

# Exosomes in Aesthetic Practice: Current Applications and Future Directions

Dr. Gunjan Jagdish Deshmukh

**Abstract:** By transmitting bioactive substances like proteins, lipids, and nucleic acids, exosomes nanoscale extracellular vesicles that range in size from 30 to 150 nm play an important part in intercellular communication. Their potential for skin repair, anti-aging, and hair regeneration has garnered significant attention in cosmetology and regenerative medicine in recent years. Exosomes produced from a variety of sources, especially mesenchymal stem cells, have the capacity to control inflammation, encourage the production of collagen, and improve tissue regeneration. The biogenesis, mode of action, and therapeutic uses of exosomes in aesthetic practice are examined in this research. Their use in conjunction with procedures including microneedling, lasers, and chemical peels is reviewed, as well as their involvement in skin rejuvenation, pigmentation disorders, scar management, and hair restoration. Limitations include lack of uniformity, high cost, and inadequate long-term clinical evidence persist despite encouraging results. Large-scale research and future developments could solidify their place in aesthetic medicine.

**Keywords:** Exosomes; Extracellular vesicles; Skin regeneration; Aesthetic medicine; Anti-aging therapy; Cell-to-cell communication; Collagen synthesis; Skin rejuvenation; Hair restoration; Regenerative cosmetology; Photoaging; Mesenchymal stem cells

## 1. Introduction

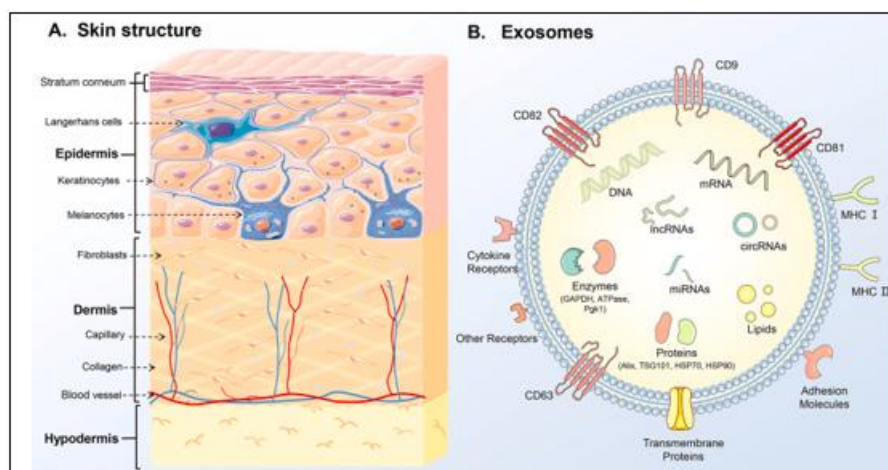
Exosomes are nanosized vesicles released by cells that play a crucial role in communication between both adjacent and distant cells and in maintaining tissue health. [3] In recent years, they have gained significant attention in the field of cosmetology and regenerative medicine because of their ability to support skin repair and regeneration. [2]

The skin works as a protective barrier for the body against external factors such as UV radiation, injuries, and environmental stress. [2] Ongoing exposure to these elements, particularly UV radiation, results in a phenomenon called photoaging, marked by wrinkles, hyperpigmentation, and decreased skin elasticity. [1] In addition, conditions such

as inflammation and systemic diseases can further delay the natural healing process of the skin. [2]

Exosomes contain various bioactive components, including proteins, lipids, and nucleic acids, which help in cellular communication and the regulation of biological processes. [3] They are known to decrease oxidative stress and inflammation while enhancing collagen and elastin production, crucial for preserving healthy and youthful /skin. [1]

Because of these characteristics, exosomes are being more widely investigated as an encouraging method in cosmetology for skin regeneration and the management of different skin conditions.



**Figure 1:** Structure of human skin and schematic representation of exosome composition and surface markers.

**Source:** Adapted from Xiong et al., 2021 [3]

## 2. Aim of the Study

With an emphasis on their biological roles, mechanisms of action, and clinical applications in skin rejuvenation, anti-aging, and hair restoration, this study aims to investigate the role of exosomes in aesthetic and regenerative medicine.

## 3. Objectives

- 1) To comprehend exosome production, composition, and function in intercellular communication.
- 2) To examine the ways in which exosomes support skin regeneration, including how they affect tissue healing, inflammation, and collagen formation.

