Advancements in Non-Invasive Plastic Surgery Techniques: Evaluating Efficacy, Safety, Patient Outcomes and Potential Complications

Jumana H. Timraz[1], Hadi A. Bakour[1], Rayyan Rafat Samman[1], Kenanah Maher Alawi[1], Fathima Shamma Mohammed Bava[1], Fatin Awwad Alkhdaidi[1], Marya Aref AlGhorab[1], Mohamed Amer Alabbassi[1], Husna Irfan Thalib[1*], Saleha Khan[1], Faisal Makki[1], Abdulbaset Alsolamy[2]

[1]General Medicine Practice Program, Batterjee Medical College, Jeddah 21442, Saudi Arabia
[2]Plastic Surgery Division, King Fahad Armed Forces Hospital, Jeddah 23311, Saudi Arabia

***Corresponding author:** Husna Irfan Thalib,
General Medicine Practice Program, Batterjee Medical College, Jeddah 21442, Saudi Arabia
E-mail: husnairfan2905@gmail.com

KEYWORDS
Non-invasive, Plastic Surgery, Patient outcomes, Complications

ABSTRACT

Traditional plastic surgeries have been a major concern for many patients as for their possible complications and estimated costs. Meanwhile, non-invasive procedures have shown a magnificent progress as they offer significant aesthetic outcomes compared to traditional methods with reduced recovery time and fewer complications. However, non-invasive techniques can cause minor complications such as erythema, mild pain, and swelling, which usually resolve without intervention. Major complications are rare to occur. Non-invasive procedures include neuromodulator injections known as Botox, dermal fillers, fat reduction which aims to improve the body's appearance, fat freezing (cryo-lipolysis), Radio frequency (RF), and High-intensity focused ultrasound (HIFU). Other non-invasive techniques can include Laser and Intense Pulse Light (IPL) treatment for discoloration and tighten sagging skin, Chemical peels to remove damaged outer skin layers, and Sclerotherapy injections for collapsing surface veins. This study has found that the overall patient satisfaction rate is 74.5%, with a reported 40% rise in minimally invasive techniques since 2021. The review highlights several popular non-invasive procedures. These methods offer reduced hospitalization, anesthesia risks, and shorter recovery periods. This review aims to explore the latest advancements in non-invasive plastic surgery, focusing on key areas such as facial enhancements, skin rejuvenation, and fat reduction. Studies show high satisfaction rates with non-invasive procedures. By evaluating the efficacy, safety, and patient satisfaction associated with these procedures, we aim to provide a comprehensive overview of their advantages and potential limitations, offering valuable insights for both practitioners and patients.

Introduction

Plastic surgery is one of the oldest surgical specializations that deal with innovation, implantation, replantation, and transplantation of tissues. It restores deformities, abnormalities, and defects of different organs, improving their function, form, and aesthetic appearance [1]. In ancient years, simple reconstructive procedures were performed, primarily to restore mutilated body parts from war or punishment; in the modern era, however, with an increase in understanding of human anatomy as well as with innovative advancements in technology, there has been significant development in the field of plastic surgery, including various types of reconstructive procedures, microsurgery, and aesthetic surgery [2-5]. However, most plastic surgery procedures often involve invasive methods that require increased recovery times, higher risks of morbidity, and overall health care costs. These drawbacks have further aided in the recent development of non-invasive or minimally invasive procedures with fewer complications, shorter recovery periods, and lower costs [6]. Therefore, this review explores the latest advancements in non-invasive procedures within plastic surgery, focusing on facial enhancements like neuromodulator injections, dermal fillers, skin rejuvenation and resurfacing, and fat reduction procedures.

The objectives of this review are to Identify and evaluate the latest non-invasive plastic surgery procedures, to assess the efficacy and safety of non-invasive techniques compared to traditional procedures, to explore the advantages and limitations of non-invasive procedures in terms of patient experience and cost-effectiveness, and to develop evidence-based recommendations for integrating non-invasive techniques in plastic surgery treatment plans. The review aims to provide a well-rounded understanding of non-invasive plastic surgery techniques' current state and future potential, aiding physicians and patients in making informed decisions.

The latest non-invasive plastic surgery procedures

Recently, a prompt progress in the non-invasive cosmetic procedures has been noticed as for their high demand [7]. The International Society of Aesthetic Plastic Surgery (ISAPS) has conducted a study which demonstrated a drastic increase in minimally invasive procedures of 40% since 2021 all over the world [8]. Furthermore, using minimal invasive procedures allows divers options for enhanced appearance with minimal discomfort, resulting in aesthetic improvements without a long recovery period and with less risk compared to traditional surgical procedures [9].

Non-invasive procedures as summarized in Table 1 commonly include the following [10]:

1. Facial enhancement

1.1. Neuromodulator injections

Botulinum toxin (Botox) has been of great advantage in temporarily improving the appearance of moderate to severe face wrinkles in adults, most commonly forehead wrinkles, frown lines and crow's feet [11]. Botox injections have been utilized massively with over sixteen million non-invasive procedures throughout the past four years [12].

1.2. Dermal Fillers

Dermal fillers medical device implants approved by the FDA use in helping to create a smoother and/or fuller appearance in the face including treating volume loss, scars, wrinkles, facial sculpting, contouring, and enhancing specific anatomical areas like the lips [13].

1.3. Skin rejuvenation and resurfacing

Sun, skin disorders and aging can all contribute to skin imperfections on the face and elsewhere on the body such as wrinkles, acne scars, pigmentation changes like freckles, sunspots and visible blood vessels. Examples of skin rejuvenation and resurfacing treatment include Laser and Intense Pulse Light (IPL) treatment for discoloration and/or tighten sagging skin, Chemical peels using various acid combinations to remove damaged outer skin layers, and Sclerotherapy injections for collapsing surface veins in spider vein treatment [14].

2. Fat Reduction

There are currently four leading non-invasive techniques aim to improve the body's appearance by reducing localized subcutaneous adipose tissue particularly in areas in which fat persists despite optimal diet and exercise routines including the following: low-level laser therapy (LLLT), Fat freezing (cryo-lipolysis), Radio frequency (RF), and High-intensity focused ultrasound (HIFU) [15,16].

Table 1: Advantages and Complications of Latest Non-Invasive Plastic Procedures [17-19]

Procedure	Advantages	Complications
Neuromodulator injections [17]	Effects are transient. Include proteins used to treat a range of conditions including hyperhidrosis, migraines. Improve the appearance of moderate to severe face lines.	Injection related: bruising, swelling, edema, needle marks and pain. Toxin-related: brow or lid ptosis,cheek paralysis or palsy and asymmetry.
Dermal Fillers [18]	Treating volume loss, scars, wrinkles, facial sculpting, contouring.	Permanent dermal fillers: Vascular occlusion and necrosis. Temporary dermal fillers: associated with a very low incidence of complications. Most complications are mild and of limited duration.
Skin rejuvenation and resurfacing [19]	High skin coverage rate Low purchase price High versatility	Low incidence of complications Possible complications: Swelling, erythema and alteration of the color of the skin or nails

Fat reduction [20-23]	Minimum risk No Anesthesia required Ordinary daily activities done promptly proceeding the treatment (Fat freezing)	Skin irritation and burns if laser intensity is increased Eye damages (proper eye protection should always be used during LLLT treatment) LLLT is confined to patients with dark skin Possible pain that subside after Weeks (Fat freezing)

Efficacy and Safety of Non-invasive Techniques Compared to Traditional Surgery

Noninvasive techniques can give a youthful appearance with little recovery time and a low chance of complication. The main goal of any procedure is to perform it correctly, and also execute it accurately and securely. Early recognition of complications when they occur is crucial for preventing long-term issues [24]. The local injection site produces normal reactions such as bruising, swelling, pruritus, and pain [25].

