Cosmetic Gynecology: Present and Future Perspectives

Prabhu Chandra Mishra *1, Diana Mihai 2, Nidhi Khurana 3, Manar Jabbar 4

1President, International Association of Stem Cell and Regenerative Medicine, New Delhi, India; info@stemgenn.com
2Gynecologist; Diana Medical Center, Bucharest, Romania; dr.dianamihai@gmail.com
3Chief Scientific Officer, StemMax Research and Therapeutics Pvt. Ltd. New Delhi, India; stemgenn.cso@gmail.com
4Specialist OBG-M.B.Ch.B./F.I.C.O.G; Al Raffah Hospital, Muscat; dr.manarjh@gmail.com

*Corresponding author: Prabhu Chandra Mishra; info@stemgenn.com

Received 09 November 2021; Accepted 20 November 2021; Published 17 November 2021

Abstract

Postmenopausal women and events like childbirth, and aging may cause structural and functional changes in women genitalia. The arising indications do not only cause psychological distress to women but negatively affect the sexual well-being and deteriorate the quality of their lives. Regenerative/cosmetic gynecology procedures enable women to treat the functionality issues and modify the physical structure of vagina. This review discusses the latest developments in this field with regards to various kinds of procedures that are available, particularly the use of energy-based devices, and adipose tissue derived stem cells therapy for fat grafting which have revolutionized the regenerative gynecology procedures. These offer non-invasive modalities to treat the conditions like urinary incontinence among others which occur in high prevalence among women. Despite the advancements made in this field, it lacks regulatory guidelines and standardized procedures which imposes one of the biggest challenges of the field. Alongside, we have documented a procedure called Intimacell® which has been standardized for fat grafting procedures in vulvovaginal region.

Keywords: Cosmetic Gynecology, Vaginal Rejuvenation, Stem Cell in aesthetic gynecology, energy based devices.

Introduction

Regenerative Gynecology is a branch of cosmetic and aesthetic surgery which comprises of surgical and non-surgical procedures to enhance the aesthetic appearance and functionality of the vulvo/vaginal region. Events like pregnancy, childbirth and ageing affect the structure of vagina thereby causing changes in its appearance and physical response to stimuli. Most commonly women are affected by birthing injuries, uterine prolapse, incontinence issues, vaginal atrophy, genitourinary syndrome of menopause, perimenopausal and menopausal changes, lichen sclerosus, sexual dysfunction, and vulvovaginal laxity. These indications not only affect sexual well-being of women but deteriorate the overall quality of life [3,4]. Cosmetic gynecology procedures enable pelvic floor toning and regain the integrity of the tissues, hence, giving an opportunity to women to achieve a better quality of life through increased comfort and sexual confidence [9]. Table 1 lists cosmetic gynecology procedures in practice.

Table 1: Overview of the procedures and treatments performed in cosmetic gynecology

| Surgical Procedures | Platelet Rich Plasma therapy |
|---------------------|-----------------------------|
| Labia minoraplasty  | Lipofilling/Lipograft        |
| Clitoral hood reduction (Hoodoplasty) |
| Labia majoraplasty  |
| Vaginal caliber reduction   |
| Monsplasty             |
| Vaginoplasty           |
| Perineoplasty          |
| Colporineoplasty       |

| Minimally Invasive Procedures | Surface cooled monopolar Radio frequency |
|--------------------------------|-----------------------------------------|
|                                | Cryogen cooled monopolar Radio frequency |
|                                | Erbium YAG laser therapy                |
|                                | CO2 laser therapy                      |
|                                | HIFU                                    |
|                                | 1470 Diode Laser                       |

Table 1 lists cosmetic gynecology procedures in practice.

www.ijirms.in
Platelet Rich Plasma (PRP) therapy for vaginal rejuvenation

Over the last 20 years PRP has been used as an effective treatment for various indications including maxillofacial surgery, wound treatment, orthopedic, soft tissue injuries, gastrointestinal surgeries, scars, burns, gynecological disorders, and in cosmetic procedures. PRP is enriched with several growth factors and cytokines that are released in response to cellular damage and stimulate the process of fibroblast collagen synthesis. Figure 1 shows separation of blood into three layers after centrifugation while PRP preparation.

A study in 2017 conducted a pilot study with sixty eight women of ages between 32-90 years, to measure their responses to PRP therapy as a treatment for overactive bladder, stress incontinence, varying degrees of sexual dysfunction (orgasm, libido, and dyspareunia) and lack of lubrication. There were two sessions of PRP therapy was provided two months apart. The results revealed that 94% of women were satisfied and only 6% of them who had the indication of overactive bladder, did not show any improvement. The study concluded that the treatment is effective, and safe for women seeking changes in the vulvo-vaginal region.

Long et al in 2021 conducted a study to evaluate the effectiveness of autologous PRP injection as a therapy for women with SUI indication. Twenty women were enrolled in this study and PRP was injected at anterior vaginal wall. Follow up was done at the interval of 1 month and 6. Secondary outcomes including sexual function and treatment effect sorted by age were analyzed. They found that PRP treatment is effective in relieving SUI symptoms without significant adverse reactions at both 1 month and 6 month follow up. PRP is also used as an adjunct therapy along with energy-based devices procedures to enhance the efficacy of the treatment. In another study by Willison F et al 2021, feasibility, safety, and efficacy of FsCO2 (Fractional Microablative CO2) vaginal laser treatment and PRP was evaluated in 62 women with refractory urge urinary incontinence (UUI) with urinary function and sexual function as secondary outcome measures. The participants underwent three sessions of transvaginal FsCO2 laser and PRP which were administered at 4–6-week intervals. The 12-month follow up data revealed that the average severity of all self-reported measures of primary and secondary outcomes was significantly reduced and no adverse events were reported.

