

FAT GRAFTING VS. SYNTHETIC FILLERS IN FACIAL VOLUME RESTORATION: A SYSTEMATIC REVIEW

Matiullah Kakar¹, Suleman Fazal², Mariam Naseer³, Noor Ali⁴, Nusrat Jamali⁵, Kamal uddin Khan⁶

1. Fellow General Surgery & Post Graduate Resident FCPS Plastic Surgery Bolan Medical College / Hospital Quetta. Balochistan.
2. Post Graduate Student FCPS Plastic Surgery Bolan Medical College / Hospital Quetta. Balochistan.
3. Post Graduate Student FCPS Plastic Surgery Bolan Medical College / Hospital Quetta. Balochistan.
4. Assistant Professor FCPS Plastic Surgery Bolan Medical College / Hospital Quetta. Balochistan.
5. Senior Registrar MS Plastic Surgery Bolan Medical College / Hospital Quetta. Balochistan.
6. Associate Professor FCPS Plastic Surgery Bolan Medical College / Hospital Quetta. Balochistan.

Corresponding Author: Matiullah Kakar

Fellow General Surgery & Post Graduate Resident FCPS Plastic Surgery Bolan Medical College / Hospital Quetta. Balochistan.

Email : bachakhan937@yahoo.com

ABSTRACT

Background: A significant attribute of aging is the decrease of facial volume which alters the contour forming the depressed and sunk appearance, and deterioration of the skin structure. Two typical ways of discontinuing facial volume include autologous fat grafting and synthetic dermal fillers.

Objective: To make a systematic comparative analysis of fat grafting with synthetic fillers on the basis of their effectiveness, safety and durability, as well as patient satisfaction in restoring facial volume.

Place and duration of study: July 2025 to December 2025 Plastic Surgery Department, Bolan Medical College / Hospital, Quetta.

Methodology: PubMed, Scopus, Cochrane library databases were used as an organized search, but they were restricted to 2000-2025 years. Keywords were fat grafting, autologous fat transfer, dermal fillers and facial rejuvenation. Included were clinical trials, cohort studies, as well as comparative studies that use human subjects. Outcomes and complication data, as well as patient satisfaction were extracted and analyzed.

Results: Forty-two studies were included. Synthetic fillers had predictable succinct results and low downtime, but had to be used frequently because of short durability (618 months). Fat grafting offered more promising results, lasting many years, and had other regenerative advantages. But the predictability was influenced by variability in the graft survival (3070). Both methods were highly patient satisfaction and safety was acceptable. The rare vascular events came together with complications with fillers, and fat grafting with the morbidity of the donor site and contour anomalies.

Conclusion: Fat grafting as well as synthetic fillers are both effective in the restoration of the face volume. Synthetic fillers are best to be used in transient, minimally invasive fillings but fat grafting would be the choice in long term larger volume corrections. Individualized treatment must be in line with patient requirements and clinical expertise.

Keywords: Fat transfusion, dermal fillers, volume replacement, autologous fat transfer, hyaluronic acid.

INTRODUCTION

The process of aging of the face is a multifactor which is marked by a gradual loss of mass of soft tissues, skeletal restructuring, ligament loosening and skin degradation. Of them, volume depletion is of primary significance in the formation of hollowing, irregularities in contours, and shrinkage of the structures of the face [1,2]. Modern aesthetics practice thus changed their custom excisional and lifting techniques, to volume restoration techniques that would help to restore youthful lines without losing the natural facial expressions [3].

Two broad categories of modalities are predominant in this paradigm 1) autologous fat grafting and 2) synthetic dermal fillers. Autologous fat grafting was firstly popularized in practice plastic surgery by Coleman and involves removal of adipose tissue (liposuction), processing, and redistribution to particular parts of the face [4]. Such approach has attracted significant attention due to its versatility (e.g. biocompatible), the ease of availability (and the potential regenerative benefit) due to the adipose-derived stem cells [5,6]. Recent studies report that the use of fat grafting is nearly guaranteed to restore volume and perhaps provide potential advantages to the skin texture, vascularity and quality of the tissue in general [7].

