Radiofrequency in Cosmetic Dermatology

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KEYWORDS

• Radiofrequency • Skin tightening • Body contouring • Cellulite reduction • Noninvasive • Monopolar • Unipolar

KEY POINTS

- Radiofrequency (RF) has become an important and frequently used technology in cosmetic dermatology.
- RF is most commonly used for tissue heating and tightening as well as body contouring and cellulite reduction.
- RF treatments are safe, effective, and have minimal to no downtime.
- RF energy can be delivered by monopolar, bipolar, unipolar methods and can be combined with other light or energy sources.
- Continued research of RF devices will help to improve the efficacy and increase the knowledge about this rapidly developing technology.

INTRODUCTION

The demand for noninvasive methods of facial and body rejuvenation has experienced exponential growth over the last decade. There is a particular interest in safe and effective ways to decrease skin laxity and smooth irregular body contours and texture without downtime. These noninvasive treatments are being sought after because less time for recovery means less time lost from work and social endeavors. Radiofrequency (RF) treatments are traditionally titrated to be nonablative and are optimal for those wishing to avoid recovery time. Not only is there minimal recovery but there is also a high level of safety with aesthetic RF treatments.

RF energy has been used for decades in a variety of medical applications, including tissue electrodessication, cardiac catheter ablation, and endovenous ablation of varicose veins.[1,2] Unlike laser energy, RF energy does not depend on selective photothermolysis but rather heating of water; therefore, any skin type may be treated. The mechanism of action of RF in a medical application is based on an oscillating electrical current forcing collisions between charged molecules and ions, which are then transformed into heat. RF-generated tissue heating has different biologic and clinical effects, depending on the depth of tissue targeted, the frequency used, and specific cooling of the dermis and epidermis. The depth of penetration of RF energy is inversely proportional to the frequency. Consequently, lower frequencies of RF are able to penetrate more deeply. RF technology also has the ability to noninvasively and selectively heat large volumes of subcutaneous adipose tissue. By selecting the appropriate electric field, one can obtain greater heating of fat or water.

In cosmetic dermatology, RF is most commonly used to noninvasively tighten lax skin; to contour the body by influencing adipocytes; and, consequently, to improve the appearance of cellulite. As a noninvasive treatment of facial rejuvenation

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and skin tightening, the use of RF is typically reserved for deeper skin heating without causing ablation of the epidermis and dermis. RF devices are within the frequency range of 3 KHz to 24 GHz, which comprises an RF band, which is reserved for industrial, scientific, and medical (ISM) uses. The general population is most familiar with ISM bands for Wi-Fi 2.5- to 5.0-GHz radio bands used in the industrial sector. In clinical studies of lax skin treated with RF, the dermis, which is composed of collagen, elastin, and ground substances, has shown an immediate and temporary change in the helical structure of collagen. Electron microscopy from treated skin has revealed collagen fibrils with greater diameter compared with fibers pretreatment. Also, there was an increase in collagen expression as measured using Northern blot analysis.[3] It is also thought that RF thermal stimulation results in a microinflammatory stimulation of fibroblasts, which produces new collagen (neocollagenesis), new elastin (neoelastogenesis), and other substances to enhance dermal structure.[4] RF has not only been proven effective for skin tightening but it has also been studied and proven effective in diminishing adipocytes.

Body consciousness continues to increase as does the portion size and daily caloric count in our society. As the accessibility of food calories increases in all developed countries, so do the methods of reducing the effects of fat accumulation. Multiple modalities to induce adipocyte apoptosis in order to reduce pockets of fat noninvasively have recently become obtainable. These modalities primarily aim at targeting the properties of fat, which differentiate it from skin and muscle, thus resulting in selective removal or dissolution of fat otherwise known as lipolysis. By manipulating skin cooling, RF can be used for heating and reduction of fat. RF thermal stimulation of adipose tissue is thought to result in a thermal-mediated stimulation of adipocyte metabolism and augmented activity of lipase-mediated enzymatic degradation of triglycerides into free fatty acids and glycerol. Induction of apoptosis of fat cells is another proven mechanism.[5] In addition to fat reduction, RF can be used to improve the appearance of cellulite. Cellulite, the dimpled appearance of the skin caused by fatty deposits trapped and tethered between fibrous septa of the dermis, continues to be an elusive and highly sought after treatment. RF energy is able to heat the deep dermis and adipose tissue; hence, it should theoretically improve the cellulitic appearance of the skin.

RF can be delivered using monopolar, bipolar, or unipolar devices. Other variants of RF delivery include fractional, sublative, and combination technologies that add light, laser, massage, or electromagnetic fields (**Table 1**). There is also a novel multipolar RF device that delivers a field of energy to the skin and fat without contacting the skin. This article reviews the methods of RF delivery and highlights some of the most commonly used RF devices in cosmetic dermatology.

METHODS OF RF DELIVERY

Monopolar

The ISM bands were first established at the International Telecommunications Conference of the International Telecommunication Union in Atlantic City in 1947. The initial use of RF for medicine included the pinpoint coagulation of blood vessels during surgery. This use was the first use of monopolar RF requiring patients to have a grounding plate in contact with the skin. RF-induced heat ablation has been applied to other fields of dermatology, including soft tissue (basal cell carcinoma) ablation, endovenous ablation of saphenous system varicosities, and treatment of vascular abnormalities. There are many medical devices on the market, and each has wide-ranging methods of RF delivery. RF devices may be monopolar in which patients are grounded and the RF is delivered through the skin, into the body, and ultimately to the grounding electrode. Typically, RF travels through structures with the highest water content with greatest resistance by fat. In general, monopolar devices have a more deeply penetrating effect than bipolar or unipolar devices. Pain during the treatment is related to the duration of the pulse. Some devices are painful and some feel more like a heated massage. Monopolar RF can be delivered in a static or a dynamic fashion.

Monopolar devices may be delivered in a static or stamped mode in which a short 1- to 2-second cycle is delivered while the handpiece is held in place (Thermage, Solta Medical, Hayward, CA). Alternatively, monopolar RF may be delivered in a dynamic or a continuous pulse with constant rotation of the handpiece (Exilis, BTL, Prague, Czech Republic). In the static, stamped method, a single pulse is delivered; the handpiece is then moved to an adjacent marked area and fired again. This technique is performed for hundreds of pulses until a premarked area is treated. Each pulse is measured for temperature while spray cooling is applied so that a skin temperature of 45°C is not exceeded. With dynamic monopolar RF, the handpiece is continuously moved and specific areas of laxity can be targeted in a relatively short time to a final temperature that is monitored by continuous surface temperature measurements, often built