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Review

The role of a polycaprolactone stimulator in the facial rejuvenation process

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Abstract . *Background:* Aging is a process that mainly affects human fibroblasts since they have a limited ability to divide. In general, cells lose their proliferative capacity and enter a slowdown period, also known as cellular senescence. This review focuses on non-surgical techniques for both functional and cosmetic facial rejuvenation, with particular attention to polycaprolactone (PCL) fillers as an effective collagen stimulator. *Aim:* The aim of this study is to evaluate the efficacy of polycaprolactone stimulators in facial rejuvenation by assessing improvements in skin texture, volume restoration, and overall aesthetic outcomes. *Methods:* A systematic review was conducted between May 2022 and October 2023, involving a comprehensive analysis of twenty-five articles. *Results:* The studies presented below, each designed to address various aspects related to PCL dermal fillers, are extensively analyzed, encompassing enhancements in dermal properties, histopathological insights, patient satisfaction and safety, the assessment of potential complications, and combination therapies. *Conclusion:* PCL is a safe and effective material for skin rejuvenation, and it is a viable choice in the realm of aesthetic and functional enhancements, addressing the perennial quest for youthful and rejuvenated appearances with minimal risks and maximal patient satisfaction.

Key Words: polycaprolactone filler, anti-aging, dermal filler, skin aging

Background

Aging represents a progression of changes in functionality and reproductive capacity, ultimately resulting in increased morbidity. A pivotal discovery made by Hayflick and Moorhead regarding human fibroblasts revealed their finite capacity for division. This phenomenon leads to cellular senescence, characterized by a reduction of cells proliferation and the secretion of specific factors that promote inflammation and tissue deterioration[1]. The natural aging process alters tissue functions, leading to structural changes in bones, muscles, ligaments, and fat. These changes result in signs of aging such as wrinkles, elastosis, fat redistribution, and bone resorption[2].

Dissecting the aging process

Skin aging

The skin's functions are well known, and include its role as a protective barrier against internal and external stimuli, maintaining homeostasis and preventing TEWL. Being constantly exposed to different stimuli (UV radiation, free radicals, foods with a high glycemic index, constant gesticulation, genetic and hormonal factors, among others) progressively diminish the functions of the skin, resulting in wrinkles, xerosis, and elastosis[1].

From an anatomical perspective, substantial changes occur throughout the aging process, affecting both the structure and functionality (Table 1).

Polycaprolactone stimulators

Collagen stimulators, such as polylactic acid, polyglycolic acid, calcium hydroxyapatite, and polycaprolactone, are long-lasting and promote type 1 collagen production and the improvement of the skin's quality[2,4,5,6].

An injectable polycaprolactone (PCL) stimulator is a biodegradable polymer that is composed 30% of 25–50 μm microspheres of a totally bioresorbable polymer, polycaprolactone (PCL), and 70% by an aqueous carboxymethyl cellulose (CMC) gel carrier. While the CMC gel carrier is gradually resorbed by macrophages in 6–8 weeks, the PCL microspheres are protected from phagocytosis, ideally adapted to use in aesthetic treatments. Moreover, in human studies, the use of polycaprolactone filler has demonstrated remarkable outcomes. It has been found to stimulate the formation of new type 1 collagen, elastin, and blood vessels, a series of processes commonly referred to as neocollagenesis, neoelastinogenesis, and neovascularization. These findings highlight the potential of polycaprolactone filler to promote tissue regeneration and improve skin quality in clinical settings[4,7].

Cellular response to PCL

The implanted material in the cellular environment creates a mechanical tension that stretches fibroblasts, prompting them to produce collagen type 1. Various cellular interactions, including cell-matrix, cell-cell, and cell-ECM-material interactions, involve a complex network of sensors and effectors that utilize different signaling pathways. The cellular process is known to convert mechanical forces into intracellular signals, operating primarily through collagen and plays a central role in mechanobiology. It can be viewed as the primary contributor to the PCL filler's mechanism of action. Additionally, other cellular interactions, such as cross-talk between fibroblasts and keratinocytes or adipocytes, are under investigation and may explain various properties, such as skin quality or interactions in the hypodermis[8].