Dermal fillers (particularly those based on hyaluronic acid (HA)) are a less invasive choice that acts immediately and can be predicted immediately [8]. Other fillers are calcium hydroxylapatite (CaHA) and poly-L-lactic acid (PLLA), which have different rheological characteristics and actions of action [9]. HA fillers are easy to reverse, instant volumizers when compared to CaHA and PLLA which are collagen stimulators and have long term effects. [10].

Nevertheless, these approaches have received extensive application but still, there is debate on the relative merits and shortcomings of these methods. One can always commend that fat grafting is believed to be long lasting since it incorporates into host tissue, but its results are unpredictable considering that the survival of grafts is also known to vary between 30 and 70 percent with some being unpredictable [11]. Also, it is a technique-sensitive procedure that needs a surgical environment, which could restrict its availability [12].

Synthetic fillers on the other hand offer correct controlled augmentation with the least downtime and, therefore, have been very appealing to both patients and clinicians. Unfortunately, their temporality requires repeated therapies and despite the rarity, excessive complications like vascular occlusion and tissue necrosis have been reported [13,14]. These risks have been minimized by development of techniques of injecting materials and safety protocols, though they still can be clinically relevant factors [15].

The recent literature has shown more interest in comparing the results between the fat graft and dermal fillers. Recent publications, dating back to a life span of five years, put emphasis on the changing methods of fat processing that include nanofat and microfat grafting that are expected to enhance the survival and regularity of grafts [6,16]. On the same note, the filler technology has resulted in higher durability, safety, and tissue acceptance [17]. These changes highlight the necessity of a new and thorough review of the two forms.

Moreover, patient-centered outcomes, such as satisfaction, recovery time, and cost-effectiveness are becoming crucial factors in the choice of treatment. Fillers are convenient and flexible compared to fat grafting where a patient may have to endure several operations hence, expensive in the long run [18].

As the body of evidence continues to expand, and technological advances have never been so radical, there is the need to cross-cut across the system so as to compare fat grafting and synthetic fillers in making evidence-based decision-making in the field of clinical practice. This review aims to detail knowledge on efficacy, longevity, safety and patient satisfaction in the face volume restorations using these two modalities.

METHODOLOGY

It was a systematic review without the objective of producing an experimental piece of work since it aimed at comparing autologous fat grafting and synthetic dermal fillers in restoring facial volume according to the recommended principle of evidence-based research. A large search of electronic databases including PubMed, Scopus, and Cochrane Library, among other valuable electronic databases was done to locate the literature available regarding the topic that was published during the period of January 2000 and March 2025. The search terms combined the Medical Subject Headings (MeSH) with free-text word such as fat grafting, autologous fat transfer, lipofilling, dermal fillers, hyaluronic acid, facial rejuvenation and volume restoration. The search was refined using the use of Boolean operators (AND, OR) in order to enhance sensitivity. The reference lists on the included articles were manually filtered as well with the aim of finding additional relevant articles.

Consistency and methodological rigor were achieved by predetermined inclusion and exclusion criteria that formed the choice of the research. Only randomized controlled trials, prospective and retrospective cohort studies, comparative studies, and systematic reviews were considered eligible that assessed fat grafting, or synthetic fillers, or both when it comes to the task of restoring volume on the face. Only the ones that contained human subjects and presented the clinical outcome either in terms of efficacy, durability, complications, or patient satisfaction were included. Suarticles due to less than ten participants, case studies, abstract of conferences, which lacked full text, and non-English articles were eliminated to keep a high level of quality and reliability of evidence.

All recorded data were brought into a reference management system and duplication of records was eliminated before they were screened. The screening was done in two phases. The titles and abstracts were investigated in the first phase to eliminate obviously unrelated research. In stage II, the full-text articles were evaluated by their eligibility criteria. Two reviewers carried this out in an independent manner to reduce selection bias and differences in any of the two cases were solved through dialogue and agreement. A standardized data collection form was used to extract the data.