The most popular noninvasive procedures are injectable botulinum toxin (BoNT), soft-tissue fillers, and chemical peels. Each has a special application for enhancing facial appearance [24].
While aiming to achieve aesthetic improvements, patients may experience common side effects like bruising, erythema, and pain. These are common complications that can happen from BoNT and soft-tissue filler injections. Moreover, they are rare and can be avoided by having excellent knowledge of facial anatomy, choosing patients correctly, using excellent procedure techniques by slow and precise injections, using tiny gauge needles, immediate application of cold compresses or pressure to the area following injection, and stopping the use of aspirin 7–10 days before injections; and following appropriate skin care and post-treatment [25,26].
Soft-tissue fillers can volumize and reshape aging, sagging skin with impressive results quickly and with a low chance of side effects [27]. Also, it is approved by the FDA, and other filing agents can correct facial wrinkles that range from moderate to severe; it includes hyaluronic acid, which helps your body make more collagen and moisten your skin [28].
Chemical peels are also a technique that induces skin injury with re-epithelialization, ultimately improving the skin's appearance by improving texture, tone, and pigmentation. Peels perforate different depths of the epidermis with or without dermis depending on the chemical composition and concentration applied to exposed skin. Firstly, superficial peels, such as glycolic acid and

salicylic acid, are used for acne treatment to increase the penetration of topical agents, reduce the appearance of superficial scarring, and improve post-inflammatory hyperpigmentation. Secondly, combination peels, such as Monheit's combination, Jessner's solution, and Brody's combination can be used for deeper penetration to help improve the appearance and texture. All procedures are performed safely and effectively under very trained professionals [28].

Soft-tissue fillers continue to increase because they are easy, fast and noninvasive alternatives as indicated in Figure 1 to traditional facial augmentation and volume improvement surgeries [29]. Through multiple clinical trials, Filler efficacy has been demonstrated, and it shows prolonged improvements with impressive safety profiles when proper injection technique is adhered to; it can also provide dramatic instantaneous results. The armamentarium of FDA-approved soft-tissue fillers is broad, and each composition varies and has approved uses [25].

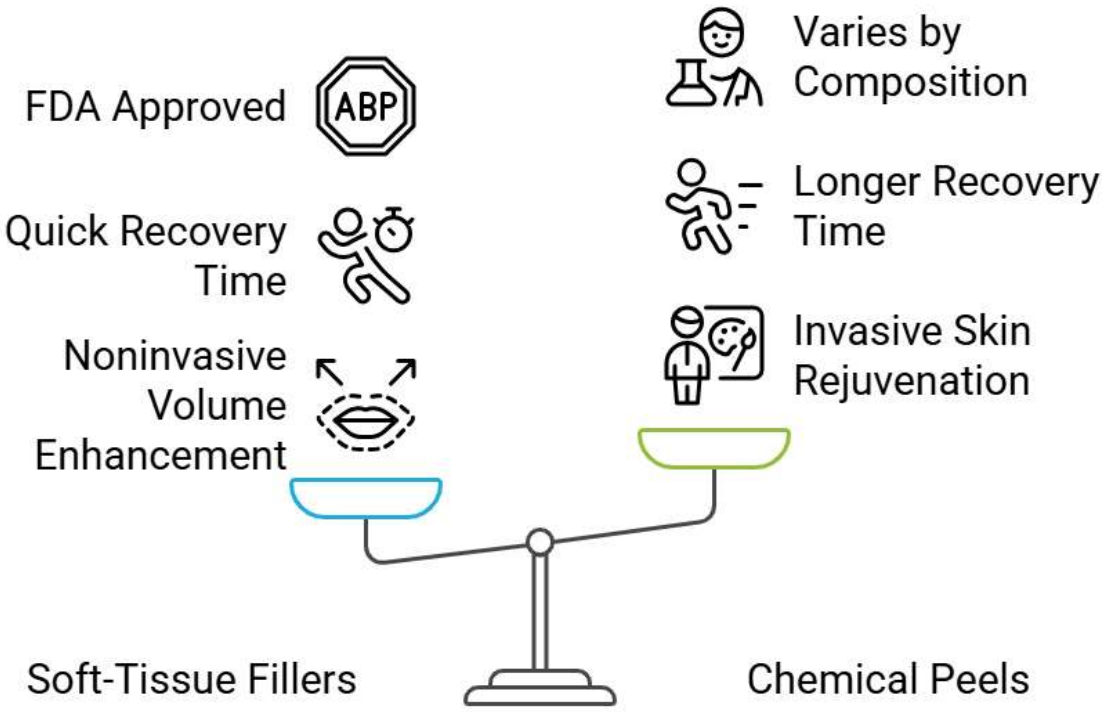

Figure 1: Comparing Soft tissue fillers and Chemical Peels

Image credits: Husna Irfan Thalib

Advantages of non-invasive procedures in terms of patient experience and cost-effectiveness

Micro Needling (MN) is a widely used non-invasive procedure, particularly effective in treating scars, amongst other indications of this non-invasive procedure. It has been used in Asia and the

Middle-East for years, due to its low risk of post-procedure pigmentary changes, even in darker skin tones. MN just recently gained interest in the United States as an efficient, well-tolerated aesthetic treatment.

MN and its counterpart fractional radiofrequency MN (FRF-MN) as indicated in Figure 2 were used as monotherapy to deliver energy below the epidermal surface, thus avoiding epidermal damage and subsequent dyspigmentation, or in combination with topical, surgical or systemic treatments. Patients treated with MN and FRF-MN treatment resulted in clinical improvement of scar appearance from baseline, and no serious adverse events occurred. Patients preferred MN on other modalities such as intralesional triamcinolone (ILTAC) or 1450 nm diode laser [30].

Ultrasound technology, with a variety of applications, has proven useful and safe in plastic and reconstructive surgery procedures for skin rejuvenation procedures. Applications can include micro-focused US under direct visualization, and the use of US to guide percutaneous surgical devices in carpal tunnel release (CTR), and guiding corticosteroid injection more accurately to relieve carpal tunnel syndrome (CTS). Also, targeted the US, in other applications. The cost-effectiveness or cost-utility of ultrasound devices has not been studied extensively. Surgeons must be aware that the cost of implementing these devices and their associated infrastructure may not actually lead to cost-saving but the US efficiently facilitates the procedures, has low rates of complications, does not subject the patient to radiation exposure and increases patient satisfaction by providing actual objective results [31].

Non-ablative RF devices have broad applications in the field of plastic surgery. In few studies that have used objective means for evaluation, results have overall been favorable. These studies reported improvement, sometimes statistically significant, and overall patient satisfaction. The side-effect of these devices is more benign than that of invasive and ablative modalities. Side effects included transient erythema, edema, and patient discomfort [32]. A systematic review for cost-effectiveness of minimally invasive techniques versus surgery showed that when managing varicose veins, radiofrequency ablation (RFA) and EVLA both costs more than surgery and with little difference in quality-adjusted life-year (QALYs) they cannot be considered cost-effective at the usual threshold. However, there were limited cost data for the procedures apart from surgery, where costs reported were widely variable. Therefore, the differences in costs between treatment modalities are quite uncertain [32].