Immediate and sustained mechanism

The PCL filler demonstrates a unique dual-effect mechanism in its application, immediate and long-term. The immediate effect is primarily attributed to the CMC gel, characterized by its remarkable capacity to support the tissue and its highly hygroscopic properties. This immediate effect is transient, as the CMC gel is naturally resorbed by the body within 2-3 months[8].

Following the immediate effect, the production of type 1 collagen is stimulated by the PCL filler. This process involves the formation of a 3D scaffold composed of evenly distributed PCL microspheres embedded with collagen fibers. This scaffold interacts with the surrounding cellular environment and prevents cluster formation. The deposition of collagen leads to the extension of the sustained effect over time[8].

Table 1. Functional and structural changes[1,3].

Epidermis	Lessened capacity for barrier function and restoration
	CD44 glycoprotein levels decreased (a regulator of keratinocytes proliferation)
	Thickness decreases
	Deceased exchange of nutrients
Dermis	The dermal extracellular matrix suffers structural and functional changes
	Production of type I procollagen significantly declined and increased degradation due to photoaging
	Accumulation of type III collagen
	Elastic fibers change their conformation and organization
	Number of fibroblasts decreases
Soft tissue and muscles	Ligaments and SMAS lose supports causing volume redistribution
Bone	Enlargement of the frontal bone
	Bone resorption

Methods

A systematic review was conducted between May 2022 and October 2023, focusing on the field of aesthetic medicine and dermal fillers, with a particular emphasis on polycaprolactone (PCL) fillers. The search was carried out using comprehensive queries on two prominent databases: Web of Science and PubMed. Keywords were meticulously chosen based on MeSH descriptors to ensure a precise research. The selected search terms included "polycaprolactone filler," "anti-aging," "dermal filler," and "skin aging."

An initial pre-selection phase involved evaluating articles based on their titles and publication year (2012 onwards). The following criteria were applied during this phase:

- Articles published in indexed journals.
- Language limitations: with inclusion of articles in English and Spanish only.
- Relevance to polycaprolactone dermal fillers.

This process resulted in the preselection of twenty-seven original articles that met the outlined criteria, these were subsequently subjected to the inclusion and exclusion criteria presented below.

Inclusion and exclusion criteria

In this medical review, we established clear inclusion and exclusion criteria to guide the selection of relevant articles. The inclusion criteria encompassed several key aspects. Firstly, we considered research articles that contained original research findings, specifically focusing on the topic of interest. Additionally, we concentrated on articles published in indexed, peer-reviewed journals renowned for their established quality and editorial standards. Language-wise, articles composed in English and Spanish were accepted for review, primarily due to considerations of language accessibility and the proficiency of our reviewer. Furthermore, the inclusion criteria encompassed articles directly related to polycaprolactone dermal fillers within the context of facial aesthetic medicine, anti-aging, and skin aging.

Conversely, our exclusion criteria were designed to delineate the types of articles that did not meet the review's parameters. We excluded case reports and case series, as well as other non-research article types such as editorials, commentaries, and letters to the editor. This decision stemmed from the need for in-depth research, rather than individual cases or non-research opinions. Additionally, articles from non-indexed or non-peer-reviewed journals or sources were excluded to ensure that the selected content underwent rigorous review and maintained quality standards. Lastly, to maintain a focused approach on the topic of interest, articles that were not directly related to polycaprolactone dermal fillers or the specified contexts of facial aesthetic medicine, anti-aging, and skin aging were not considered.

Out of the 27 original articles subjected to the criteria, three articles were excluded. One was excluded by the study design, as it was a case report, while the remaining two were found to be unrelated to the subject of polycaprolactone dermal fillers in facial rejuvenation.