Role of Adipose Derived Stem Cells and Fat Transfer in Rejuvenation and Treatment of Female Genital Area

Stem cell therapy is a process of isolating autologous adult stem cells and injecting them at the site which requires healing or regeneration. Recent reports have identified that adipose contains the highest percentage of adult stem cells in the body. The ADSCs harvested from the patient’s own body fail to elicit an immunological response and therefore their administration into the targeted site does not lead to rejection. It has a varied composition: mature adipocytes, ECM (extracellular matrix) and a stromal vascular fraction (SVF) which consists of a variety of cells including adipose derived stem cells (ADSCs), endothelial cells, erythrocytes, pericytes, fibroblasts, hematopoietic cells, vascular smooth muscle cells, and other immune cells.

Fat Transfer is performed for genital volume restoration, for rejuvenation of vaginal wall and vulvar skin, and vaginal recalibration by lipofilling technique. Lipofilling procedure consists of reducing the vaginal caliber by thickening the vaginal walls employing adipose tissue transplant. It is indicated for those patients who are concerned by the sensation of a wide vagina. The causes are often post gravid in multiparous women and a few times constitutional.

Protocol

For adipose tissue derived stem cell regenerative gynecology, we use an in-house developed methodology called Intimacell®. The protocol includes preparation of Klein solution (tumescent anesthesia) which consists of 500 mg- lidocaine, 0.5 mg-epinephrine, and 10 mEq-sodium bicarbonate in 1 L of normal saline; lipospiration followed by centrifugation at 1100 rpm for 4 mins, collecting the micro-fragmented adipose tissue, and homogenization by ultrasonication (Figure 2). The flowchart for Intimacell® methodology for SUI treatment is shown in Figure 3.
Take a mixture of micro-fragmented adipose tissue and secretomes

Inject transurethral via cystoscope under local anaesthesia

The injections are placed directly under mucosa 1.7 cm distal from the urethral neck at 3 and 9 o’clock. Injected volume is to be 4-5 ml per patient

Two additional concomitant injections of MAT mixed with hPGRP (volume 2.5 ml) were injected 3.5 mm distally to bring the MAT in contact with the urethral musculature

Patients can be followed up at 3-, 6- and 12-months interval

Gynecological examinations to be included: A vaginal ultrasonography, a cough test, a 24-hour pad test, standardized questionnaires, and urodynamic evaluations at 6 months

Figure 3: Intimacell® methodology for the treatment of Stress Urinary Incontinence

Energy Based Devices (EBD)

Energy-based devices are the latest development in this sector which has brought with it a promising approach to help alleviate vaginal concerns [68,69]. The EBDs apply thermal or nonthermal energy to the skin tissue which stimulates collagen formation, contraction of elastin fibres, neovascularization, induce tissue remodeling, and improve lubrication. The use of EBDs to vaginal tissue address genitourinary syndrome of menopause, vulvovaginal atrophy by increasing the proliferation of vaginal epithelium, stimulating neo-collagenesis, and increasing vascular and neural regeneration, thereby moving from pure aesthetics to functional gynecology applications [70]. The two types of lasers that are commonly used to treat vulvovaginal tissue are carbon dioxide (CO2) and erbium:yttrium-aluminum-garnet (Er:YAG).

Carbon Dioxide Laser

The carbon dioxide (CO2) laser emits light at wavelength of a 10.600 nm, which is greatly absorbed by tissue water and the depth of penetration is dependent on the water content while being independent of melanin and hemoglobin [71]. The heat produced by CO2 laser denatures the proteins and upregulates the expression of TGFB which in turn activates the fibrogenic process (Fig 1). CO2 laser treatment has beenfound to be highly efficacious in rejuvenating the vulvovaginal tissues. Many studies had reported significant improvement in indications like, genitourinary syndrome of menopause, vaginal laxity, sexual function, and women’s quality of life following treatment with CO2 laser therapy [74-78]. One of the first studies performed by Cruz et al (2014) reported that CO2 laser therapy improved a number of symptoms for genitourinary syndrome of menopause (GSM) as compared to the group that was subjected to vaginal estrogen therapy. 45 post-menopausal women with GSM were included in the study [79].

In 2011, Gaspar et al. conducted a study in which they observed that the women with GSM who underwent CO2 laser treatment therapy, PRP, and pelvic exercises showed increased fibroblast activity, neogenesis in the ECM (Extracellular matrix), increased fibrillar components, improvement in vaginal epithelium and in glycogen concentration within the epithelium [80]. Furthermore, a study in 2015 reported that following CO2 laser treatment vaginal epithelium thickness was increased as well as storage of glycogen, and fibroblast synthesis of collagen was increased [81]. Recently, Ruangphoo et al. conducted a randomized controlled trial with 88 postmenopausal women experiencing GSM. They found significant improvements in the VHI (Vaginal Health Index), which clinically evaluates vulvovaginal atrophy, and the VAS (Visual Analog Scale) which evaluates symptoms of GSM [82]. In a retrospective study conducted in 2020 found that vaginal CO2 laser therapy emerged as the most cost-effective treatment as compared to vaginal estrogen therapy and ospemifene therapy [83].

Erbium:Yttrium-Aluminum-Garnet

The Er:YAG laser is a near-infrared ablative laser which is employed to induce tissue resurfacing. It emits light at a wavelength of 2,940 nm and yields an absorption coefficient which is 16 times higher than that of the CO2 laser. The penetration depth of Er:YAG laser is confined to approx. 1–3 mm of tissue per J/cm2, in comparison to the 20–30 mm provided by the CO2 laser [73]. This particular feature enables a more precise skin ablation, with very little thermal damage to the surrounding tissues. The use of Er:YAG laser may lead to a milder post-operative discomfort, edema, and erythema, and overall faster healing time as compared to the CO2 laser [84]. This laser exposes the underlying collagen tissue to heat which leads to contraction of the collagen, thereby inducing the wound healing cascade which consequently stimulates fibroblasts to synthesize collagen [85-87].

The Er:YAG laser is employed for indications like vaginal laxity, and GSM and for SUI indications, it is more commonly used than CO2 laser. A number of studies have reported the efficacy of the Er:YAG laser on rejuvenating and revitalizing the vulvovaginal tissue and its effectiveness in management of aforementioned conditions [85,86,88-90]. In a study by Lapii et al. [87] vaginal biopsies from 18 patients with SUI were analysed before and 1-2 months after the exposure. The results showed an increase in epithelial glycogen content and increased thickness of epithelial layer by 64.5%. They also observed an increase in active fibroblasts and neo-collagenogenesis apart from increased density of capillaries [87]. Recently, in a cohort study by Reisenauer et al. [90] with 30 patients who received two treatments of Er:YAG laser therapy, it was observed that the quality of life was significantly improved for the patients.