EVLA and RFA were marginally more effective than surgery, so if their costs were equivalent to the cost of surgery, they would be considered cost-effective. Other issues of importance to patients such as the less invasive nature of some options, and the opportunity to avoid larger scars and general anesthesia, may be of importance in choosing the procedure [33]. The principle of cryo-lipolysis technology uses the premise that adipocytes are more susceptible to cooling than other skin cells. The clinical efficacy and safety of cryo-lipolysis has been studied in both humans and animals. In separate studies, animal models demonstrated a reduction of up to 40% of the total fat

layer thickness after a single exposure without any harm to the overlying skin. Studies in humans have shown comparable outcomes. One study that included ten subjects reported a reduction in the fat layer by 20.4% after 2 months of treatment. More recently, a retrospective multicenter study using patient survey, photographic documentation, was published by Dierickx et al reported that 86% of 518 subjects showed improvement. The body sites at which cryolipolysis was most effective were the back, abdomen, and flank [34]. Some supporters of the modality claim that the outcomes of cryolipolysis are comparable to those of liposuction. Others admit that the results of cryolipolysis are not similar to liposuction and if multiple areas are treated, the procedure costs nearly the same as liposuction. Sasaki et al reported <5% of improvement 6 weeks after treatment, as judged by independent evaluators. Dierickx et al found little or no benefit in the treatment for the buttocks, thighs, and knees [35].

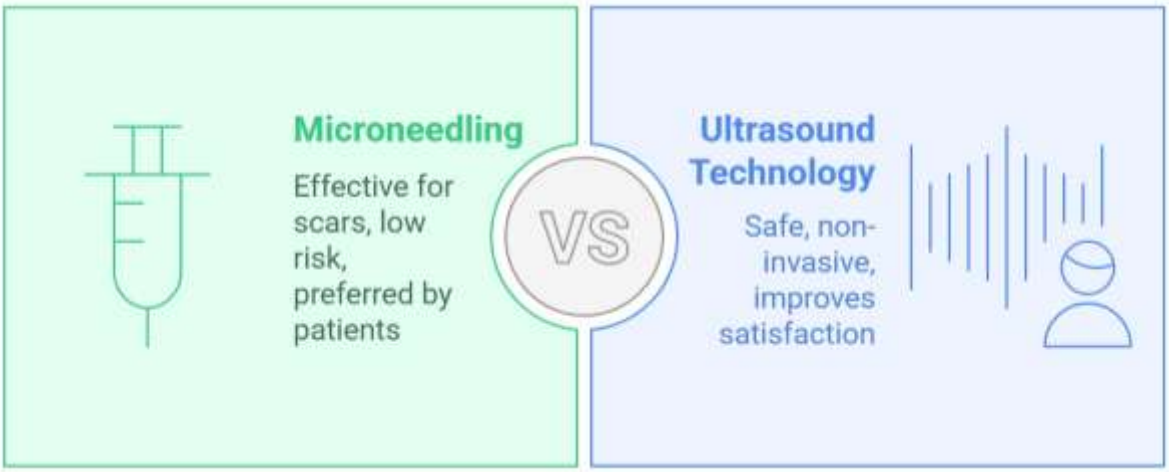

Figure 2: Comparing Microneedling and Ultrasound technology with regards to effectiveness and cost-efficiency

Image credits: Husna Irfan Thalib

Patient satisfaction rates and long-term outcomes of non-invasive techniques

Combining MN treatment with 1550 nm laser or PRP resulted in higher satisfaction rates among patients. 50% to 100% of the patients were satisfied with MN or FRF-MN modalities; 33% of them reported that they would like to proceed with further treatment, while 94% of the patients would recommend the treatment to others [30].

Recently, in a study using a patient survey, patients completed a satisfac-tion questionnaire, with 73% of them reporting that they were satisfied and 82% of them would recommend cryo-lipolysis to a friend. Most patients described mild to tolerable discomfort during the procedure. 89% of respondents reported a positive perception of the treatment duration. In a report on the clinical and commercial experience with cryo-lipolysis in a private plastic surgery practice, only six of 528

patients were dissatisfied with the clinical results; four of these six patients were satisfied when treated for a second time [34].

In a study conducted to determine the satisfaction rates with ultrasound-assisted liposuction (UAL), about 80% of the patients were completely or almost entirely satisfied with UAL (79% were very satisfied or satisfied, 21% were unsatisfied or very unsatisfied), and with nearly 75% of them would recommend the treatment to a friend or a family member. We found that 90% of the satisfied responders who underwent the procedure would recommend UAL to others, whereas only 25% of unsatisfied them were willing to do so [36].

The recent study by El-Domyati and colleagues evaluated six volunteers that were treated over the periorbital region with the Aurora system, for a total of six sessions at 2-week intervals. The outcomes were assessed using photographs and punch biopsies taken at the end of the treatment and 3 months later. Wrinkle improvement, skin tightening and texture, and overall satisfaction were evaluated on a 5-point scale. Improvements in wrinkles, skin tightening and texture, and overall satisfaction at 3 months were 75% to 80%, 70% to 75%, 95% to 100%, and 95% to 100%, respectively. Sadick and colleagues reported similar results in 108 patients treated using the Aurora system. Each patient received five full-face treatments every 3 weeks and was assessed according to photographic evaluation and patient satisfaction. The overall percentage of skin improvement was 75.3%, and the overall average of wrinkle improvement was 41.2%. Skin laxity and texture improved by 62.9% and 74.1%, respectively. Additionally, features such as pore size, pigmentation, and vascular concerns were measured, all of which improved between 65% and 79.3%. Overall patient satisfaction rate was at 92% at 15 weeks after treatment [32].

Currently it is recommended that minimally invasive percutaneous collagen induction not be used on scars until they are at least 1-year-old. A clinical trial included 25 women for the treatment of postsurgical scars with minimally invasive percutaneous collagen induction was done to investigate whether stimulating the wound bed during scar maturation with the treatment could be done safely, and if so, whether any particular timing for initiation of treatment improves the clinical aesthetic results of scars. Three treatments total were completed, one at time of starting treatment, followed by treatments at 4 and 8 weeks. The SkinPen Precision MN device was utilized. Patients' treatments were initiated from 6 weeks to 16 weeks postoperatively. When analyzing data for patients in the 6 to 7-week postoperative group, they were markedly better than those in the 13- to 16-week postoperative group. It was sought to utilize minimally invasive percutaneous collagen induction to increase local release of growth factors, during a time in the late proliferation to early maturation phase of scar healing which resulted in more aesthetic scars, and improved appearance of scars with few side effects or complications. Upon analyzing data from the study, we found that there was marked improvement in all groups of patients over the course of treatment as would be expected of any healing wound. What the study focused on is that, by waiting, a window of opportunity may pass. Therefore, surgeons interested in maximizing scar management may elect for early treatment with MN before development of undesirable scars as a preventive care.