As the writing progressed, a secondary search was initiated within these databases to pinpoint precise data capable of augmenting the initial findings. This supplementary investigation was further enriched by incorporating an additional systematic review, culminating in the comprehensive review of 25 studies. These 25 studies were meticulously examined as part of this systematic review, with a particular emphasis on seventeen of them, due to their significant relevance to the subject matter under scrutiny. Concurrently, the remaining eight studies served as valuable supplementary sources in the development of the theoretical framework for this study.

The systematic review aimed to provide a comprehensive and rigorous analysis of the available literature regarding polycaprolactone fillers in the context of facial aesthetic medicine, specifically targeting their role in addressing anti-aging concerns and skin aging.

Results

The studies presented below, each designed to address various aspects related to PCL dermal fillers, are extensively analyzed ahead, encompassing enhancements in dermal properties, histopathological insights,

patient satisfaction and safety, the assessment of potential complications, and combination therapies (Table 2).

Improvements in the dermis

In a Korean clinical investigation led by Dr. Jong Seo Kim, a cohort study of 13 patients underwent a regimen involving the administration of 1000 microinjections of PCL filler, each measuring 0.0005 cc, directly into the dermal layer. The assessment of cutaneous thickening was conducted via an ultrasound examination, revealing a 26.74% increased dermal thickness. This observed change presented a statistical significance ($p < 0.0001$). These positive effects were sustained up to one-year post-treatment, demonstrating a substantial 21.31% augmentation relative to the initial evaluation.

The examination of surrounding tissue reactions unveiled localized inflammatory responses, along with the presence of fibroblasts, giant cells, newly formed capillaries, neocollagenesis, and the emergence of fresh elastic fibers surrounding the PCL particles. Notably, the longevity of PCL particles aligned with expectations, signaling their potential to endure beyond a four-year timeframe. Importantly, no reports of severe adverse events were documented throughout the course of this investigatio[13].

Histopathological Features

In a comprehensive examination of the histological features of various PCL fillers, multiple studies yielded significant insights.

A retrospective study employed microscopic light technology and digital camera microscopy to ascertain the size of PCL particles, revealing consistent particle sizes as expected[5]. Furthermore, a randomized double blinded study using rat models for evaluation displayed noteworthy results. The injection of PCL fillers led to increased dermal thickness and elasticity, akin to observations made with the Folliscope® (an automated microscopic camera). Notably, skin surface height remained relatively unchanged from the surrounding area after 6 hours, while skin elasticity increased following the filler injection[12-13].

Additionally, the analysis of two patients who received 1 cc of PCL filler in the temporal fossa and underwent surgical intervention thirteen months later, with biopsies, provided further insight. Biopsy specimens, taken from the removed tissue, revealed an even distribution of PCL and confirmed type I collagen production. H&E and MT staining showed prominent collagen deposition surrounding the PCL spheres. These findings collectively contribute to a deeper understanding of the histological features and performance of PCL fillers, with potential implications for medical professionals in the field[14].

Application Process

Original in vivo research proved that mixing a PCL dermal filler with lidocaine did not significantly alter its rheology. With 15 mixing strokes the lidocaine solution can effectively be mixed into the dermal filler resulting in a homogenous blend. The viscosity, elasticity, and the extrusion force decrease with increasing lidocaine volume, and it is sufficient to keep the PCL microspheres in suspension. There were no needle jams. The pH of the PCL dermal filler mixed with lidocaine solution is equivalent to that of the original dermal filler. Meanwhile, a retrospective study, suggested a technique to counteract adverse effects by injecting a tumescent solution before the PCL dermal filler. In a study of 30 patients, the left side of the face, where a tumescent solution was used, had significantly reduced adverse effects compared to the right side, where only 0.3 cc of lidocaine was used directly. The effectiveness of the dermal filler was not compromised in either case, and important differences in pain, edema, and ecchymosis were observed between injection by PCL injection after pre-injection by tumescence (left side) and pre-mixing PCL filler with lidocaine (right side) mainly in pain (mean score, 4.7)[15,16].

Patient Satisfaction and Safety

Numerous studies have explored the safety and satisfaction provided by polycaprolactone collagen stimulators over the years.