Radiofrequency (RF)

In RF therapy, a device emits focused electromagnetic waves which generates heat. This heat reaches a thermal dose threshold, beyond which the collagen fibers fold its triple helix structure and become thicker and shorter. This denaturation of collagen begins at 60°C and it fully denatures at 70-75 °C. At 67 °C, partial denaturation of collagen elicits mild inflammatory response leading to the activation of fibroblasts for collagen and elastin synthesis [91-93] which occurs at a temperature at 40–45 °C thereby resulting in skin tightening [94]. However, if the surface temperature of the skin exceeds 45 °C, it is common to feel pain and have thermal burns during and after the RF treatment [95]. Till now, no thermal burns are reported in vaginal tissue treatment with RF up to 47 °C, but at approximately 55 °C, burns and blisters have been observed. The monopolar RF devices used currently for vaginal treatment employ mobile delivery, with target surface temperature at or below 45°C.

www.iijirms.in
In a study performed with 20 women, it was found that three RF treatments led to the increased concentration of collagen [96]. Various clinical studies have also shown the effectiveness of RF for treating vaginal laxity, GSM, sexual dysfunction, and particularly SUI [97,98]. In a study by Sarmento et al. in 2020, post-menopausal women diagnosed with GSM underwent three treatments with RF. Vaginal smears were obtained and assessed, throughout the treatment at different intervals. The results showed a significant decrease in the vaginal pH, an increase in the amount of parabasal cells and superficial epithelia cells, increase in the concentration of lactobacillus species, and improvement in VHI score and GSM [99].

**HIFU**

It stands for ‘High Intensity Focused Ultrasound’. The first use of dermatologic, aesthetic use of HIFU was reported by White et al. in 2008. HIFU was approved by the FDA (Food and Drug Administration) in 2009 for use in browlifting [100]. Currently, it is employed for facial rejuvenation, tightening lifting, and body contouring, which are regarded ‘off-label use’ [101-103]. The principle behind HIFU is that it generates instant microthermal lesions by accumulating high-frequency ultrasound beams at the target site without causing damage to the epidermis and surrounding tissue. This induces cellular damage and volume reduction of the target area which in turn aids in new collagen/elastin formation and ECM. In a study by Sekiguchi et al. 2018, safety and efficacy of HIFU treatment was evaluated for vaginoplasty for 29 patients with median age of 46 years. They concluded that HIFU vaginoplasty can improve quality of life for women who suffer from pelvic floor disorder. Other studies have also shown the effectiveness of HIFU for vaginal treatments [105].

According to a comparison study where neocollagenesis and neoelastogenesis were analyzed after the HIFU and RF sessions, it was found that monopolar RF led to neocollagenesis and neoelastogenesis in the papillary dermis layer along with upper, and deep reticular dermis whereas HIFU led to neocollagenesis in the mid and deep reticular dermis layer and neoelastogenesis in the deep reticular dermis. HIFU showed highest level of both processes, neocollagenesis and neoelastogenesis in the deep reticular dermis. It was concluded that although both HIFU and RF affect deep tissues but HIFU impacts focal regions and monopolar RF impacts diffuse regions [105]. A comparative analysis of the depth range of the energy-based devices is illustrated in Figure 4.

For optimal results from the use of EBDs, it is recommended to include at least three sessions in the treatment which should be spaced 4 weeks apart followed by a touch-up session. EBDs also find their place as an adjuvant therapy to augment the results of other procedures that address sexual dysfunction or enhancements like G-spot or O-spot augmentation. The scope of services therefore sees an overlap not just to urogynaeology, but also to associated fields like urology, plastic surgery, and cosmetic dermatology.

**Histological Effects**

Following the ablative skin resurfacing using CO₂ and Er:YAG lasers, histological changes include the formation of collagen (neocollagenesis) at around 6 weeks post-treatment [106]. The studies reveal that post CO₂ laser elicited resurfacing, the facial skin of the patients showed upregulation of IL1β, TNFα, TGF-β1, procollagens I and III, metalloproteinases (Figure 5).

For optimal results from the use of EBDs, it is recommended to include at least three sessions in the treatment which should be spaced 4 weeks apart followed by a touch-up session. EBDs also find their place as an adjuvant therapy to augment the results of other procedures that address sexual dysfunction or enhancements like G-spot or O-spot augmentation. The scope of services therefore sees an overlap not just to urogynaeology, but also to associated fields like urology, plastic surgery, and cosmetic dermatology.

**Histological Effects**

Following the ablative skin resurfacing using CO₂ and Er:YAG lasers, histological changes include the formation of collagen (neocollagenesis) at around 6 weeks post-treatment [106]. The studies reveal that post CO₂ laser elicited resurfacing, the facial skin of the patients showed upregulation of IL1β, TNFα, TGF-β1, procollagens I and III, metalloproteinases (Figure 5).

In a study following fractional CO₂ laser resurfacing, it was observed that 1-3 days posttreatment, the wound healing process showed granulation which was followed by dermal remodeling and neocollagenesis upto 30 days after the treatment.
was observed to continue for several months thereafter as it has been seen after the treatment with standard ablative CO2 laser [107].

The effects of fractional CO2 laser treatment on vaginal mucosa are increased thickness of squamous stratified epithelium, increased levels of glycogen and a huge number of glycogen-rich cells depositing at the epithelial surface. Increased ECM content which includes collagen and ground substance, and active fibroblasts were also observed in the connective tissue of the lamina propria. Additionally, undulated epithelium, newly formed connective tissue papillae, and blood capillaries penetrating inside the papillae were detected post treatment [79,83]. Similar results were obtained post treatment of vaginal mucosa by fractional Er:YAG laser. The study reveals that it led to increased cellularity and thickness of the epithelium and a compact lamina propria with dense connective tissue arrangement, increased elastin and collagen content [100]. With RF treatment, the creation of new dermal volume is extensively studied and is shown to improve mechanical characteristics of the skin and skin laxity [95].