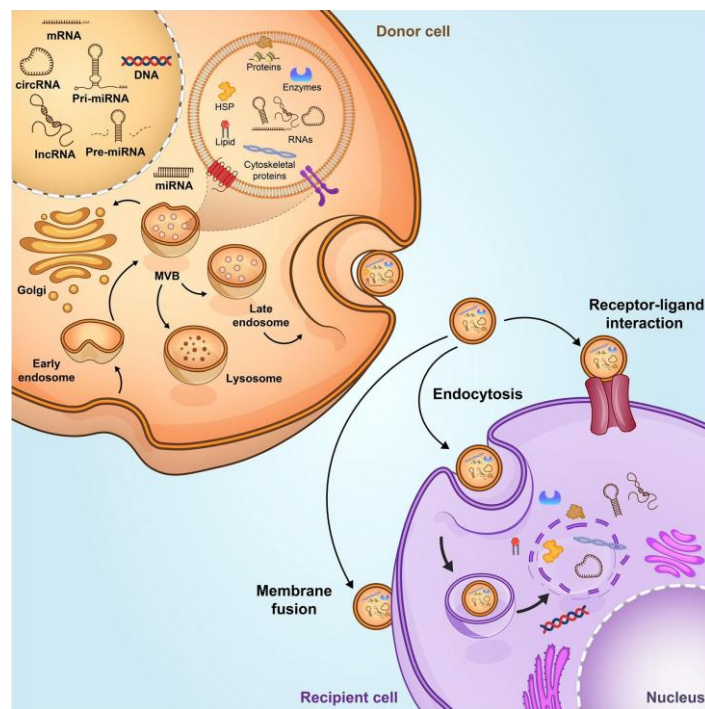
- 3) To assess the current clinical uses of exosomes in cosmetic procedures, including hair restoration, scar repair, pigmentation control, and skin rejuvenation.
- 4) To assess the use of exosomes in combination with aesthetic procedures like microneedling, laser therapy, and chemical peels.
- 5) To determine the risks, restrictions, and difficulties related to exosome-based treatments.
- 6) To investigate potential future paths and developments in the application of exosomes in regenerative medicine and cosmetology.

### Biogenesis

The majority of cell types release extracellular vesicles, which are tiny, membrane-bound particles seen in a variety of biological fluids like blood, urine, and saliva. By carrying a wide variety of bioactive chemicals, such as proteins, lipids, and nucleic acids, they play a crucial part in intercellular communication. Extracellular vesicles can be generically categorized into apoptotic bodies, microvesicles, and exosomes based on their size and origin. [4]

The endosomal pathway gives rise to a particular subtype of extracellular vesicles called exosomes. Early endosomes are formed as a result of the plasma membrane's inward budding. These early endosomes grow into late endosomes, which in turn become multivesicular bodies (MVBs). Multiple intraluminal vesicles (ILVs) are present in the structure of MVBs. These intraluminal vesicles originate inside the MVBs during the biogenesis process and act as exosome precursors. Exosomes are the term used to describe the intraluminal vesicles that are released into the extracellular environment when multivesicular bodies merge with the plasma membrane. [4,5]

A range of bioactive cargo, such as proteins, lipids, messenger RNA (mRNA), and microRNA (miRNA), are carried by exosomes and represent the traits of their parent cells. Exosomes can interact with recipient cells after being released by internalizing or fusing with the cell membrane. This makes it possible for molecular signals to be transferred, which can affect cellular behaviour, control gene expression, and support processes like tissue repair, inflammation, and regeneration. [5, 6]



**Figure 2:** Exosome biogenesis via the endosomal pathway and their uptake by recipient cells.

Source: Adapted from Hajjaliasgary Najafabadi et al., 2024 [1]

## 4. Mechanism of Action of Exosomes in Skin Regeneration

By moving bioactive chemicals from donor cells to destination cells, exosomes mainly use intercellular communication to carry out their biological effects. Proteins, lipids, and nucleic acids including messenger RNA (mRNA) and microRNA (miRNA) found in these nanoscale vesicles have the ability to alter target cells' gene expression and biological processes. Exosomes are essential for preserving skin homeostasis and encouraging tissue regeneration through these processes. [2, 3].