Table 2. Comprehensive studies on polycaprolactone-based dermal fillers in the facial rejuvenation process: clinical insights.

Authors	Methods	End points	Adverse events
Jong Seo Kim	N = 30 PCL 0.00005 cc per 1000 injections	- Increased in dermal thickness by 26.74% - Enhanced skin quality, texture, and reduction of fine lines, stimulates neocollagenesis - Long-lasting results - No serious adverse events.	- Slightly swollen immediately after injection No serious adverse events
Jin-Su Kim MS, et al.	N = 66 hairless mice (22 per group) 22 mice conventional PCL 22 mice SF – 01 22 mice control Dose: 100 μL	- Histopathological studies confirmed collagen fiber formation for both types of filler. - Neocollagenesis was superior in SF-01, compared with conventional PCL filler.	No adverse events have been reported.
Jong Seo Kim	Microscopic light technology (Olympus BX41) Verification that the size of the particles is consistent	- Microscopic analysis showed that the size of the particles remained consistent as expected.	No adverse events have been reported.
Ji Yeon Hong, et al.	N= 10 rat models Dose: h 250 μL injected in each spot Follow up: Serial biopsies were taken in every session	- Increased dermal thickness and elasticity. - Similar morphological changes were observed using a Folliscope ® - The skin surface did not show any significant difference in height from the surroundings after 6 hours. - Skin elasticity increased after the filler injection	No adverse events have been reported.
Jong Seo Kim	N= 2 patients Dose: 1 cc of PCL filler in the temporal fossa. Follow up: Surgical intervention thirteen months	- Even distribution of PCL - The production of collagen was confirmed by biopsy and H&E and MT stainings	No adverse events have been reported.
Francisco de Melo, et al.	No patients. Tested in laboratories only 1.1mL syringes of the PCL 2.0% lidocaine	- Mixing PCL with lidocaine did not significantly alter its rheology. - The viscosity and elasticity of the dermal filler is sufficient to keep the PCL microspheres in suspension	No adverse events have been reported.
Jong Seo Kim	N = 30 patients Left side: a tumescent solution Right-side: lidocaine	- Reduced pain, swelling, and ecchymosis with tumescent anesthesia without compromising effectiveness. - Important differences in pain, edema, and ecchymosis were observed in the side with tumescent anesthesia.	- Swelling (mean score 4.8) - Pain (mean score 4.7) - Ecchymosis (mean score 4.2) - No serious adverse events
Byunggi Bae, et al.	N = 58 patients Evaluation: Global Aesthetic Improvement Scale (GAIS)	- Increased satisfaction over time, lasting up to two years. The scores increased markedly from 1 to 3 months and were maintained at 24 months.	- Edema (n= 58) - Ecchymosis (n=58)
Marion M. Moers-Carpi, et al.	N = 40 patients Dose: Two PCL injections Evaluation: Global Aesthetic Improvement Scale (GAIS)	- Efficacy was maintained at 12 months with sustained improvement in 90% and 91.4% of patients.	No adverse events have been reported

Table 2. Comprehensive studies on polycaprolactone-based dermal fillers in the facial rejuvenation process: clinical insights.