Tissue ablation by light-based devices induces the process of collagen shrinkage induced by heat followed by neocollagenesis. This process occurs at 45-50°C in the area surrounding the ablated tissue. The rise in temperature causes the activation of heat shock response (HSR) in the cells which leads to the upregulation of heat shock proteins (HSPs). Studies have shown that particularly HSP70 has a key role in coordinating the expression of growth factors like transforming growth factor-beta (TGF-β) which further elicits inflammatory response, and fibrogenic process leading to the formation of new collagen, elastin and ECM (Figure 5) [78]. The mechanism of action behind neocollagenesis is that any energy-based device application causes the collagen to denature and break into shorter collagen fibers. This partially denatured collagen stimulates the production of new collagen fibers which causes tissue tightening after skin-resurfacing procedures [109]. New elastin formation that is unique to RF, effectively treated vaginal laxity. Excessive transfer of heat to dermis may however lead to adverse effects like scarring and permanent hypopigmentation. Since with age and due to hormonal influence, the vaginal tissue varies in its water content and cellular component, it should be noted that controlled power of the energy source must be used. The use of EBDs has been associated with wither no or minimal adverse effects which may include discomfort during treatment, dysuria, vaginal discharge, vaginal bleeding, edema, itching, and mild burn [118,72].

Recently in 2018, US FDA issued a public warning regarding the use of EBDs to perform vaginal cosmetic procedures or vaginal rejuvenation. FDA highlighted that although, the FDA is aware of the usage of such devices, it has not approved their usage for any specific gynecological condition. With this claim came another challenge for the medical practitioners, manufacturers, and the women who seek such procedures to use these devices. To overcome this issue American Urogynecologic Society (AUGS) released the clinical consensus statement in May 2020 on vaginal energy-based devices according to which a total of forty statements were assessed and divided into five categories: patient criteria, health care provider criteria, efficacy, safety, and treatment considerations [114].

**Conclusion**

The past decade has seen a substantial rise in technological advancements with the advent of new tools and procedures to reverse age-related tissue remodeling, and for tissue functional restoration. The implementation of these new modalities for vaginal rejuvenation has opened up a new dimension to explore cosmetic indications in conventional gynecology. The social acceptance and the formation of regulatory bodies for better practice of these procedures is long overdue. However, looking ahead, this field has emerged with immense potential and promise to improve the quality of life of the patients and has been successful in carving its own niche. The issues that are being addressed by the cosmetic gynecology procedures are among those which generally are not spoken about openly. Ironically, women do not even bring the symptoms up to be discussed with their doctors and partly it is due to the lack of awareness of such procedures and widely acceptance of these to get rid of the functionality issues or improving self-esteem by accentuating the aesthetic appearance. With this field rapidly evolving, it is vital for standardized procedures to come into place for a safer practice. Long-term studies are required to understand the outcome of the procedures and to validate the treatment using the novel approaches in this field.

**Ethics approval and consent to participate**

Not applicable

**List of abbreviations**

- PRP: Platelet Rich Plasma
- ADSCs: Adipose derived stem cells
- EBD: Energy based devices
- RF: Radiofrequency
- HIFU: High Intensity Focused Ultrasound
- ECM: Extracellular matrix

**Data Availability**

Not applicable

**Financial support**

None.

**Conflicts of Interest**

The authors have no conflicts of interest to declare.

**Authors’ contributions**

PM conceptualized, designed and supervised the study, collected the data and performed the analysis. DM supervised the study, collected the data and performed literature review. NK was a major contributor in writing the manuscript, literature review and study design. MJ contributed towards data collection, analysis and writing of the manuscript. All authors read and approved the final manuscript.

**References**

[1] Borris K. Introduction: the prehistory of homosexuality in the early modern sciences. InThe Sciences of Homosexuality in Early Modern Europe 2013 Jan 11 (pp. 13-52). Routledge.
Wilkie G, Bartz D. Vaginal rejuvenation: a review of female genital cosmetic surgery. Obstetrical & gynecological survey. 2018 May 1;73(5):287-92.

[3] Barbara G, Facchin F, Buggio L, et al. Vaginal rejuvenation: current perspectives. International journal of women's health. 2017;9:513.

[4] Desai SA, Kroumpouzos G, Sadick N. Vaginal rejuvenation: From scalpel to wand. International journal of women's dermatology. 2019 Jun 1;5(2):79-84.

[5] Pauls RN, Fellner AN, Davila GW. Vaginal laxity: a poorly understood quality of life problem; a survey of physician members of the International Urogynecological Association (IUGA). International urogynecology journal. 2012 Oct;23(10):1435-48.

[6] Farage MA, Neill S, MacLean AB. Physiological changes associated with the menstrual cycle: a review. Obstetrical & gynecological survey. 2009 Jan 1;64(1):58-72.

[7] Guo SA, DiPietro LA. Factors affecting wound healing. Journal of dental research. 2010 Mar;89(3):219-29.

[8] House M, Kaplan DL, Socrate S. Relationships between mechanical properties and extracellular matrix constituents of the cervical stroma during pregnancy. InSeminars in perinatology 2009 Oct 1 (Vol. 33, No. 5, pp. 300-307). WB Saunders.

[9] Garcia B, Scheib S, Hallner B, et al. Cosmetic gynecology—a systematic review and call for standardized outcome measures. International urogynecology journal. 2020 Oct;31:1979-95.

[10] Sharp G, Maynard P, Hudaib AR, et al. Do genital cosmetic procedures improve women’s self-esteem? A systematic review and meta-analysis. Aesthetic surgery journal. 2020 Oct;40(10):1143-51.

[11] Maisel A, Waldman A, Furlan K, et al. Self-reported patient motivations for seeking cosmetic procedures. JAMA dermatology. 2018 Oct 1;154(10):1167-74.