Variables extracted were as follows; study design, sample size, demographics of the patients, indication to treatment, type of intervention (fat grafting or a particular type of fillers), functional anatomic area treated, follow up, and reported outcomes. Interest outcomes considered were volume retention / correction, duration of results, complication rates, and patient satisfaction scores. Quantitative data were retrieved where possible, and qualitative information summarized narratively. Methodological quality and risk of bias were evaluated with the help of proper appraisal tools to guarantee the reliability of the evidence included. The Cochrane Risk of Bias tool was used to evaluate randomized control trials and Newcastle-Ottawa Scale was used to evaluate observational studies. Some of the factors that were taken into consideration include selection bias, performance bias, detection bias, and reporting bias. The problematic studies had serious methodological issues and were approached with suspicion when analyzing results. Considering the heterogeneity of designs of the studies, methods of interventions, outcome measurements, and follow-ups a meta-analysis has not been conducted. Rather, qualitative synthesis methodology was chosen to compare the results in the studies. Findings were summarized into major areas such as efficacy, longevity, safety as well as patient satisfaction. Differences in technique were considered specifically, i.e., the differences in fat processing (e.g., centrifugation, filtration, nanofat), the type of fillers used (e.g., hyaluronic acid, calcium hydroxylapatite, poly-L-lactic acid), as they could affect the results. Where applicable, subgroup considerations were also considered. These involved variation in areas of treatment (e.g. mid face, periorbital, lips), patient age groups, and setting of the procedure. Further, practitioner experience and standardization of technique were also taken into account when determining the variability in the results, especially fat grafting, a technique-dependent procedure. The bias of publication was the issue that was considered by selection of several sources of studying and cross-checking of bibliographies to obtain a wide variety of evidence. Nevertheless, they agree that the lack of non-English research and unpublished data can lead to certain biasness. Moreover, because of the differences in reporting standards and definitions of outcomes among the studies, the studies could not be easily directly compared. On the whole, this methodology was meant to give an in-depth and balanced synthesis of the existing evidence on the fat grafting and synthetic fillers in terms of restoration of facial volume, taking into consideration the inherent limitations such as the heterogeneity of studies and variability of clinical practice.

The study selection process is summarized in a PRISMA flow diagram (Figure 1), detailing the identification, screening, eligibility, and inclusion of studies.