Although optimal time for initiation of treatment is still to be further investigated, the results showed that MN doesn't need to be delayed until 6 to 12 months postoperatively when looking for scar optimization [37].

The current population of breast cancer survivors is growing due to the increased incidence of breast cancer, improved survival rates as a result of early screening and due to more effective treatment options. As a result, secondary goals such as cosmetic outcome and quality of life (QoL) are becoming more important. However, poor outcomes are still observed in up to one-third of patients undergoing BCS. The two key factors affecting the cosmetic outcome are a larger excision volume and the management with secondary radiotherapy. For this, achieving tumor-free margins while excising a small volume of breast tissue during the initial procedure is crucial to oncological and cosmetic outcomes. The (COBALT) trial was to compare ultrasound-guided surgery (USS) with standard palpation-guided surgery (PGS). The implementation of the USS procedure led to a huge reduction in margin involvement. Moreover, USS allowed for the achievement of optimal excision volumes, whereas PGS resulted in volumes almost twice the optimal [38].

Over the years that Thermage monopolar RF trans-epidermal delivery has been available, there have been significant advances on the clinical outcomes. Recent studies of a very large number of patients showed significant improvement over the original Thermage treatment for rhytid reduction in the face and neck skin tightening. The original Thermage systems used very high energy and the patient's discomfort was significant. Studies were able to demonstrate that approximately 26% of patients showed immediate tightening and 50% to 60% of patients observed skin tightening that was measurable 6 months after treatment. However, almost one half of patients found the procedure too painful and only approximately 70% of the patients found that the results met their expectations as indicated in Figure 3. With a shorter RF pulse setting, it showed that almost 90% of patients observed immediate tightening and that more than 90% of patients had visible and measurable moderate skin tightening 6 months after treatment. Only 5% of patients now find the procedure too painful and more than 94% find that results meet their expectations. In addition, these trans-epidermal RF procedures can be combined with other modalities, either during the same treatment session or at subsequent dates to enhance the synergistic aesthetic results. The success of Thermage and the non-ablative trans-epidermal delivery of RF resulted in the evolution of other monopolar RF technologies that would possibly improve the epidermal-dermal junction superficially, as well as provide some deep RF tightening effect. And when patients are appropriately selected for the procedure, the clinical outcomes tend to be good [39].

Initial studies have shown the efficacy of cryo-lipolysis for subcutaneous fat layer reduction. Studies have suggested that applying post-treatment manual massage may enhance the effectiveness of cryo-lipolysis treatment, and that histological analysis revealed no evidence of neither necrosis nor fibrosis resulting from the massage, thus showing that the massage to be a safe and effective method to further reduce the fat layer after cryo-lipolysis treatment. Generally, the length of follow-up ranged from 2 to 6 months, although one study presented reports on two

patients at 2 and 5 years after treatment, noting the persistent reduction at these times when comparing pre- and post-treatment photographs. Objective outcome measures in the studies included fat caliper measurements, three-dimensional imaging, and ultrasound measurements, noting a significant reduction in fat volume in the treated areas, although outcomes varied greatly based on treatment site. Average reduction in caliper measurement ranged between 14.67% and 28.5%. Average reduction by ultrasound ranged from 10.3% to 25.5%. While outcomes of cryo-lipolysis are rather moderate, this technology is well suited for patients who desire nonsurgical spot reduction at small sized adiposities, and it appears to be an effective and safe measure in the short term, with a limited side effect. Also, it is an effective way that can draw new patients into the aesthetic surgery practice [40].

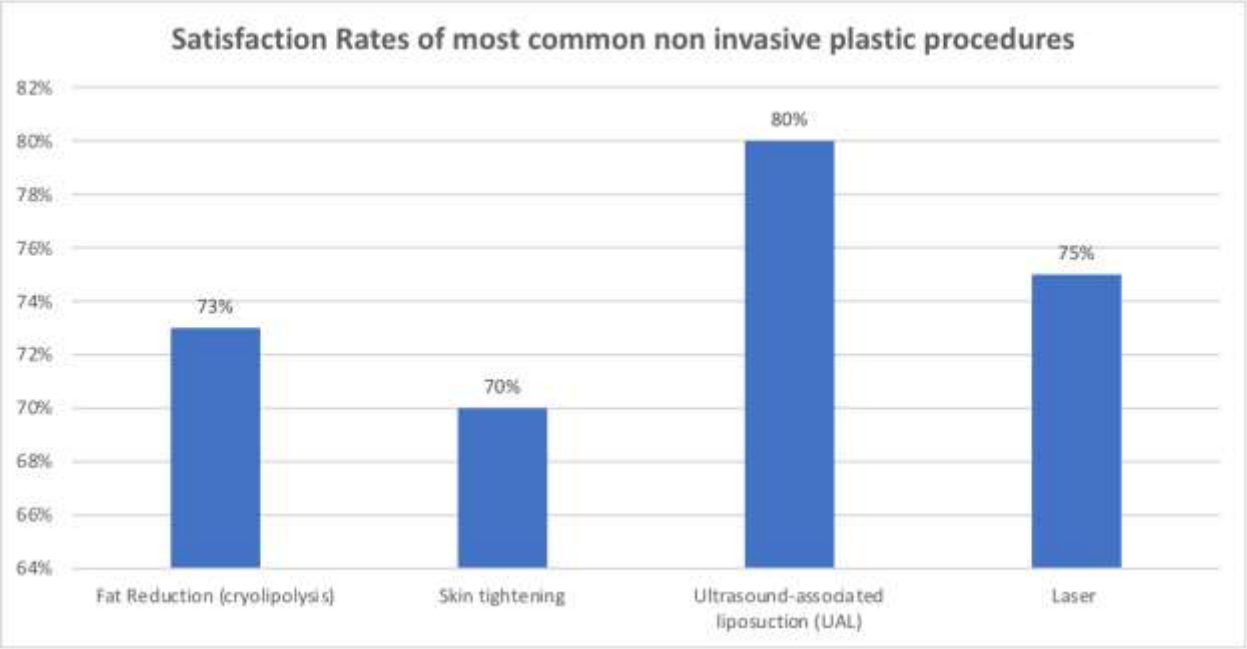

Figure 3: Satisfaction rates of most common non-invasive plastic procedures. [30, 32, 34, 36]

Image credits: Saleha Khan

Potential complications or adverse effects associated with non-invasive techniques

The presence of pinpoint bleeding in the treatment areas is one of the therapeutic adverse effects of MN modalities devices. Therefore, post-procedure erythema is an expected complication of the treatment. Transient erythema with roller MN (RMN) may last for a day and often resolves by itself within three to seven days. Another common adverse effect of MN includes mild pain as indicated in Figure 4. In different studies, patients reported perceiving pain in various manners, as in decreasing with each successive RMN treatment in some patients, whereas decreasing pain in others with successive sessions. Edema also has been reported in multiple studies as an adverse effect, which usually resolves spontaneously within 24 hours, but also can last up to three days.

Post-inflammatory hyperpigmentation is a common AE and could be managed with bleaching creams. Rarely, patients who underwent MN may find AEs such as pain or hyperpigmentation intolerable, as five patients who withdrew from a study participation because of these AEs [41].

High-intensity focused ultrasound applications involve delivering ultrasonic energy to a localized area, and undesired tissue injury is always considered as an AE. And so, unwanted burns and pain could occur. In addition, High-intensity focused ultrasound (HIFU) can cause vasospasm and hemorrhage under conditions that would generate concomitant cavitation in tissue [42].