Authors	Methods	End points	Adverse events
Shang-Li Lin, et al.	N = 780 patients 5595 syringes of PCL were used in 1111 treatments	- 4.5% of edema - 2.7% of bruising - 0.72% of malar edema - 0.45% of temporarily palpable lumps - 0.18% of discoloration.	No further adverse events have been reported.
Ximena Wortsman, et al.	1-mL siringe injected in freshly cut porcine skin pieces Study on PCL filler morphology using ultrasound.	- Ultrasound patterns confirm the attributes of the material, substantiating its safety profile for human applications.	No adverse events have been reported
Hassan Galadari, et al.	N = 30 Case group (n=15) 1 ml of PCL Control group (n=15) 1 ml polynucleotide filler.	- Both treatments are effective, but PCL results in fewer adverse effects and longer-lasting outcomes. - At the time of injection (P= 0.5637) - Two weeks later (P= 0.0047) - Four weeks later (P=0.4142).	No adverse events have been reported
Hyunsuk Oh, et al.	N = 32 100 μL intradermally Follow up: 24 weeks.	- New filler shows uniform microspheres and higher elasticity, potentially reducing adverse effects and inflammation.	No adverse events have been reported
Irem Yanatma, et al.	N = 30 rats The control group (n = 10) received no injections PCL group (n = 10) CaHa group (n = 10)	- Both groups show a significant increase in collagen density compared to the control group. - PCL group has the highest fibroblast count.	No adverse events have been reported
Tae-Rin Kwon, et al.	N = 24 mice Evaluation: PRIMOS and immunohistochemical analysis	- PCL particles are smooth and uniform with high values for specific parameters. - Collagen production is similar among all three fillers.	No adverse events have been reported
Hassan Galadari, et al.	N = 40 patients, Each technique was applied to one side of the face Follow up: 12 months.	- PCL achieves significant improvements at six months. - HA effects diminish at nine and twelve months	No adverse events have been reported
Francisco de Melo, et al.	N = 6 experts Follow up: ≥83% agreement rate	- This combination of aesthetic techniques allowed treating different areas and for tissue repositioning, volumizing, and neocollagenesis.	Mild to moderate adverse effects and easily manageable (0.0231%) overall

A retrospective study on forehead augmentation, evaluating 58 patients using the Global Aesthetic Improvement Scale (GAIS) showed an increased satisfaction over time, lasting up to two years. The mean GAIS score at 1, 3, 6, 12, and 24 months was 2.14 +/- 0.95, 2.38 +/- 0.77, 2.50 +/- 0.76, 2.45 +/- 0.52, and 2.33 +/- 0.50, respectively[17].

In a prospective, randomized, controlled study of Moers-Capri and Sherwood, efficacy, safety, longevity, and volume of two PCL formulas for the correction of nasolabial folds were evaluated. In this study, 40 subjects received PCL fillers with varying durations (12 months and 24 months). The results showed no statistically significant differences in the promised duration, but all subjects reporting improvement based on the GAIS scale, PCL-1 and PCL-2 were consistently maintained, with sustained improvement in 90% and 91.4% of patients, respectively. Patient satisfaction at 24 months was 72.4% for PCL-1 and 81.7% for PCL-2. Both products were found to be safe and well tolerated[18].

Adverse Effects and Complications:

A retrospective study covered 780 patients who received PCL filler syringes mixed with lidocaine. This large cohort reported minor complications: 50 cases of edema (4.5%), 30 cases of bruising (2.7%), 8 cases of malar edema (0.72%), 5 cases of temporarily palpable lumps (0.45%) and 2 cases of discoloration (0.18%)

but no major complications such as nodules, granulomas, or infections were observed[7].

It is relevant to refer to a prospective comparison of the morphological characteristics of polycaprolactone when introduced into both porcine and human tissue specimens. Ultrasound imaging was employed in the examination of freshly excised porcine skin samples, wherein a 1-milliliter prefilled syringe was used for the injection of the substance. The ultrasonic visualization of polycaprolactone within porcine and human dermal layers exhibited remarkable similarity, revealing a matrix structure replete with hypoechoic deposits interspersed with conspicuously bright hyperechoic punctuations, characterized by a distinctive mini-comet-tail artifact. This sonographic morphological pattern conveys the anticipated structural attributes of the material, thus substantiating its safety profile for human applications[19].

Combination Therapy

De Melo et al. developed a method where various physicians exposed their knowledge about PCL. Each physician, expert in the area, was individually tasked with expressing their personal preferences regarding the most effective combined rejuvenation treatment for predefined target areas. Additionally, participants were instructed to conduct a detailed analysis of common aesthetic issues specific to each area, such as a loss of the jawline contour and submental cervical angle in the lower face, in patients exhibiting mild to moderate or severe signs of aging. These individual preferences were subsequently compiled into anonymized summary tables, which were later presented for discussion during a consensus meeting. This study design set a baseline or such combinations, which includes the utilization of absorbable polyglycolic acid sutures to facilitate the immediate repositioning of sagging tissues. Additionally, a choice of cross-linked hyaluronic acid specific to the treatment area is recommended. The guideline further incorporates the use of PCL collagen stimulators to stimulate neocollagenesis, restore volume, and enhance skin quality. This multi-agent approach encompasses tissue repositioning, volumization, and neocollagenesis, ultimately leading to enhanced outcomes in aesthetic procedures[25].