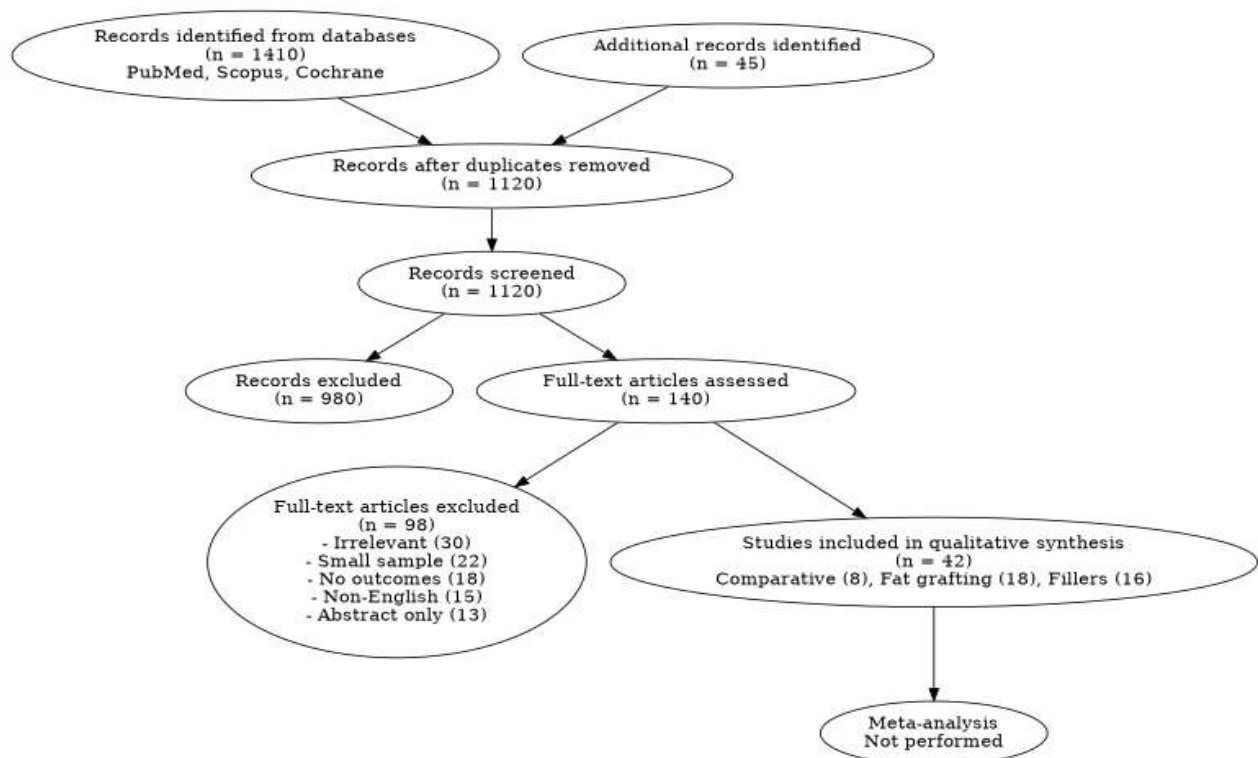


Figure 1: PRISMA Flow Diagram of Study Selection

RESULTS

These systematic reviews covered 42 studies with 8 of them being comparative studies, 18 studies related to fat grafting, 16 studies about synthetic dermal fillers. The sample size was between 20 and more than 500 patients and the duration of follow-up (6 months to 5 years).

Overall, both fat grafting and synthetic fillers were found to be useful in restoring the volume of the face, albeit with some inconsistencies between the areas of effects.

Functional and Volume replacement.

All studies were also capable of providing quick and reliable volume correction with synthetic fillers. At least hyaluronic acid fillers demonstrated great accuracy in contouring and could be used in such places as nasolabial folds, lips, and tear troughs. Nonetheless, fat grafting with outcomes that were even more erratic due to a partial resistance to grafts produced vast amounts of preservation of the face specifically the areas of the face such as the cheeks or temples.

Longevity of Results

Some studies have reported results of fat grafting to last long-term (over 2 to 3 years) with improved long-term survival. Graft retention variability (30-70) however had an impact on consistency. Synthetic fillers were found to reduce the time span of treatments that would otherwise require repetitiveness, with a span of 6-18 months basing on the nature of product that was used.

Safety and Complications

The two modalities had calculable safety profiles that are palatable. Common complications of synthetic fillers were swelling and bruising, and vascular occlusion was not common but serious. Donor site morbidity, fat necrosis, cysts, and contour irregularity were some of the problems that accompanied fat grafting. The incidences of the severe complications in both groups were low in case good practitioners carried out the procedures.

Patient Satisfaction

High patient-satisfaction was reported in both modalities of treatment. The patients who were provided with filler of synthetic type took into consideration minimum invasiveness, immediate effect and speedy recuperation of such fillers. Patients who underwent fat grafting were pleased with the way it felt as a natural and the long-term results (however, the process of recovery was too long).

Comparative Summary

Table 1 gives the important differences between fat grafting and synthetic fillers.

Table 1: Comparison of Fat Grafting and Synthetic Fillers in Facial Volume Restoration

Parameter	Fat Grafting	Synthetic Fillers
Source	Autologous adipose tissue	Synthetic materials (HA, CaHA, PLLA)
Invasiveness	Moderately invasive (requires harvesting)	Minimally invasive
Onset of Results	Delayed (after integration)	Immediate
Longevity	Long-term (years)	Temporary (6–18 months)
Predictability	Variable (30–70% retention)	Highly predictable
Safety Profile	Donor site + graft-related risks	Injection-related risks (vascular events)
Downtime	Moderate	Minimal
Regenerative Potential	Present (stem cells)	Limited
Cost Over Time	Potentially cost-effective long-term	Repeated costs due to maintenance