Complications following aesthetic treatment with RF-based devices can be viewed as complications from the patient's point of view, if the expectations of the patient were not met and the discussion of any temporary deformity with the patient was not done before the procedure. Other AEs such as minor complications are those that will self-resolve without further management, although they might cause prolonged temporary deformity or other symptoms. Minor complications can include: prolonged swelling, which can be managed by administration of NSAIDs and limitation of activity which can help edema to resolve more quickly. Another minor complication of RF treatment is prolonged bruising in the treatment area, which can be managed with cold compresses accompanied by arnica containing medication in either pill or form of topical gel. While cold compresses placed on the treatment area might help, ice packs applied directly to treated skin can be of a risk, as the concomitant numbness sustained from the procedure may promote thermal injury. Prolonged erythema can be a low-grade bacterial infection, which can be managed by antibiotics. Prolonged numbness can be managed by light moving touch extending from the periphery of the treatment area towards the central region. If repeated, it can help in guiding the path of the regenerating nerves. The restoration of proper sensation is not guaranteed, but improvement can occur. Major complications are considered to occur with RF-assisted aesthetic treatments and are those that do require further intervention, and it can include: second- or third-degree burn. Burns that develop a component of full thickness skin loss almost always require surgical intervention. Direct excision with a precise layered closure is the best intervention in most cases. If the 3rd-degree burn is small, usually an excision with a circular dermal punch can be an effective management. Complications such as large hematomas rarely heal and require surgical early evacuation. Also, seromas rarely heal spontaneously and require full excision of the seroma 'lining'. Other complications such as contour irregularities usually require treatments such as subcision revisions to release the depression, which can be done using a 'Rigottomy' technique, traditional subcision, laser-assisted release. Usually, depression also requires some type of transferring fat or filler to correct the irregularity appropriately, especially if it is focal depression [43].

A study conducted to determine the effect of cold exposure of cryo-lipolysis on sensory nerve function. At 6 months after treatment, there were no long-term sensory disturbances. Six of the patients had mild transient reduction in sensation, which returned normal with 7 weeks of treatment, and a biopsy of one patient showed no significant changes. Another study evaluated the

effect of cryo-lipolysis on serum lipid levels and liver function tests in 40 patients. No significant changes were noticed in either of the tests after a 12-week follow-up, suggesting that the technology has unlikely adverse effects over lipid profiles and liver function. There is a considerable risk of temporary sensory nerve dysesthesia, but it resolves within 2 to 3 months [44].

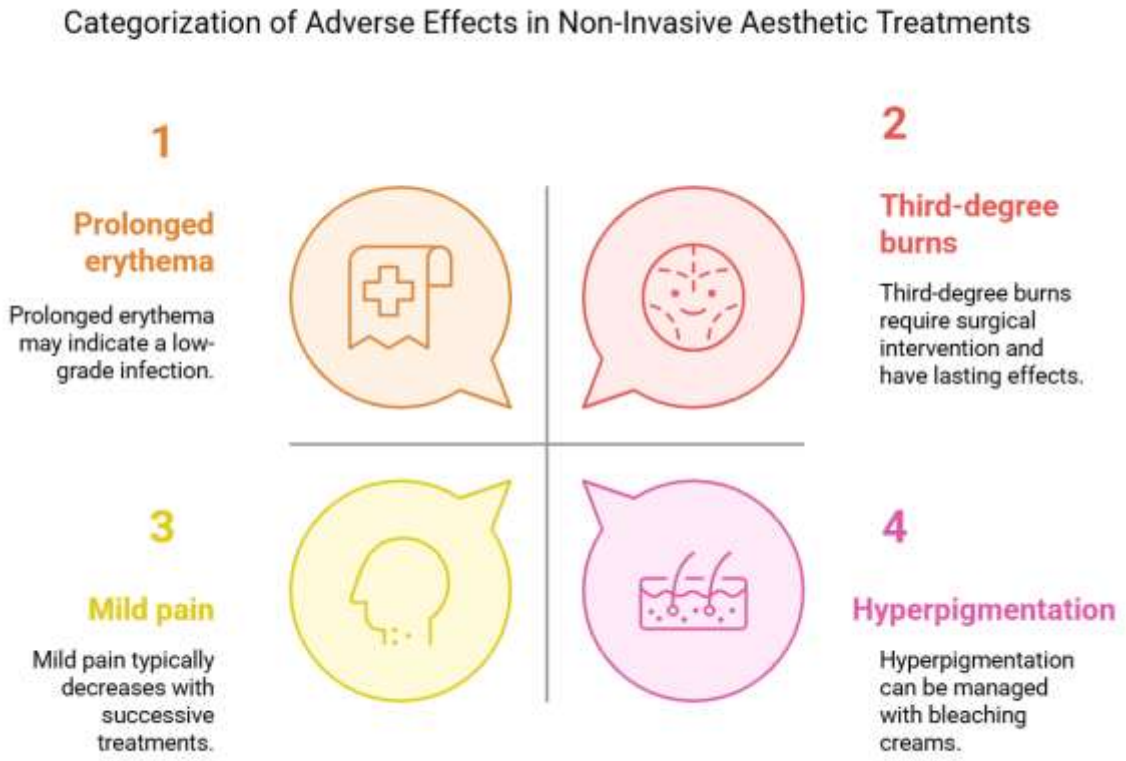

Figure 4: Adverse Effects in Non-Invasive Aesthetic Treatments

Image credits: Husna Irfan Thalib

Evidence-based recommendations for integrating non-invasive techniques in plastic surgery treatment plans

Major plastic surgical procedures have minor to severe drawbacks, including hospitalization, anesthesia risk, swelling, prolonged recovery, and pain. Patient expectations and demands are now directed toward procedures that provide safer, less discomfort, limited complications, and a shorter recovery. It is for these reasons that noninvasive and minimally invasive methods have become the latest appealing areas in plastic surgery. Non-invasive and minimally invasive procedures are those that do not require an incision or to remove tissue. These non-invasive procedures provide refreshing and reviving outcomes without using a scalpel. There is much evidence that supports

the integration of the non-invasive procedure in plastic surgery treatment such as micro needling, ultrasound, radiofrequency, and cryo-lipolysis therapies [45].

Skin micro needling therapy is a recent addition to the noninvasive plastic treatment approach. This technique relies on studding fine needles rolling along the skin in different directions. The benefit of this technique depends on stimulating the production of collagen to manage photoaged skin, stretch marks, and post-acne scarring [46]. A study done by El-Domyati, et, to evaluate the subjective improvement in wrinkles, skin texture, and patient satisfaction of 10 patients. The result showed that over a three-month course of micro needling, collagen types one, three, with tropoelastin level showed a statistically significant increase [47].

Moreover, the ultrasound technology is used as a non-invasive treatment for skin laxity associated with photoaging. The Ulthera system (Ulthera, Inc.) is the technique that delivers waves focused energy to the dermal and subcutaneous layers to generate heat and induce thermal coagulation [48]. A study was done to evaluate the efficacy of ultrasound treatment of face and neck laxity in 2012 on twelve female volunteers who enrolled in the study. Areas treated included the face and neck. Two blinded, experienced clinicians evaluated pre- and post-treatment (day 90) with photographs and patient self-assessment methods. The result indicated that the two blinded clinicians reported 80% clinical improvement 90 days post-treatment. In addition, (90%) of volunteers reported subjective improvement [49].