[12] Sobanko JF, Dai J, Gelfand JM, et al. Prospective cohort study investigating changes in body image, quality of life, and self-esteem following minimally invasive cosmetic procedures. Dermatologic Surgery. 2018 Aug 1;44(8):1121-8.

[13] Haas CF. Motivating factors for seeking cosmetic surgery: a synthesis of the literature. Plastic Surgical Nursing. 2008 Oct 1;28(4):177-82.

[14] Sobanko JF, Taglienti AJ, Wilson AJ, et al. Motivations for seeking minimally invasive cosmetic procedures in an academic outpatient setting. Aesthetic surgery journal. 2015 Nov 1;35(8):1014-20.

[15] Garcia B, Scheib S, Hallner B, et al. Cosmetic gynecology—a systematic review and call for standardized outcome measures. International urogynecology journal. 2020 Oct;31:1979-95.

[16] Gandhi J, Chen A, Dagur G, et al. Genitourinary syndrome of menopause: an overview of clinical manifestations, pathophysiology, etiology, evaluation, and management. American journal of obstetrics and gynecology. 2016 Dec 1;215(6):704-11.

[17] Goodman MP. Female genital cosmetic and plastic surgery: a review. The journal of sexual medicine. 2011 Jun 1;8(6):1813-25.

[18] Abedi P, Jamali S, Tadayon M, et al. Effectiveness of selective vaginal tightening on sexual function among reproductive aged women in Iran with vaginal laxity: A quasi-experimental study. Journal of Obstetrics and Gynaecology Research. 2014 Feb;40(2):526-31.

[19] Desai SA, Dixit VV. Audit of female genital aesthetic surgery: Changing trends in India. The journal of Obstetrics and Gynaecology of India. 2018 Jun;68(3):214-20.

[20] Goodman MP. Female genital cosmetic and plastic surgery: a review. The journal of sexual medicine. 2011 Jun 1;8(6):1813-25.

[21] Wolfenbuttel KP, Menon VS, Grimsby GM, et al. Clitoral hoodplasty in females with disorders of sex development. Eserdağ S, Kurban D, Kisli M, Alan Y, Alan M. A New Practical Surgical Technique for Hymenoplasty: Primary Repair of Hymen With Vestibu-Introital Tightening Technique. Aesthetic surgery journal. 2021 Mar;41(3):333-7. 2017 Feb 1;13(1):61-e1.

[22] Redueli A, Romano D, Marciano A. Face and neck revitalization with platelet-rich plasma (PRP): clinical outcome in a series of 23 consecutively treated patients. Journal of drugs in dermatology: JDD. 2010 May 1;9(5):466-72.

[23] Banihashemi M, Nakhazehadeh S (2014) An introduction to application of PRP in skin rejuvenation. Rev Clin Med 1: 38-43.

[24] Mishra PC, Bandi J, Khurana N, et al. Platelet Rich Plasma (PRP) therapy: a perspective into gynaecological disorders. International Journal of Current Medical and Pharmaceutical research. 2021 Feb; 7(2):5579-5585.

[25] Shin MK, Lee JH, Lee SJ, et al. Platelet-rich plasma combined with fractional laser therapy for skin rejuvenation. Dermatologic surgery. 2012 Apr;38(4):623-30.

[26] Sclafani AP, McCormick SA. Induction of dermal collagenesis, angiogenesis, and adipogenesis in human skin by injection of platelet-rich fibrin matrix. Archives of facial plastic surgery. 2012 Mar 1;14(2):132-6.

[27] Ziegler CG, Van Sloun R, Gonzalez S, et al. Characterization of growth factors, cytokines, and chemokines in bone marrow concentrate and platelet-rich plasma: a prospective analysis. The American journal of sports medicine. 2019 Jul;47(9):2174-87.

[28] Yu M, Wang X, Liu Y, et al. Cytokine release kinetics of concentrated growth factors in different scaffolds. Clinical oral investigations. 2019 Apr;23(4):1663-71.

[29] Neto JB. O-Shot: Platelet rich plasma in intimate female treatment. J Women’s Health Care. 2017;6:395.

[30] Long CY, Lin KL, Shen CR, et al. A pilot study: effectiveness of local injection of autologous platelet-rich plasma in treating women with stress urinary incontinence. Scientific Reports. 2021 Jan 15;11(1):1-8.

[31] Belinia-Willison F, Nguyen TT, Norbury AJ, et al. Promising impact of platelet rich plasma and carbon dioxide laser for stress urinary incontinence. European journal of obstetrics & gynecology and reproductive biology: X. 2020 Jan 1;5:100099.

[32] Bellini E, Grieco MP, Raposio E. The science behind autologous fat grafting. Ann Med Surg (Lond). 2017 Nov 10;24:65-73. doi: 10.1016/j.amsu.2017.11.001. PMID: 29188051

[33] Baer PC, Geiger H. Adipose-derived mesenchymal stromal/stem cells: tissue localization, characterization,
Therapy (ISCT). Cytotherapy. 2013 Jun 1;15(6):641-9.

Smith P, Adams Jr WP, Lipschitz AH, et al. Autologous human fat grafting: effect of harvesting and preparation techniques on adipocyte graft survival. Plastic and reconstructive surgery. 2006 May 1;117(6):1836-44.

Barzelay A, Levy R, Kohn E, Sella M, Shani N, Melik B, Entin-Meer M, Gur E, Loewenstein A, Barak A. Power-assisted liposuction versus tissue resection for the isolation of adipose tissue–derived mesenchymal stem cells: phenotype, senescence, and multipotency at advanced passages. Aesthetic surgery journal. 2015 Sep 1;35(7):NP230-40.

Keck M, Kobor J, Riedl O, et al. Power assisted liposuction to obtain adipose-derived stem cells: impact on viability and differentiation to adipocytes in comparison to manual aspiration. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2014 Jan 1;67(1):e1-8.

Yuan Y, Zhang S, Gao J, et al. Spatial structural integrity is important for adipose regeneration after transplantation. Archives of dermato logical research. 2015 Oct;307(8):693-704.