Exosome's capacity to control cellular communication through paracrine signalling is one of their primary functions. Exosomes interact with recipient cells through endocytosis or direct fusion with the cell membrane after being released. This makes it possible for their molecular cargo to be transferred, impacting cellular processes related to differentiation, proliferation, and repair. [2, 3].

Additionally, exosomes have strong anti-inflammatory qualities. They are known to promote anti-inflammatory signalling pathways while inhibiting the synthesis of pro-inflammatory cytokines. This aids in lowering persistent inflammation, which is a significant cause of skin aging and slowed wound healing. [1, 2].

The promotion of collagen and elastin formation is another crucial role of exosomes. Exosomes increase the formation of extracellular matrix components by stimulating dermal fibroblasts, which improves the elasticity, hardness, and structural integrity of the skin. [1, 3].

Additionally, by encouraging the development of new blood vessels, exosomes support angiogenesis. This supports tissue regeneration and repair by improving the skin's availability of oxygen and nutrients. [2].

By promoting cell migration, proliferation, and tissue remodelling, exosomes also hasten the healing of wounds. They show great promise in dermatological and cosmetic applications due to their capacity to control several regeneration pathways. [2,3].

## 5. Clinical Applications of Exosomes in Aesthetic Practice

Because of their function in intercellular communication and capacity to transport bioactive compounds that control cellular processes, exosomes have become viable therapeutic agents in aesthetic medicine. They are very important in dermatological and cosmetic applications because of their role in tissue repair, immunological regulation, and extracellular matrix remodelling. [2,3,5,6].

### 1) Skin Rejuvenation

By encouraging fibroblast proliferation and boosting the production of collagen and elastin, exosomes significantly contribute to skin renewal. The elasticity, texture, and general look of the skin are all enhanced by these benefits. Exosomes also aid in lowering inflammation and oxidative stress, two major causes of skin aging. [1,3,5].

Among the clinical results are:

- A decrease in wrinkles and fine lines
- Enhanced hydration and suppleness of the skin
- A more radiant complexion

### 2) Pigmentation and Scar Management

By regulating inflammatory pathways and encouraging tissue rebuilding, exosomes aid in the treatment of pigmentation disorders and scarring. They are helpful for acne scars and post-inflammatory hyperpigmentation because they can affect melanocyte activity and aid in the healing of injured skin. [2, 3, 6]. Their capacity to control collagen deposition aids in enhancing the general quality of the skin and the texture of scars.

### 3) Hair Restoration

Exosomes are being investigated for their potential to activate dermal papilla cells and control the cycling of hair follicles in hair regeneration. Their payload, which includes microRNAs and growth factors, helps to promote hair development and lessen disorders like androgenetic alopecia that cause hair loss. [3,5].

Benefits that have been noted include:

- A higher density of hair
- A thicker hairstyle
- An increase in follicular activity

### 4) Adjunctive Use with Aesthetic Procedures

The usage of exosomes in conjunction with cosmetic procedures like chemical peels, laser therapy, and microneedling is growing. By increasing skin permeability, these techniques improve exosome penetration into deeper layers of the skin. [2,4].

After the surgery, exosomes:

- Quicken the healing of wounds
- Decrease discomfort and inflammation
- Promote the remodelling of collagen
- Enhance treatment results overall [5,6]

## 6. Safety Consideration

Because of their acellular origin and incapacity to multiply, exosomes are increasingly seen as a safer substitute for cell-based therapies in regenerative and cosmetic medicine. Exosomes are more appropriate for cosmetic applications where safety is a top priority because they do not pose the risk of unchecked cellular proliferation or tumor formation, unlike stem cell therapies. Furthermore, especially when produced from mesenchymal stem cells (MSCs), their lipid bilayer shape and small size enable effective cellular uptake with comparatively minimal immunogenicity [2,5].

However, the source, separation, and purification techniques of exosome-based treatments have a significant impact on their safety. The content and biological impact of exosomes generated from various cell types can differ greatly. Exosomes derived from infected or inadequately grown cells, for example, may contain undesirable or potentially dangerous molecular signals. Therefore, to guarantee safety and reproducibility, stringent quality control and consistent production procedures are crucial [4,5].

The absence of long-term clinical evidence is another crucial factor. There is little information on the long-term safety profile of exosome-based treatments, especially in aesthetic therapy, even if short-term trials and early clinical applications have demonstrated encouraging results with few side effects. Further research through well planned clinical trials is necessary to address potential issues such unwanted immunological reactions, off-target effects, or changed cellular signalling pathways [1,6].