Lastly, a new approach of effective body-contouring called cryo-lipolysis is an effective body-contouring technique. It is a nonsurgical technique employed for localized fat reduction and body contouring through Cooling applicators. Post-procedure patient satisfaction surveys and evaluation assessments have proved a significant fat reduction [50]. Finally, it is essential to note that the majority of these noninvasive procedures, such as MN, ultrasound therapy, and cryo-lipolysis, are procedures that can depend on many factors. Thus, results can vary widely depending on many factors such as employees' experience, amount of pressure, and duration and/or frequency of the treatment.

Cultural perspectives regarding non-invasive cosmetic procedures

Cultural perceptions related to non-surgical cosmetic procedures depend greatly on social, historical, and media influences as summarized in ***Figure 5***. Non-invasive treatments like Botox, dermal fillers, and chemical peels have been considerably accepted in Western culture, particularly in the United States and Europe, as a means of enhancing natural beauty without the risks of surgery. These forms of cosmetic procedures are usually related to taking care of oneself and building self-confidence, in line with today's contemporary concepts of individualism and body self-determination. Besides, advantages in technology have made such procedures safer and more available; hence, the number of people, regardless of their age, has considerably increased [51, 52]. In East Asia, non-invasive cosmetic enhancements are influenced by culturally specific ideals of beauty such as a whiter complexion, V-shaped facial structures, and larger eyes. Skin-whitening treatments, for example, remain in high demand due to cultural associations between white skin

and social status with elegance. Similarly, procedures like high-intensity focused ultrasound (HIFU) and thread lifts are particularly popular in countries like South Korea, where the desire for youthful and symmetrical facial features is very commonly prevalent. These preferences highlight the role of cultural beauty standards in shaping demand for specific procedures in specific regions [53,54].

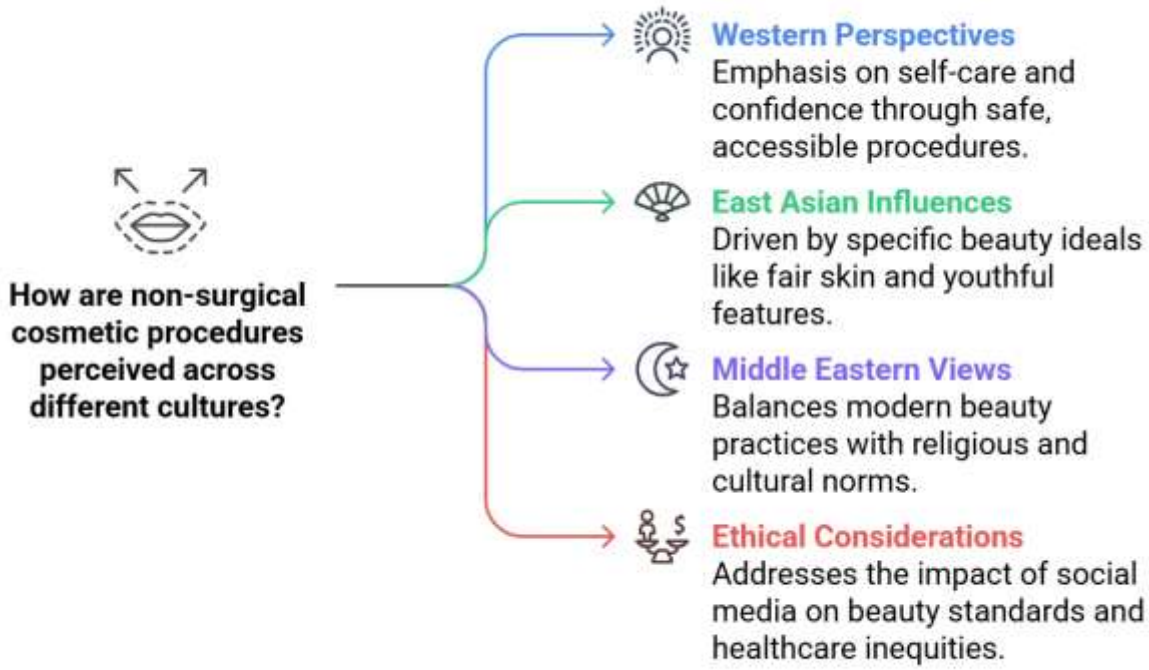

Figure 5: Cultural perspectives regarding non-invasive cosmetic procedures

Image credits: Husna Irfan Thalib

In the Middle East, the view is very different: religious and cultural norms determine the attitudes towards cosmetic treatments. Non-invasive treatments are more commonly chosen than surgery since they come within the beliefs of modesty and the least modification of the body. Microdermabrasion and laser hair removal treatments have gained widespread acceptance as these procedures fulfill the balance between traditional values and modern beauty practices. Apart from this, social relevance for viewing oneself and others as presentable and young, both personally and professionally, is another factor that motivates demand for these procedures in the region [55,56]. Though popular, non-invasive cosmetic procedures raise ethical and psychological concerns throughout the world. Some studies show that while these treatments may be associated with improved self-esteem, they also promote unattainable standards of beauty through social media and celebrity culture. Therein, its influence is significantly related to increasing body

dissatisfaction and potential misuse of cosmetic enhancement practices. Accessibility to these procedures also gives rise to several ethical considerations particularly differences and overall inequities within health care and socio-economic circumstances. These issues emphasize the need to bring about a balanced and informed approach to non-invasive cosmetic interventions [57].

Conclusion

In conclusion, plastic surgery is one of the oldest surgical specialties, and with various innovative technologies and a better understanding of human anatomy, the field has significantly developed in the modern era. Traditional reconstructive plastic surgery procedures, however, are often highly invasive, expensive, and carry a high risk of complications. So, in recent years, newer non-invasive procedures have emerged that perform various facial rejuvenation procedures and fat reduction procedures that offer fewer complications, lower costs, and shorter recovery periods compared to traditional techniques.

This review shows that recent non-invasive techniques have gained popularity among patients and have a high satisfaction rate. In several studies, non-invasive skin rejuvenation procedures using radiofrequency and ultrasound technology and micro-needling procedures have shown good patient outcomes. Other studies using cryo-lipolysis procedures for fat reduction have also shown promising results in animal models and comparable results in humans. While non-invasive procedures can have few side effects and complications, significant complications are rare, and most are minor, such as erythema, mild pain, mild burn, and swelling, which can be self-resolved without interventions in most cases. These factors can appeal to patients seeking an alternative to traditional invasive procedures.

Therefore, integrative non-invasive techniques in plastic surgery treatment plans can help enhance patient care by providing safer options with less discomfort and limited complications. Technological advancements and newer developments will likely provide better care and treatment outcomes and broaden the scope of non-invasive procedures in plastic surgery.

Disclaimer: All the views expressed in this paper are the authors' own views and not an official position of the institution.