Sorice SC, Li AY, Canales FL, et al. Why women request labiaplasty. Plastic and reconstructive surgery. 2017 Apr 1;139(4):856-63.

Iglesia CB, Yurteri-Kaplan L, Alinsod R. Female genital cosmetic surgery: a review of techniques and outcomes. International uro gynecology journal. 2013 Dec;24(12):1997-2009.

Aguilar P, Hersant B, SidAhmed-Mezi M, et al. Novel technique of vulvo-vaginal rejuvenation by lipofilling and injection of combined platelet-rich-plasma and hyaluronic acid: a case-report. Springerplus. 2016 Dec;5(1):1-5.

Freedman M. Vaginal pH, estrogen and genital atrophy. Menopause Management. 2008;17(4):9-13.

Freedman M. Vaginal pH, estrogen and genital atrophy. Menopause Management. 2008;17(4):9-13.

Smith YR, Haefner HK. Vulvar lichen sclerosis, American Journal of Clinical Dermatology. 2004 Apr;5(2):105-25.

Val I, Almeida G. An overview of lichen sclerosis, Clinical obstetrics and gynecology. 2005 Dec 1;48(4):808-17.

Singh N, Ghatage P. Etiology, Clinical features, and diagnosis of vulvar lichen sclerosis: A scoping review. Obstetrics and gynecology international. 2020 Apr 21;2020.

Kim SH, Park ES, Kim TH. Rejuvenation using platelet-rich plasma and lipofilling for vaginal atrophy and lichen sclerosis. Journal of menopausal medicine. 2017 Dec;23(1):63.

Angelou K, Grigoriadis T, Diakosavvas M, et al. The genitourinary syndrome of menopause: an overview of the recent data. Cureus. 2020 Apr;12(4).

Pieralli A, Bianchi C, Longinotti M, et al. Long-term reliability of fractioned CO 2 laser as a treatment for

and heterogeneity. Stem cells international. 2012 Jan 1;2012.

[34] Coleman SR. Structural fat grafts: the ideal filler? Clinics in plastic surgery. 2001 Jan 1;28(1):111-9.

[35] Coleman SR, Kvetel EB. Fat grafting for facial filling and regeneration. Clinics in plastic surgery. 2015 Jul 1;42(3):289-300.

[36] Ergün SS, Baysal EG, Kayan RB, et al. Correction of brassyire strip grooves with fat injections. Aesthetic surgery journal. 2015 Jul 1;35(5):561-4.

[37] Coleman SR, Saboeiro AP. Primary breast augmentation with fat grafting. Clinics in plastic surgery. 2015 Jul 1;42(3):301-6.

[38] Gutowski KA, Force AF. Current applications and safety of autologous fat grafts: a report of the ASPS fat graft task force. Plastic and reconstructive surgery. 2009 Jul 1;124(1):272-80.

[39] Coleman SR, Saboeiro AP. Fat grafting to the breast revisited: safety and efficacy. Plastic and reconstructive surgery. 2007 Mar 1;119(3):775-85.

[40] Harrison D, Selvaggi G. Gluteal augmentation surgery: indications and surgical management. Journal of plastic, reconstructive & aesthetic surgery. 2007 Aug 1;60(8):922-8.

[41] Guyuron B, Majzoub RK. Facial augmentation with core fat graft: a preliminary report. Plastic and reconstructive surgery. 2007 Jul 1;120(1):295-302.

[42] Butterwick KJ. Lipoinjection for aging hands: a comparison of the longevity and aesthetic results of centrifuged versus noncentrifuged fat. Dermatologic surgery. 2002 Nov;28(11):987-91.

[43] Jianhui Z, Chenggang Y, Binglun L, et al. Autologous fat graft and bone marrow–derived mesenchymal stem cells assisted fat graft for treatment of Parry-Romberg syndrome. Annals of plastic surgery. 2014 Sep 1;73:599-103.

[44] Yang H, Lee H. Successful use of squeezed-fat grafts to correct a breast affected by Poland syndrome. Aesthetic plastic surgery. 2011 Jun 1;35(3):418-25.

[45] Tuncel U, Kurt A, Gumus M, et al. Preliminary results with non-centrifuged autologous fat graft and percutaneous aponeurotomy for treating Dupuytren’s disease. Hand surgery and rehabilitation. 2017 Oct 1;36(5):350-4.

[46] Bank J, Fuller SM, Henry GL, et al. Fat grafting to the hand in patients with Raynaud phenomenon: a novel therapeutic modality. Plastic and reconstructive surgery. 2014 May 1;133(5):1109-18.

[47] Al-Hayder S, Gramkow C, Trojahn Kotte SF. Use of autologous fat grafting for the correction of burn scar contracture in the hand: a case report. Case Reports in Plastic Surgery and Hand Surgery. 2017 Jan 1;4(1):81-3.

[48] Klinger M, Lisa A, Klinger F, et al. Regenerative approach to scars, ulcers and related problems with fat grafting. Clinics in Plastic Surgery. 2015 Apr 30;42(3):345-52.

[49] Bourin P, Bun nell BA, Casteilla L, et al. Stromal cells from the adipose tissue-derived stromal vascular fraction and culture expanded adipose tissue-derived stromal/stem cells: a joint statement of the International Federation for Adipose Therapeutics and Science (IFATS) and the International Society for Cellular Therapy (ISCT). Cytotherapy. 2013 Jun 1;15(6):641-8.

[50] Tocco I, Widergow AD, Lalezari S, et al. Lipotransfer: the potential from bench to bedside. Annals of plastic surgery. 2014 May 1;72(5):599-609.

[51] Tsekouras A, Mantas D, Tsilimigras DL, et al. Comparison of the viability and yield of adipose-derived stem cells (ASCs) from different donor areas. in vivo. 2017 Nov 1;31(6):1229-34.
vulvovaginal atrophy (VVA) symptoms. Archives of gynecology and obstetrics. 2017 Nov;296(5):973-8.

[67] Mastroianni J, Thompson JA, Shiffren JL, et al. Improving the identification of genitourinary syndrome of menopause through the utilization of the Day-to-Day Impact of Vaginal Aging questionnaire. Menopause. 2020 Nov 1;27(11):1295-301.