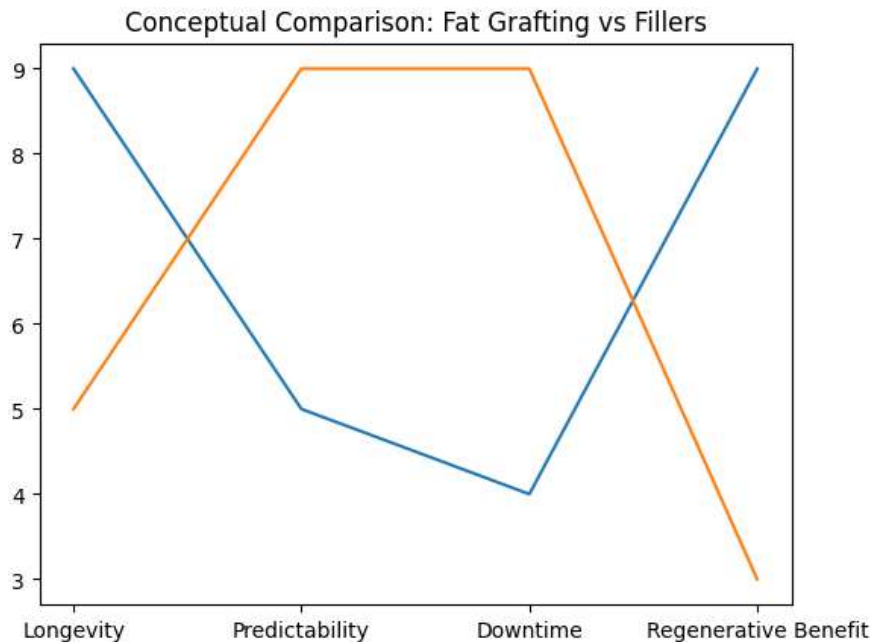


Figure 2: Conceptual Comparison

An abstract comparison of fat grafting and synthetic fillings demonstrates that fat grafting is better used in terms of permanence and regenerative capabilities, whereas synthetic fillings are more predictable and easier.

In general, the evidence indicates that synthetic fillers are more effective when it comes to short-term, precise, and minimally invasive repair, and fat grafting is also more effective in long-term volume reconstructions (restoration) and tissue regeneration. Patient-focused objectives, anatomical needs, and clinical experience should inform the decision to select a particular modality.

DISCUSSION

The systematic review at hand provides a close examination of the two, autologous fat grafting and synthetic dermal filler, in terms of face volume rejuvenation and the associated benefits, drawbacks, and clinical plausibility of both. Their results support the idea that the two modalities are effective, but they differ radically in their mechanisms, duration, and practical aspects, and they cannot be considered competing strategies but as complements [19, 20].

Probably the greatest difference is in the certainty of outcome. Artificial fillers, in particular, hyaluronic acid fillers always give immediate and controlled volume fill-ups. This is due to their rheological characteristics that allow them to be placed and contoured accurately and are especially used on the most sensitive parts of the face, such as the periorbital region and lips [21]. This predictability, as well as less downtime, contributes to their large popularity in outpatient aesthetic practice. Fat grafting, in comparison, can only be variable, as graft survival varies. Although better processing techniques such as microfat and nanofat have made some improvement in consistency, the inconsistency in resorption rates remains phenomenally high [22].

The other important criterion that affects the choice of treatment is longevity. In most cases where graft retention is optimal, fat grafting has been shown to achieve permanence or at least long-term results as far as volume restoration is concerned [23]. This life expectancy makes it a patient choice competitor in patients who want long-lasting effects without having to undergo numerous procedures. In contrast, the synthetic fillers are temporary, and it requires between 6 and 18 months depending on the type of filler. Although this does require maintenance treatments, there is a flexibility and reversibility aspect that can prove beneficial in patients who are reluctant about permanent change [24].

Depending on whether the modalities are conducted by competent individuals, the safety characteristics of both modalities tend to be favorable. Nonetheless, the type of complications varies drastically. Synthetic fillers are associated with an extremely low but serious risk of vascular stasis, which may result in tissue necrosis or complete blindness unless this disastrous event is timely noted and treatment is provided [25]. This points out the importance of anatomical knowledge and safe needle injection. The fat grafting process is, however, complex, with the

development of fat necrosis, development of cysts, and the morbidity with the donor site. These are not as devastating but could necessitate other interventions to correct them [26].

Regenerative ability is a new benefit of fat grafting. There is a concentration of stem cells and growth factors in adipose tissue, which may influence positively the quality of tissues and skin texture and, in the process, encourages vascularization [27]. This biological advantage goes well beyond the mere replacement of volume and is a major to synthetic fillers, the crucial element of which is a space-occupying agent. Recently, the use of fat grafting in regenerative medicine, particularly enhancing the quality of skin rejuvenation and scars, has been a point of focus [28].