Discussion

The pursuit for a youthful appearance is a universal aspiration, one that profoundly influences individuals' self-esteem and social interactions. To address this pursuit, the application of injectable fillers derived from polycaprolactone (PCL) has emerged as a focal point of attention in the realm of facial aesthetics and the functional enhancement of skin and soft tissues. PCL's noteworthy attributes encompass biocompatibility, solubility, and plasticity, and further extend to its remarkable capacity for neocollagenesis, neoelastinogenesis, and neovascularization. This comprehensive discussion delves into the outcomes of diverse studies, which collectively validate the effectiveness, safety, and adaptability of PCL fillers in diverse anatomical contexts[5,9].

The scientific investigation aimed at countering the effects of collagen loss in the pursuit of youthful looks has led to the emergence of PCL dermal fillers as a compelling alternative. This is underpinned by their proven compatibility and gradual degradation. These attributes, coupled with its approval by the US FDA, have brought PCL fillers into the vanguard of minimally invasive treatments aimed at mitigating the visible signs of aging[14,15,22].

As demonstrated PCL fillers, administered in small quantities to the dermis, result in significant improvements in dermal thickness signifying the substantial potential for skin rejuvenation. Long-term results are also promising. And the proliferation of fibroblasts improves skin quality, texture, and contributes to a reduction in fine lines, making PCL very versatile and a good choice for aesthetic medicine professionals[10,11].

Importantly, the durability of PCL in the dermal layer matched expectations, indicating its potential longevity beyond four years, which means that this product can represent a long-term anti-aging treatment[10].

Biopsies and histopathological assessments constitute indispensable tools in elucidating the distinctive properties of PCL fillers, thereby accentuating their biocompatibility, degradation kinetics, and long-term durability, as documented in a series of scientific studies. Through the prism of biopsy, these investigations illuminate the distinctive hallmark of

PCL – neocollagenesis – underscoring its impact on augmenting the stability of the product and its manifold advantages in the context of cutaneous health and rejuvenation processes[12,5,13,14].

The application process of PCL dermal fillers has engendered significant debates and exploration, especially regarding the need for a dilution or the incorporation of anesthesia. These considerations led to the development of innovative techniques designed to optimize both safety and efficacy, thereby underscoring the commitment to enhancing the patient's experience.

Notable among these advancements is the practice of mixing PCL dermal filler with lidocaine, as substantiated that this combination did not significantly alter the filler's rheological properties. Moreover, the strategy of incorporating a tumescent solution alongside PCL dermal filler, emerged as a proactive approach to mitigate or reduce pain, ensuring patient comfort without compromising the efficacy of the filler itself. These innovative techniques collectively represent a trend aimed at refining the application of PCL dermal fillers in aesthetic procedures[11, 14, 15].

The extensive body of research examining the efficacy and safety of PCL collagen stimulators collectively underscores their appeal to patients seeking aesthetic enhancements. Numerous studies have consistently reported high levels of patient satisfaction following PCL treatments, exemplified by Byunggi Bae et al. investigation into forehead augmentation, which indicated an increased satisfaction over time, with results enduring for up to two years[17]. Similarly, the research conducted by Dr. Moers-Capri and Dr. Sherwood, evaluating PCL fillers for the nasolabial fold correction, unveiled that all subjects experienced noticeable improvements based on the Global Aesthetic Improvement Scale (GAIS), with no statistically significant differences in the promised duration [18]. The compelling findings from these studies collectively bolster PCL's reputation as a compelling cosmetic intervention, sought by individuals seeking lasting, satisfactory outcomes.