[68] Bujnak A, Crowder CA, Krychman ML. Energy-Based Devices for Functional Vaginal Problems: Issues and Answers. Current Sexual Health Reports. 2021 Feb 26:1-3.

[69] Digesu GA, Tailor V, Preti M, et al. The energy based devices for vaginal “rejuvenation,” urinary incontinence, vaginal cosmetic procedures, and other vulvo-vaginal disorders: An international multidisciplinary expert panel opinion. Neurourology and urodynamics. 2019 Mar;38(3):1005-8.

[70] Tadir Y, Gaspar A, Lev-Sagie A, et al. Light and energy based therapeutics for genitourinary syndrome of menopause: consensus and controversies. Lasers in surgery and medicine. 2017 Feb;49(2):137-59.

[71] Aaluvalia J, Avram MM, Ortiz AE. Lasers and energy-based devices marketed for vaginal rejuvenation: A sectional-analysis of the MAUDE database. Lasers in surgery and medicine. 2019 Oct;51(8):671-7.

[72] Alshiek J, Garcia B, Minassian V, et al. Vaginal energy-based devices. Female pelvic medicine & reconstructive surgery. 2020 May 1;26(5):287-98.

[73] Fisher JC. Photons, physiatrics, and physicians: A practical guide to understanding laser light interaction with living tissue, part 1. J Clin Laser Med Surg 1992;10(6):419–426

[74] Wenstrup RJ, Florer JB, Brunskill EW, et al. Type V collagen controls the initiation of collagen fibril assembly. J Biol Chem 2004;279(51):53331–53337.

[75] Menopause society. Management of symptomatic vulvovaginal atrophy: 2013 position statement of The North American Menopause Society. Menopause 2013;20(9):888–902904.

[76] Cotreau MM, Chennathukuzhi VM, Harris HA, et al. A study of 17beta-estradiol-regulated genes in the vagina of oestrogenous women with vaginal atrophy. Maturitas 2007;58(4):366–376.

[77] Fistoníc N, Fistoníc I, Guštěk ŠF, et al. Minimally invasive, non-ablative Er:YAG laser treatment of stress urinary incontinence in women—a pilot study. Lasers Med Sci. 2016 May;31(4):635-43. doi: 10.1007/s10103-016-1884-0. Epub 2016 Feb 9. PMID: 26861984; PMCID: PMC4851697.

[78] Capon A, Mordon S. Can thermal lasers promote skin wound healing? Am J Clin Dermatol. 2003;4(1):1-12. doi: 10.2165/00128071-200304010-00001. PMID: 12477368.

[79] Salvatore S, Leone Roberti Maggiore U, Athanasiou S, et al. Histological study on the effects of microablative fractional CO2 laser on atrophic vaginal tissue: an ex vivo study. Menopause. 2015 Aug;22(8):845-9. doi: 10.1097/GME.0000000000000401. PMID: 25608269.

[80] Gaspar A, Addamo G, Brandi H. Vaginal Fractional CO2 Laser: A Minimally Invasive Option for Vaginal Rejuvenation. The American Journal of Cosmetic Surgery. 2011;28(3):156-162. doi:10.1177/074880681102800309

[81] Zerbinati N, Serati M, Origoni M, et al. A Microscopic and ultrastructural modifications of postmenopausal atrophic vaginal mucosa after fractional carbon dioxide laser treatment. Lasers Med Sci. 2015 Jan;30(1):429-36. doi: 10.1007/s10103-014-1677-2. Epub 2014 Nov 20. PMID: 25410301.

[82] Ruanphee P, Bunyavejchuvit S. Treatment for vaginal atrophy using microablative fractional CO2 laser: a randomized double-blinded sham-controlled trial. Menopause. 2020 Aug 1;27(8):838-63.

[83] Wallace SL, St Martin B, Lee K, et al. A cost-effectiveness analysis of vaginal carbon dioxide laser therapy compared with standard medical therapies for genitourinary syndrome of menopause-associated dyspareunia. American Journal of Obstetrics and Gynecology. 2020 Dec 1;223(6):890-e1.

[84] Alexiades-Armenakas MR, Dover JS, Arndt KA. Fractional laser skin resurfacing. J Drugs Dermatol. 2012 Nov;11(11):1274-87. PMID: 23135075.

[85] Gambacciani M, Palacios S. Laser therapy for the restoration of vaginal function. Maturitas. Elsevier Ireland Ltd. 2017;99:10–5

[86] Vizintin Z, Rivera M, Fistonic I, Saraçoğlu F, et al. Novel minimally invasive VSP Er:YAG laser treatments in gynecology. J Laser Health Acad. 2012;2012:46–58

[87] Lapit GA, Yakovleva AY, Neimark AL, et al. Study of Proliferative Activity of Vaginal Epithelium in Women with Stress Urinary Incontinence Treated by Er:YAG Laser. Bull Exp Biol Med. 2017 Jun;163(2):280-283. doi: 10.1007/s10517-017-3784-0. Epub 2017 Jul 18. PMID: 28726192.

[88] Gaviria JE, Lanz JA. Laser Vaginal Tightening (LVT) – evaluation of a novel noninvasive laser treatment for vaginal relaxation syndrome. J Laser Health Acad Artic J LAHA. 2012;2012:59–66

[89] Arêas F, Valadares ALR, Conde DM, et al. The effect of vaginal erbium laser treatment on sexual function and vaginal health in women with a history of breast cancer and symptoms of the genitourinary syndrome of menopause: a prospective study. Menopause. 2019 Sep;26(9):1052-1058. doi: 10.1097/GME.0000000000001533. PMID: 31453969.

[90] Reisenaeger C, Hartlieb S, Schoenfisch B, et al. Vaginal therapy of mild and moderate stress urinary incontinence using Er: YAG laser: a real treatment option. Archives of gynecology and obstetrics. 2019 Dec;300(6):1645-50.