## 7. Limitations

The extensive clinical use of exosomes in aesthetic medicine is presently constrained by a number of issues, despite their encouraging therapeutic promise.

The absence of standardization in isolation and characterisation methods is one of the main obstacles. Exosomes can be isolated using a variety of procedures, including ultracentrifugation, filtering, and precipitation; however, the efficiency, purity, and yield of these processes vary. Because of this, there is a great deal of variation in exosome preparations, which has an immediate effect on their clinical effectiveness and repeatability of outcomes [4,5].

The high expense and technical difficulty of producing exosomes is another drawback. Strict quality control procedures and sophisticated laboratory equipment are needed for the cell culture, isolation, purification, and storage processes. As a result, therapy becomes more expensive overall and less accessible in regular aesthetic practice [2].

Moreover, there is currently a dearth of proof. Exosome research is mostly preclinical, *in vitro*, or based on small-scale clinical trials. Large randomized controlled trials that can determine uniform treatment procedures, ideal dosage, and long-term results are scarce. Because of this, exosome therapies cannot be fully incorporated into evidence-based clinical practice [1, 3].

Furthermore, there are regulatory obstacles. Exosome-based products are either classified as biologics or are not yet fully licensed in many countries, necessitating thorough validation prior to clinical usage. This raises questions about their clinical use and legal standing.

## 8. Future Directions

With continuous research aimed at enhancing their therapeutic efficacy, safety, and clinical applicability, exosomes hold great potential for the future of aesthetic and regenerative medicine.

The application of combination medicines is one of the most crucial areas of development. The usage of exosomes in conjunction with treatments like chemical peels, laser therapy, and microneedling is growing. By improving skin permeability and forming microchannels, these techniques improve exosome penetration and activity. It is anticipated that this collaborative strategy will shorten healing times and enhance clinical results [2, 3].

The creation of targeted or customized exosome treatment is another new avenue. Exosomes may be produced from autologous sources or modified to transport certain therapeutic compounds thanks to developments in biotechnology. This can reduce the possibility of immunological reactions while enabling tailored treatment for each patient's needs [5,6].

The alteration of exosomal cargo loading exosomes with certain proteins, growth factors, or genetic material to increase their capacity for regeneration is another area of increasing interest. This strategy could greatly increase their use in the realms of medicine and aesthetics.

Lastly, the development of standardized procedures and extensive clinical studies will be critical to the future of exosome therapy. To ascertain the ideal dosage, frequency of treatment, long-term safety, and relative efficacy with current medicines, well-designed trials are required. In order to guarantee safe and extensive clinical use, regulatory approvals and recommendations will also be essential [1,4].

## 9. Conclusion

Exosome's capacity to improve cellular communication, lower inflammation, and encourage tissue regeneration makes

them a potential development in cosmetic and regenerative medicine. Their flexibility is demonstrated by their uses in hair restoration, pigmentation problems, scar treatment, and skin rejuvenation. Exosomes are anticipated to become a dependable therapeutic option in aesthetic medicine with further study and technology developments, despite obstacles including expense, lack of standardization, and insufficient clinical data.

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## Author Profile

**Dr. Gunjan Jagdish Deshmukh** is a qualified medical professional and faculty at I2CAN Institute, Pune, with a strong academic and clinical background. She holds a Bachelor's degree in Homeopathic Medicine and Surgery (BHMS) from Takhatmal Shrivallabh Homeopathic Medical College (2024) and has further advanced her expertise with a Post Graduate Diploma in Clinical Cosmetology (PGDCC) and certification in Semi-Permanent Makeup (PMU) under the Master in Medical Beauty and Aesthetics (MMBB) program from I2CAN Institute. With two years of clinical experience in homeopathic practice, Dr. Deshmukh has developed a solid foundation in holistic and patient-centred care. She is actively involved in academics and has been working as a faculty member at I2CAN Institute, Pune, for the past one year, where she trains doctors and beauty professionals in cosmetology, trichology, and semi-permanent makeup procedures. Her clinical approach integrates principles of homeopathy with modern aesthetic practices, reflecting her interest in skin regeneration, anti-aging therapies, and evidence-based cosmetology.