Additionally, the safety profile of PCL fillers has been demonstrated in several studies, with a consistent track record of minor complications and rare major issues[7,19]. Remarkably, the absence of major complications such as nodules, granulomas, or infections emphasizes the minimal risk associated with PCL procedures. Furthermore, it is important to accentuate the significance of sonography in identifying potential complications from PCL dermal fillers, thus enhancing patient safety. Cumulatively, these findings attest to the desirability of PCL as a safe and effective option for patients seeking aesthetic enhancements.

PCL dermal fillers stand out as the primary choice when compared to alternative options. A series of in-depth studies consistently highlights the unique advantages of PCL, as it not only minimizes adverse effects but also extends the duration of its positive outcomes[20-24].

PCL significantly increases type I collagen density and fibroblast count within the PCL group, further emphasizing the advantages of PCL in dermal treatments. Lastly, it surpasses hyaluronic acid in the nasolabial fold treatment, solidifying PCL's superiority with pronounced improvements at six months compared to the diminishing effects of hyaluronic acid at the same follow-up. These collective findings underscore the compelling case for PCL fillers in the field of dermal enhancements, positioning them as the optimal choice for both patients and clinicians[20-24].

In the ever-evolving field of dermatology and aesthetics, the use of combination therapies is a burgeoning trend offering enhanced outcomes with a multifaceted approach that incorporates PCL collagen stimulators, renowned for their neocollagenesis, volume restoration, and skin quality improvement. This has been proposed as a holistic solution to address tissue repositioning and volumization, ultimately elevating the results of aesthetic procedures. To summarize, the multifaceted benefits of PCL with other treatments represents an exciting frontier in achieving comprehensive facial rejuvenation[25]. This synergistic approach not only underscores the versatility of PCL fillers but also highlights their pivotal role in advancing the realm of cosmetic procedures.

Conclusions

Polycaprolactone (PCL) has emerged as a significant player in the past decade for the formation of new collagen and filling activity showing safe and satisfying

results. It is essential to delve into the multifaceted implications, encompassing histopathological assessments, safety considerations, and patient satisfaction, in order to provide the most effective and comprehensive treatments. This exploration is instrumental in ensuring that PCL continues to serve as a viable and valuable choice in the realm of aesthetic and functional enhancements, addressing the perennial quest for youthful and rejuvenated appearances with minimal risks and maximal patient satisfaction.

