment area.

Redness and swelling: Redness, erythematous papules, and swelling are commonly seen endpoint, in sensitive skin with fair skin types is more prominent. It goes down in a few hours or a day.

Bruising: It is seen when skin is overheated, it is preceded with erythema. Overheating can cause breakdown of capillaries. Bruising

BOX 1: Complications of high-intensity focused ultrasound (HIFU).

Potential complications of HIFU:
- Pain swelling
- Bruising
- Paresthesias
- Nerve damage
- Thyroid and parotid atrophy

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can last for 3–5 days. Keen observation while treatment can prevent this.

Infection: Bacterial or viral infections in predisposed patients can occur, treatment should be carried out judiciously if active pustule acne is present, prophylactic use of antivirals in patients with history of herpes simplex should be undertaken.

Scarring: In rare cases, scars can occur if there is vesiculation or blistering after treatment.

Numbness/tingling: Some individuals may experience temporary numbness or tingling in the treated area, which usually resolves within a few days.

Epidermal burns: This may happen if gel is applied in very thin layer, energy setting is too high, repetitive passes in same area causing overheating.

Hyperpigmentation: This is a rare and can occur only if epidermis is overheated in dark and sensitive skin types.

Nerve damage: Numbness and neuropraxia are rare but can occur if the depth of damage reaches the cutaneous branches of facial nerve, it can lead to ipsilateral motor function loss and may take long time to recover **(Figs. 5 and 6)**.

Management of Complications

- Before undergoing any facial treatment, it is essential to consult with a qualified and experienced practitioner to discuss the risks and benefits of the procedure.
- Following post-treatment care instructions carefully can help to minimize the risk of complications.
- Have knowledge of anatomy, no-go zones, mark the treatment area, and document preexisting asymmetry
- Be aware of the potential risks and side effects of the treatment before undergoing it
- Detailed counseling is mandatory.

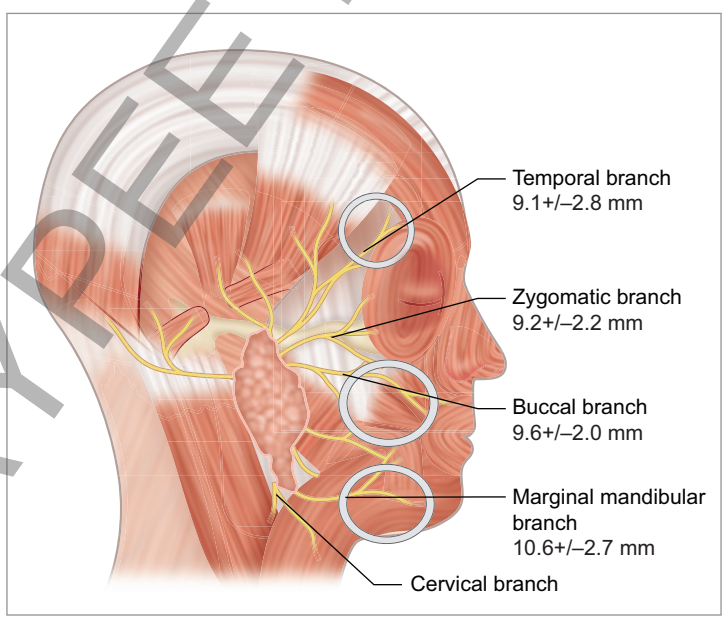

Fig. 5: Depth of various facial nerves.

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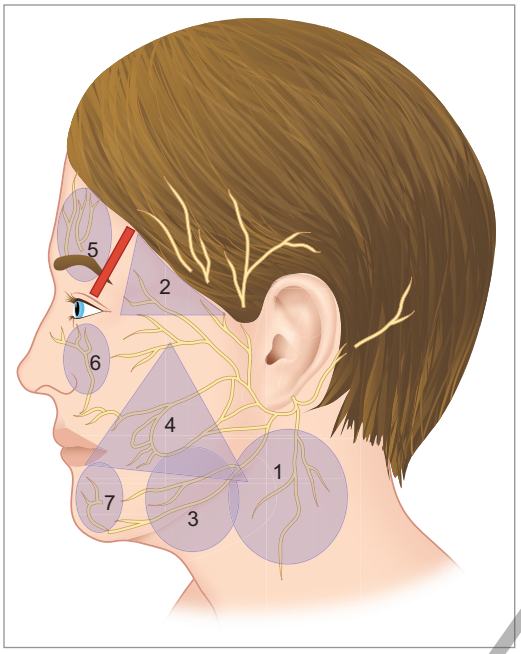

Fig. 6: Danger zone for superficial temporal nerve.

Skin burns: Steroids—oral or topical, antibiotics—oral or topical, wound repair—creams and moisturizers with sun protection.

Hyperpigmentation: Pigment lightening agents and sun protection.

Nerve damage: Neurapraxia, nonsteroidal anti-inflammatory drugs (NSAIDs), pregabalin, vitamin B12, topical anesthetics, other modalities like facial muscle stimulation to be considered after nerve inflammation settles.

Infection: Oral and topical antibiotics.

Scarring: Silicone gel sheets, scar repair gels, and fractional lasers.