References

1. Chandra R, Agarwal R, Agarwal D. Redefining plastic surgery. Plastic and Reconstructive Surgery–Global Open. 2016 May 1;4(5):e706. Available from: https://journals.lww.com/prsgo/FullText/2016/05000/Redefining_Plastic_Surgery.16.aspx
2. Champaneria MC, Workman AD, Gupta SC. Sushruta: father of plastic surgery. Annals of plastic surgery. 2014 Jul 1;73(1):2-7. Available from: https://journals.lww.com/annalsplasticsurgery/abstract/2014/07000/sushruta__father_of_plastic_surgery.2.aspx

3. Macionis V. History of plastic surgery: Art, philosophy, and rhinoplasty. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2018 Jul 1;71(7):1086-92. Available from: https://doi.org/10.1016/j.bjps.2018.03.001
4. Pećanac MĐ. Development of plastic surgery. Medicinski pregled. 2015;68(5-6):199-204. Available from: https://doiserbia.nb.rs/Article.aspx?ID=0025-81051506199P
5. Mustoe TA, Han H. The effect of new technologies on plastic surgery. Archives of Surgery. 1999 Nov 1;134(11):1178-83. Available from: https://jamanetwork.com/journals/jamasurgery/article-abstract/390427
6. Hallock GG. A brief history of minimally invasive plastic surgery. InSeminars in plastic surgery 2008 Feb (Vol. 22, No. 01, pp. 005-007). © Thieme Medical Publishers. Available from: https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-2007-1019136
7. Frankeny A. Shaping tomorrow: The boom in noninvasive body contouring and laser procedures. American Society of Plastic Surgeons. 2023. Available from: https://www.plasticsurgery.org/news/articles/shaping-tomorrow-the-boom-in-noninvasive-body-contouring-and-laser-procedures
8. Triana, L., Palacios Huatuco, R. M., Campilgio, G., & Liscano, E. (2024). Trends in Surgical and Nonsurgical Aesthetic Procedures: A 14-Year Analysis of the International Society of Aesthetic Plastic Surgery-ISAPS. *Aesthetic plastic surgery*, 10.1007/s00266-024-04260-2. Advance online publication. https://doi.org/10.1007/s00266-024-04260-2
9. Sinha V, Malik M, Borrelli MR, Sinha A, Cavale N. The quality of online information regarding non-surgical aesthetic procedures. Journal of Plastic Reconstructive & Aesthetic Surgery [Internet]. 2021 Aug 1;74(8):1881–7. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1748681520306719
10. Healthdirect Australia. Guide to cosmetic surgery. Healthdirect. Available from: https://www.healthdirect.gov.au/guide-to-cosmetic-surgery#alternatives
11. Sarwer, D. B. (2019). Body image, cosmetic surgery, and minimally invasive treatments. *Body Image*, *31*, 302–308. https://doi.org/10.1016/j.bodyim.2019.01.009
12. Jankovic J, Brin MF. Therapeutic uses of botulinum toxin. New England Journal of Medicine. 1991 Apr 25;324(17):1186–94. Available from: https://doi.org/10.1056/nejm199104253241707
13. Ballin, A.C., Brandt, F.S. & Cazzaniga, A. Dermal Fillers: An Update. Am J Clin Dermatol 16, 271–283 (2015). Available from: https://doi.org/10.1007/s40257-015-0135-7

14. American Society of Plastic Surgeons. Skin rejuvenation and resurfacing . American Society of Plastic Surgeons. Available from: https://www.plasticsurgery.org/cosmetic-procedures/skin-rejuvenation-and-resurfacing

15. Nilforoushzadeh MA, Heidari-Kharaji M, Fakhim T, Behrangi E, Shahverdi M, Rafiee S, et al. Efficacy of Endolift laser for arm and under abdomen fat reduction. Journal of Cosmetic Dermatology. 2023 Feb 16;22(7):2018–22. Available from: https://doi.org/10.1111/jocd.15684

16. Kennedy J, Verne S, Griffith R, Falto-Aizpurua L, Nouri K. Non-invasive subcutaneous fat reduction: a review. Journal of the European Academy of Dermatology and Venereology. 2015 Feb 9;29(9):1679–88. Available from: https://doi.org/10.1111/jdv.12994

17. Dermatology, F. the D. of. Understanding how to prevent and treat adverse events of... : Plastic and reconstructive surgery – global open. LWW. https://journals.lww.com/prsgo/fulltext/2016/12001/understanding_how_to_prevent_and_treat_adverse.6.aspx

18. Sánchez-Carpintero (2010, August 20). Dermal fillers: Types, indications, and complications. Actas Dermo-Sifiliográficas (English Edition). https://doi.org/10.1016/S1578-2190(10)70660-0

19. Babilas, P., Schreml, S., Szeimies, R., & Landthaler, M. (2010). Intense pulsed light (IPL): A Review. Lasers in Surgery and Medicine, 42(2), 93–104. https://doi.org/10.1002/lsm.20877

20. Avci, P., Gupta, A., Sadasivam, M., Vecchio, D., Pam, Z., Pam, N., & Hamblin, M. R. (2013). Low-level laser (light) therapy (LLLT) in skin: stimulating, healing, restoring. Seminars in cutaneous medicine and surgery, 32(1), 41–52.

21. professional, C. C. medical. (2024, May 1). Fat Freezing (cryolipolysis). Cleveland Clinic. https://my.clevelandclinic.org/health/treatments/21060-fat-freezing-cryolipolysis

22. Ingargiola, M. J., Motakef, S., Chung, M. T., Vasconez, H. C., & Sasaki, G. H. (2015). Cryolipolysis for fat reduction and body contouring: safety and efficacy of current treatment paradigms. Plastic and reconstructive surgery, 135(6), 1581–1590. https://doi.org/10.1097/PRS.0000000000001236

23. Rousseaux, I., & Robson, S. (2017). Body Contouring and Skin Tightening Using a Unique Novel Multisource Radiofrequency Energy Delivery Method. The Journal of clinical and aesthetic dermatology, 10(4), 24–29.

24. Levy LL, Emer JJ. Complications of Minimally Invasive Cosmetic Procedures: Prevention and Management. Journal of Cutaneous and Aesthetic Surgery [Internet]. 2012 [cited 2020 May 21];5(2):121–32. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3461789/

25. Emer J, Waldorf H. Injectable neurotoxins and fillers: there is no free lunch. Clinics in dermatology. 2011 Nov 1;29(6):678-90.

26. Lu DW, Lippitz J. Complications of botulinum neurotoxin. Disease-a-Month. 2009 Apr 1;55(4):198-211.

27. Andre P. Evaluation of the safety of a non-animal stabilized hyaluronic acid (NASHA–Q-Medical, Sweden) in European countries: a retrospective study from 1997 to 2001. Journal of the European Academy of Dermatology and Venereology. 2004 Jul;18(4):422-5.

28. Kessler E, Flanagan K, Chia C, Rogers C, Glaser DA. Comparison of α-and β-hydroxy acid chemical peels in the treatment of mild to moderately severe facial acne vulgaris. Dermatologic surgery. 2008 Jan 1;34(1):45-51.

29. Bray D, Hopkins C, Roberts DN. A review of dermal fillers in facial plastic surgery. Current opinion in otolaryngology & head and neck surgery. 2010 Aug 1;18(4):295-302.