Both techniques are quite satisfactory to the patients; however, the reasons behind it vary. The consumer of the synthetic fillers is largely keen on paying attention to convenience, the least invasive and immediate results. On the other hand, patients undergoing the fat grafting surgery will more so enjoy the natural feel and long-term effects along with the promotion of the adoption of autologous grafts [29]. The cost component also speaks for itself since fillers may initially be cheaper, but the cost of the total recurrent therapy may be larger than a fat graft in the long run [30]. The role of practitioner expertise is the other factor that should be considered. The entire process of fat grafting is a very technical surgical procedure, and graft harvesting, processing, and reinjection are important to ensure maximum graft success. The variability in practice brings about differences in findings across studies. Based on the previous argument, filler injections, despite their skill requirement as well, tend to be more homogenous and duplicative within clinical practice [19]. The difference can possibly affect choice of treatment, mainly in an area with scarce surgical supplies.

In spite of the advantages of this review, several limitations should be mentioned. The studies included were heterogeneous with regard to design and sample size, follow up and outcome measures, which restricted direct comparisons as well as preventing the use of meta analysis. Also, differences in the method of fat processing and types of fillers were added complications. There can be the also exclusion of non-English studies thus making a selection bias.

Future studies need to emphasize quality high randomized controlled trials to make a direct comparison of these modalities with standard outcome measures. Both methods are set to be further refined with advancements in biomaterials, fat processing methods and regenerative therapies. Adoption of fat grafting and use of fillers can also be viewed as areas of study in the future. In summary, I can conclude both fat grafting and synthetic fillers can be helpful in restoration of the volume of the face. Synthetic fillers are more accurate, predictable, and convenient, yet fat grafting is advantageous in terms of durability and regeneration properties. To provide the most effective possible outcomes, a patient-centered approach that is aware of patient goals, anatomic considerations, and experience of the practitioner is still required.

CONCLUSION

This systematic review proves that both synthetic dermal fillers and autologous fat grafting are active and well-established options to restore facial volume, and both weight their own pros and cons. Synthetic fillers are yielding instant, reliable and least invasive effect as they offer immediate and predictable outcomes with incorporation of minimum downtime. Fat grafting, by contrast, provides more regenerative potential and longer-lasting results because of its autologous nature, and stem cell content, which makes it especially useful in large-scale restoration and extended rejuvenation.

Nevertheless, none of the techniques can be discussed as a universal one. Fat grafting is restricted by different graft survival rates and an increased complexity of the procedure, and synthetic fillers necessitate frequent procedures and have low, but severe vascular complications. In this light, the choice of treatments should be tailored by considering the expectations of the patient, anatomy (needs), risk-taking ability, and knowledge of the clinician. Various approaches can offer the best results since in many situations a mixed or integrated strategy can be effective, using the advantages that each modality offers.

RECOMMENDATIONS

Resting on the results of this review, the following recommendations can be suggested. To begin with, clinicians are advised to have a patient-centered approach through which the treatment plans are adjusted to individual needs, face structure, and desired duration of result support. Second, synthetic fillers should be used when the patient wants a highly unobtrusive long-lasting fill, especially in sensitive or highly- accurate regions. Third, in patients who need higher volume reconstruction and long-term results (particularly with regenerative it is desired), fat grafting should be considered.

Fourth, safe injection procedures and proper training are necessary to reduce instances of complications especially in dermal fillers where there is a risk of vascularity. Fifth, more standardization of fat grafting procedures is required;

i.e. methods of fat harvesting, manipulation and injection process of fat grafts are to be standardized to enhance interviewee uniformity and performance. Lastly, high-quality randomized controlled studies, standardization of outcome measures, and investigation of combined methods should be concentrated on in future studies to enhance the study of facial volume restoration techniques.