[91] Karcher C, Sadick N. Vaginal rejuvenation using energy-based devices. Int J Womens Dermatol. 2016 Jun 21;2(3):85-88. doi: 10.1016/j.jiwd.2016.05.003. PMID: 28492016; PMCID: PMC5418869.

[92] Güneş A, Alinsod RM. A mini-review of aesthetic gynecology and leading gynecology associations’ approaches to this issue. Turk J Obstet Gynecol. 2018 Jun;15(2):105-111. doi: 10.4274/tjogtraits.33407. Epub 2018 Jun 21. PMID: 29971188; PMCID: PMC6022427.

[93] Clark Z. Labial tissue rejuvenation and sexual function improvement using a novel noninvasive focused monopolar radio frequency device. J Cosmet Laser Ther. Taylor & Francis. 2018;20:66–70. https://doi.org/10.1080/14764172.2017.1368565

[94] Dunbar SW, Goldberg DJ. Radiofrequency in Cosmetic Dermatology: An Update. J Drugs Dermatol. 2015 Nov;14(11):1229-38. PMID: 26580871.
[95] Alexiades-Armenakas M, Dover JS, Arndt KA. Unipolar versus bipolar radiofrequency treatment of rhytides and laxity using a mobile painless delivery method. Lasers Surg Med. 2008 Sep;40(7):446-53. doi: 10.1002/lsm.20667. PMID: 18727024.

[96] Leibaschoff G, Izaza PG, Cardona JL, et al. Transcutaneous Temperature Controlled Radiofrequency (TTCRF) for the Treatment of Menopausal Vaginal/Genitourinary Symptoms. Surg Technol Int. 2016 Oct;26:149-159. PMID: 27608749.

[97] Caruth JC. Evaluation of the safety and efficacy of a novel radiofrequency device for vaginal treatment. Surg Technol Int. 2018 Jun 1;32:145-9.

[98] Vicariotto F, De Seta F, Faoro V, Raichi M, et al. Dynamic quadripolar radiofrequency treatment of vaginal laxity menopausal vulvo-vaginal atrophy. Minerva ginecologica. 2017 Aug;69(4):342-9.

[99] Sarmento AC, Fernandes FS, Marconi C, et al. Impact of microablative fractional radiofrequency on the vaginal health, microbiota, and cellularity of postmenopausal women. Clinics (Sao Paulo). 2020;75:e1750. doi: 10.6061/clinics/2020/e1750. Epub 2020 Aug 3. PMID: 32756817; PMCID: PMC7384205.

[100] White WM, Makin IR, Barthe PG, et al. Selective creation of thermal injury zones in the superficial musculoaponeurotic system using intense ultrasound therapy: a new target for noninvasive facial rejuvenation. Archives of facial plastic surgery. 2007 Jan 1;9(1):22-9.

[101] Alam M, White LE, Martin N, et al. Ultrasound tightening of facial and neck skin: a rater-blinded prospective cohort study. Journal of the American Academy of Dermatology. 2010 Feb 1;62(2):262-9.

[102] Suh DH, Shin MK, Lee SJ, et al. Intense focused ultrasound tightening in Asian skin: clinical and pathologic results. Dermatologic surgery. 2011 Nov;37(11):1595-602.

[103] Chan NP, Shek SY, Yu CS, et al. Safety study of transcutaneous focused ultrasound for non-invasive skin tightening in Asians. Lasers in surgery and medicine. 2011 Jul;43(5):366-75.

[104] Sekiguchi, Y, Nakamura, R, Ninomiya, N et al. Safety and efficacy of High Intensity Focused Ultrasound treatment for vaginal ultra vera-preliminary results. Women’s Clinic LUNA JAPAN, Japan; Women’s Clinic LUNA JAPAN Osaka, Japan. Proceedings of the ISSWSH 2017 Annual Meeting

[105] Suh DH, Choi JH, Lee SJ, et al. Comparative histometric analysis of the effects of high-intensity focused ultrasound and radiofrequency on skin. J Cosmet Laser Ther. 2015;17(5):230-6. doi: 10.3109/14764172.2015.1022189. PMID: 25723905.

[106] Alexiades-Armenakas MR, Dover JS, Arndt KA. The spectrum of laser skin resurfacing: nonablative, fractional, and ablative laser resurfacing. Journal of the American Academy of Dermatology. 2008 May 1;58(5):719-37.

[107] Dover JS. Fractional laser skin resurfacing. J Drugs Dermatol. 2012;11(11):1274-87.

[108] Lee MS. Treatment of vaginal relaxation syndrome with an erbium: YAG laser using 90 and 360 scanning scopes: a pilot study & short-term results. Laser therapy. 2014;23(2):129-38.

[109] Alexiades M, Berube D. Randomized, blinded, 3-arm clinical trial assessing optimal temperature and duration for treatment with minimally invasive fractional radiofrequency. Dermatologic Surgery. 2015 May 1;41(5):623-32.

[110] Shobeiri SA, Kerkhof MH, Minassian VA, Bazi T. IUGA committee opinion: laser-based vaginal devices for treatment of stress urinary incontinence, genitourinary syndrome of menopause, and vaginal laxity. International urogynecology journal. 2019 Mar;30(3):371-6.

[111] Di Donato V, D’Oria O, Scudo M, Prata G, et al. Safety evaluation of fractional CO2 laser treatment in post-menopausal women with vaginal atrophy: A prospective observational study. Maturitas. 2020 May 1;135:34-9.

[112] Gaspar A, Brandi H, Gomez V, et al. Efficacy of Erbium: YAG laser treatment compared to topical estriol treatment for symptoms of genitourinary syndrome of menopause. Lasers in surgery and medicine. 2017 Feb;49(2):160-8.

[113] Gordon C, Gonzales S, Krychman ML. Rethinking the techno vagina: a case series of patient complications following vaginal laser treatment for atrophy. Menopause. 2019 Apr;26(4):423-427. doi: 10.1097/GME.0000000000001293. PMID: 30640806.

[114] Alshiek J, Garcia B, Minassian V, et al. Vaginal energy-based devices. Female pelvic medicine & reconstructive surgery. 2020 May 1;26(5):287-98.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/.

© The Author(s) 2021