CONCLUSION

Energy-based devices for face tightening, lifting, and skin resurfacing are here to stay as they are noninvasive and effective. A physician must be armed with sufficient knowledge to face and nerve anatomy and training of the device to conduct the treatment and minimize potential complications. As inevitable if complications do occur, one must handle them with diligence and adequate care.

KEY POINTS

- RF, MNRF, and HIFU are popular noninvasive devices for skin tightening, lifting, and scar treatment. RF is chromophore-independent, that heats dermis via impedance; HIFU uses focused ultrasound for SMAS lifting.
- *Key safety factors prevent emergencies:* Using adequate ultrasound gel (room temperature), no anesthesia to preserve patient feedback, monitoring skin temperature ≤42–43°C, and avoiding static shots. While for MNRF, ensuring priming, correct needle depth, and no active infections is important, for HIFU, avoiding "no-go zones" like superficial nerves, thyroid, parotid, and teeth/gum protection is preventive.
- Common complications are mild but manageable with transient pain, erythema, and edema being expected endpoints. While HIFU may cause bruising or neuropraxia, RF/MNRF could cause burns, blisters, hyperpigmentation, and scarring from overheating or poor technique, treatable with steroids, antibiotics, and sun protection.
- Serious risks include HIFU-induced facial nerve injury causing motor loss and RF/MNRF-induced electric shock that can be prevented by knowing anatomy, marking treatment areas, and using sensor-controlled devices and treated with wound care for burns, lightening agents for pigmentation, and NSAIDs, pregabalin, B12 for nerve injury.

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Handbook of Emergencies in Dermatosurgery

The field of dermatology has undergone a remarkable evolution, especially in dermatosurgery. Alongside this progress, there is also a sobering truth, that no matter how skilled or prepared we are, surgical emergencies can occur without warning. Their rarity does not diminish their seriousness, and our ability to respond swiftly and appropriately often makes the difference between resolution and complication. This book, *Handbook of Emergencies in Dermatosurgery*, is born out of decades of surgical practice, teaching, and the persistent need to prepare the next generation of dermatosurgeons not only for routine procedures but also for the critical moments when things deviate from the expected. Although the vast majority of procedures is performed under local anesthesia in well-controlled outpatient settings, emergencies such as anaphylaxis, excessive bleeding, syncope, cardiac events, airway compromise, and systemic toxicity can arise and pose significant threats to patient safety. Chapters on how to tackle violent patients, fire hazards, and medicolegal emergencies are also included. As our procedural scope expands, so too must our preparedness. The aim of this handbook is to provide a practical, clinically relevant, and concise guide to recognizing and managing emergencies that may arise before, during, or after dermatosurgical procedures. Each chapter is structured to deliver actionable insights, distilled from current evidence, clinical guidelines, and personal experience. Key preventive strategies and invaluable checklists that can minimize risks have been included. We hope that this book serves as a trusted reference for dermatologists, residents, and dermatosurgeons who are committed to safe, high-quality care.

Niti Khunger is a Professor and Consultant Dermatologist with over three decades of experience in clinical and aesthetic dermatology, dermatosurgery, research, and medical education. Serving at a leading teaching hospital, Dr Khunger has dedicated more than 30 years to mentoring generations of medical students and dermatology residents. Known for a commitment to evidence-based care and academic excellence, she has contributed to numerous national and international conferences, published extensively in peer-reviewed journals, edited books on chemical peels, acne scars, cosmetic dermatology, and dermatosurgery, and authored several chapters in various books. She remains actively engaged in advancing dermatological science and education. She was past editor of the Journal of Cutaneous and Aesthetic Surgery, past President of Association of Cutaneous and Aesthetic Surgery, and past Head of the Department of Dermatology, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India. Her areas of interest include acne, pigmentation, dermoscopy, scars, keloids, regenerative medicine, vascular anomalies, vulval diseases, procedural dermatology, and dermatosurgery. This contribution on Emergencies in Dermatosurgery is a culmination of years of clinical insight, teaching experience, and a passion for sharing knowledge.

Pradeep Kumari is a postgraduate alumnus of B.J. Medical College and Sassoon General Hospital located in Pune, Maharashtra, with an experience of more than 18 years. She has been working extensively in the field of dermatosurgery and is considered one of the pioneer female dermatosurgeons and hair transplant surgeons in India. Teaching and education dissemination has been a passion for Dr Kumari and makes her hugely popular among dermatology postgraduate students. She has been one of the most influential trainers in the field of dermal fillers having trained numerous dermatologists across the country in the last one and half decades. Her patients acknowledge her sincerity and dedication to making their lives better. Dr Kumari also has served various associations in her field to help progress the scientific work in the field of dermatosurgery. From 2013 onward, she has been part of various dermatology special interest groups including dermatosurgery, aesthetics, lasers and trichology and hair transplant. She has also served in administrative positions in the past—Managing Committee Member of Maharashtra IADVL and Joint Secretary ACS(I). She was Honorary Secretary General ACS(I) India for the term 2023–2025. Dr Pradeep Kumari considers her contribution to this handbook as one of the ways to give back to society and field of dermatosurgery in general.

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