30. Juhasz ML, Cohen JL. Microneedling for the treatment of scars: An update for clinicians. Clinical, Cosmetic and Investigational Dermatology. 2020 Dec;Volume 13:997–1003. doi:10.2147/ccid.s267192

31. Safran T, Gorsky K, Viezel-Mathieu A, Kanevsky J, Gilardino MS. The role of ultrasound technology in plastic surgery. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2018 Mar;71(3):416–24. doi:10.1016/j.bjps.2017.08.031

32. Lolis MS, Goldberg DJ. Radiofrequency in cosmetic dermatology: A Review. Dermatologic Surgery. 2012 Nov;38(11):1765–76. doi:10.1111/j.1524-4725.2012.02547.x

33. 1. Carroll C, Hummel S, Leaviss J, Ren S, Stevens JW, Cantrell A, et al. Systematic Review, network meta-analysis and exploratory cost-effectiveness model of randomized trials of minimally invasive techniques versus surgery for varicose veins. British Journal of Surgery. 2014 Jun 25;101(9):1040–52. doi:10.1002/bjs.9566

34. Sadick N, Luebberding S, Mai SV, Krueger N. Cryolipolysis for noninvasive body contouring: Clinical efficacy and patient satisfaction. Clinical, Cosmetic and Investigational Dermatology. 2014 Jun;201. doi:10.2147/ccid.s44371

35. Swanson E. Cryolipolysis: The importance of scientific evaluation of a new technique. Aesthetic Surgery Journal. 2015 Mar 31;35(5). doi:10.1093/asj/sju069

36. Masoumi Lari SJ, Roustaei N, Roshan SK, Chalian M, Chalian H, Honarbakhsh Y. Determinants of patient satisfaction with ultrasound-assisted liposuction. Aesthetic Surgery Journal. 2010 Sept 1;30(5):714–9. doi:10.1177/1090820x10378086

37. Claytor RB, Sheck CG, Chopra V. Microneedling Outcomes in early postsurgical scars. Plastic & Reconstructive Surgery. 2022 Jun 28;150(3). doi:10.1097/prs.0000000000009466

38. Volders JH, Haloua MH, Krekel NMA, Negenborn VL, Kolk RHE, Lopes Cardozo AMF, et al. Intraoperative ultrasound guidance in breast-conserving surgery shows superiority in oncological outcome, long-term cosmetic and patient-reported outcomes. European Journal of Surgical Oncology (EJSO). 2017 Apr;43(4):649–57. doi:10.1016/j.ejso.2016.11.004

39. Mulholland RS. Radio Frequency Energy for non-invasive and minimally invasive skin tightening. Clinics in Plastic Surgery. 2011 Jul;38(3):437–48. doi:10.1016/j.cps.2011.05.003

40. Ingargiola MJ, Motakef S, Chung MT, Vasconez HC, Sasaki GH. Cryolipolysis for fat reduction and body contouring. Plastic and Reconstructive Surgery. 2015 Jun;135(6):1581–90. doi:10.1097/prs.0000000000001236

41. M; GABH. A systematic review examining the potential adverse effects of microneedling [Internet]. U.S. National Library of Medicine; [cited 2024 May 26].

42. Miller DL, Smith NB, Bailey MR, Czarnota GJ, Hynynen K, Makin IR. Overview of therapeutic ultrasound applications and safety considerations. Journal of Ultrasound in Medicine. 2012 Apr;31(4):623–34. doi:10.7863/jum.2012.31.4.623

43. Duncan DI. Complications of treatment with radiofrequency in Aesthetic Medicine. Radiofrequency in Cosmetic Dermatology. 2014 Dec 19;81–96. doi:10.1159/000362750

44. Mulholland RS, Paul MD, Chalfoun C. Noninvasive body contouring with radiofrequency, ultrasound, cryolipolysis, and low-level laser therapy. Clinics in Plastic Surgery. 2011 Jul;38(3):503–20. doi:10.1016/j.cps.2011.05.002

45. Sobanko JF, Alster TS. Management of acne scarring, part I. American Journal of Clinical Dermatology. 2012 Oct;13(5):319–30. doi:10.2165/11598910-000000000-00000

46. Cohen BE, Brauer JA, Geronemus RG. Acne scarring: A review of available therapeutic lasers. Lasers in Surgery and Medicine. 2015 Sept 28;48(2):95–115. doi:10.1002/lsm.22410

47. El-Domyati M, Barakat M, Awad S, Medhat W, El-Fakahany H, Farag H. Multiple microneedling sessions for minimally invasive facial rejuvenation: An objective assessment. International Journal of Dermatology. 2015 Jun 20;54(12):1361–9. doi:10.1111/ijd.12761

48. Minkis K, Alam M. Ultrasound skin tightening. Dermatologic Clinics. 2014 Jan;32(1):71–7. doi:10.1016/j.det.2013.09.001

49. Lee HS, Jang WS, Cha Y-J, Choi Y-H, Tak Y, Hwang E, et al. Multiple pass ultrasound tightening of skin laxity of the lower face and neck. Dermatologic Surgery. 2012 Jan;38(1):20–7. doi:10.1111/j.1524-4725.2011.02158.x

50. Sasaki GH. Reply. Plastic and Reconstructive Surgery. 2016 Mar;137(3). doi:10.1097/01.prs.0000479983.49996.c0

51. Aldeham RK, Bin Abdulrahman K, Habib SK, Alajlan LM, AlSugayer MK, Alabdulkarim LH. Public Views About Cosmetic Procedures in Riyadh, Saudi Arabia. Cureus. 2023 Dec 7;15(12):e50135. doi: 10.7759/cureus.50135.

52. Arian H, Alroudan D, Alkandari Q, Shuaib A. Cosmetic Surgery and the Diversity of Cultural and Ethnic Perceptions of Facial, Breast, and Gluteal Aesthetics in Women: A Comprehensive Review. Clin Cosmet Investig Dermatol. 2023 Jun 7;16:1443-1456. doi: 10.2147/CCID.S410621.

53. Khattab NR, Abdelraouf N, Ashour T. Conflicting Cultural and Religious Views on Cosmesis: The Modern Women's Dilemma. Aesthetic Plast Surg. 2022 Aug;46(4):2040-2052. doi: 10.1007/s00266-022-02834-6.

54. Amiri L, Galadari H, Al Mugaddam F, Souid AK, Stip E, Javaid SF. Perception of Cosmetic Procedures among Middle Eastern Youth. J Clin Aesthet Dermatol. 2021 Dec;14(12):E74-E83.

55. Bondagji MF, Sindi EE, Alamri GE, Fageeh SM, Niyazi AA, Alquhra Alotaibi DO, Alghamdi GA, Alluhaybi AA, Shatla M. Knowledge, Attitudes, and Practices With Regard to Cosmetic Procedures Among the General Population in the Western Region of Saudi Arabia: A Cross-Sectional Study. Cureus. 2024 Jan 13;16(1):e52214. doi: 10.7759/cureus.52214.

56. Alotaibi AS. Demographic and Cultural Differences in the Acceptance and Pursuit of Cosmetic Surgery: A Systematic Literature Review. Plast Reconstr Surg Glob Open. 2021 Mar 24;9(3):e3501. doi: 10.1097/GOX.0000000000003501.

57. Alyahya T, Zakaria OM, AlAlwan A, AlMaghlouth M, Alkhars H, AlAlwan M. Local Community View of Aesthetic Surgery: Results of a Cross-Sectional Survey. Cureus. 2022 Dec 29;14(12):e33078. doi: 10.7759/cureus.33078.