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References

1. Csekes E, Račková L. Skin Aging, Cellular Senescence and Natural Polyphenols. Int J Mol Sci. 2021; 22(23):12641.
2. Ko AC, Korn BS, Kikkawa DO. The aging face. Surv Ophthalmol. 2017; 62(2):190-202.
3. Zhang S, Duan E. Fighting against Skin Aging: The Way from Bench to Bedside. Cell Transplant. 2018; 27(5):729-738.
4. de Melo F, Nicolau P, Piovano L, et al. Recommendations for volume augmentation and rejuvenation of the face and hands with the new generation polycaprolactone-based collagen stimulator (Ellansé®). Clin Cosmet Investig Dermatol. 2017; 10:431-440.
5. Kim J. Isovolemic Degradation of Polycaprolactone Particles and Calculation of Their Original Size from Human Biopsy. Plast Reconstr Surg Glob Open. 2020; 8(6):e2866.
6. Christen MO, Vercesi F. Polycaprolactone: How a Well-Known and Futuristic Polymer Has Become an Innovative Collagen-Stimulator in Esthetics. Clin Cosmet Investig Dermatol. 2020; 13:31-48.
7. Lin SL, Christen MO. Polycaprolactone-based dermal filler complications: A retrospective study of 1111 treatments. J Cosmet Dermatol. 2020; 19(8):1907-1914.
8. Figueiredo VM. A five-patient prospective pilot study of a polycaprolactone based dermal filler for hand rejuvenation. J Cosmet Dermatol. 2013; 12(1):73-7.
9. Moon SY, Eun DH, Park JH, et al. Foreign body reaction three years after injection with polycaprolactone (Ellanse®). Eur J Dermatol. 2017; 27(5):549-551.
10. Kim JS. Changes in Dermal Thickness in Biopsy Study of Histologic Findings After a Single Injection of Polycaprolactone-Based Filler into the Dermis. Aesthet Surg J. 2019; 39(12):NP484-NP494.
11. Lin SL. Polycaprolactone facial volume restoration of a 46-year-old Asian women: A case report. J Cosmet Dermatol. 2018; 17(3):328-332.
12. Kim JS, In CH, Park NJ, Kim BJ, Yoon HS. Comparative study of rheological properties and preclinical data of porous polycaprolactone microsphere dermal fillers. J Cosmet Dermatol. 2020; 19(3):596-604.
13. Hong JY, Kim JH, Kwon TR, Hong JK, Li K, Kim BJ. In vivo evaluation of novel particle-free polycaprolactone fillers for safety, degradation, and neocollagenesis in a rat model. Dermatol Ther. 2021; 34(2):e14770.
14. Kim JA, Van Abel D. Neocollagenesis in human tissue injected with a polycaprolactone-based dermal filler. J Cosmet Laser Ther. 2015; 17(2):99-101.
15. de Melo F, Marijnissen-Hofsté J. Investigation of physical properties of a polycaprolactone dermal filler when mixed with lidocaine and lidocaine/epinephrine. Dermatol Ther (Heidelb). 2012; 2(1):13.
16. Kim J. Tumescent anesthesia for reducing pain, swelling, and ecchymosis during polycaprolactone filler injections in the face. J Cosmet Laser Ther. 2017; 19(7):434-438.
17. Bae B, Lee G, Oh S, Hong K. Safety and Long-Term Efficacy of Forehead Contouring With a Polycaprolactone-Based Dermal Filler. Dermatol Surg. 2016; 42(11):1256-1260.
18. Moers-Carpi MM, Sherwood S. Polycaprolactone for the correction of nasolabial folds: a 24-month, prospective, randomized, controlled clinical trial. Dermatol Surg. 2013; 39(3 Pt 1):457-63.
19. Wortsman X, Quezada N. Ultrasound Morphology of Polycaprolactone Filler. J Ultrasound Med. 2017; 36(12):2611-2615.
20. Jeong GJ, Ahn GR, Park SJ, Hong JY, Kim BJ. A randomized, patient/evaluator-blinded, split-face study to compare the efficacy and safety of polycaprolactone and polynucleotide fillers in the correction of crow's feet: The latest biostimulatory dermal filler for crow's feet. J Cosmet Dermatol. 2020; 19(7):1593-1599.
21. Oh H, Lee S, Na J, Kim BJ, Kim JH. Comparative Evaluation of Physical Characteristics and Preclinical Data of a Novel Monodisperse Polycaprolactone Microspheres Filler. Aesthetic Plast Surg. 2022; 46(1):429-436.
22. Yanatma I, Sarac G, Gul M, Gul S, Kapicioglu Y. Comparison of polycaprolactone and calcium hydroxylapatite dermal fillers in a rat model. Dermatol Ther. 2021; 34(1):e14716.
23. Kwon TR, Han SW, Yeo IK, et al. Biostimulatory effects of polydioxanone, poly-d, l lactic acid, and polycaprolactone fillers in mouse model. J Cosmet Dermatol. 2019; 18(4):1002-1008.
24. Galadari H, van Abel D, Al Nuami K, Al Faresi F, Galadari I. A randomized, prospective, blinded, split-face, single-center study comparing polycaprolactone to hyaluronic acid for treatment of nasolabial folds. J Cosmet Dermatol. 2015; 14(1):27-32.

25. de Melo F, Carrijo A, Hong K, et al. Minimally Invasive Aesthetic Treatment of the Face and Neck Using Combinations of a PCL-Based Collagen Stimulator, PLLA/PLGA Suspension Sutures, and Cross-Linked Hyaluronic Acid. Clin Cosmet Investig Dermatol. 2020; 13:333-344.

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