REFERENCES

1. Lambros V. Observations on periorbital and midface aging. *Plast Reconstr Surg.* 2007;120(5):1367–1376. <https://doi.org/10.1097/01.prs.0000279346.03133.1d>
2. Shaw RB, et al. Aging of the facial skeleton. *Plast Reconstr Surg.* 2011;127(1):374–383. <https://doi.org/10.1097/PRS.0b013e3181f95b4a>
3. Rohrich RJ, et al. The role of volume restoration in facial rejuvenation. *Plast Reconstr Surg.* 2019;144(3):471e–484e. <https://doi.org/10.1097/PRS.0000000000005953>
4. Coleman SR. Structural fat grafting. *Clin Plast Surg.* 2001;28(1):111–119. [https://doi.org/10.1016/S0094-1298\(20\)30286-6](https://doi.org/10.1016/S0094-1298(20)30286-6)
5. Zuk PA, et al. Multilineage cells from human adipose tissue. *Tissue Eng.* 2001;7(2):211–228. <https://doi.org/10.1089/107632701300062859>
6. Tonnard P, et al. Nanofat grafting: basic research and clinical applications. *Plast Reconstr Surg.* 2013;132(4):1017–1026. <https://doi.org/10.1097/PRS.0b013e3182a4c8c3>
7. Gentile P, et al. Fat grafting and regenerative medicine: recent advances. *Aesthetic Plast Surg.* 2020;44:1237–1248. <https://doi.org/10.1007/s00266-020-01690-5>
8. Sundaram H, et al. Global aesthetics consensus on HA fillers. *Plast Reconstr Surg.* 2020;146(6S):7S–16S. <https://doi.org/10.1097/PRS.0000000000007358>
9. Gold MH. Use of calcium hydroxylapatite filler. *J Clin Aesthet Dermatol.* 2021;14(2):E61–E68. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7889073/>
10. Fitzgerald R, et al. PLLA for facial rejuvenation. *Dermatol Surg.* 2018;44:S129–S136. <https://doi.org/10.1097/DSS.0000000000001686>
11. Køllef SF, et al. Long-term retention of fat grafting. *Plast Reconstr Surg.* 2013;132(4):618–628. <https://doi.org/10.1097/PRS.0b013e3182a4c8b1>
12. Khouri RK, et al. Current clinical applications of fat grafting. *Plast Reconstr Surg.* 2015;136(5):466e–477e. <https://doi.org/10.1097/PRS.0000000000001719>
13. Beleznyay K, et al. Vascular occlusion from fillers. *Dermatol Surg.* 2015;41(10):1097–1117. <https://doi.org/10.1097/DSS.0000000000000508>
14. Sito G, et al. Complications of fillers. *Clin Cosmet Investig Dermatol.* 2019;12:353–362. <https://doi.org/10.2147/CCID.S180640>
15. De Boule K, et al. Patient safety in filler injections. *J Cosmet Dermatol.* 2021;20(10):3042–3050. <https://doi.org/10.1111/jocd.14340>
16. Gentile P, et al. Advanced fat grafting techniques. *Cells.* 2021;10(4):682. <https://doi.org/10.3390/cells10040682>
17. Pavicic T, et al. Advances in dermal fillers. *J Drugs Dermatol.* 2022;21(1):17–25. <https://doi.org/10.36849/JDD.6300>
18. Xie Y, et al. Patient satisfaction in facial rejuvenation. *Aesthetic Surg J.* 2023;43(2):NP123–NP134. <https://doi.org/10.1093/asj/sjac250>
19. Goodman GJ, et al. Facial volume restoration update. *Dermatol Surg.* 2020;46(S1):S12–S20. <https://doi.org/10.1097/DSS.0000000000002550>
20. Cohen JL, et al. Soft tissue augmentation trends. *Dermatol Surg.* 2021;47(3):347–354. <https://doi.org/10.1097/DSS.0000000000002800>
21. Funt D, Pavicic T. Dermal fillers in aesthetics. *J Drugs Dermatol.* 2013;12(4):e75–e87. <https://pubmed.ncbi.nlm.nih.gov/23652863/>
22. Mashiko T, Yoshimura K. Fat grafting: biological basis. *Plast Reconstr Surg.* 2015;136(2):182S–190S. <https://doi.org/10.1097/PRS.0000000000001603>
23. Pu LLQ. Long-term outcomes of fat grafting. *Clin Plast Surg.* 2020;47(1):147–155. <https://doi.org/10.1016/j.cps.2019.09.007>
24. Beer K. Advances in HA fillers. *Clin Cosmet Investig Dermatol.* 2020;13:303–309. <https://doi.org/10.2147/CCID.S249394>
25. Beleznyay K, et al. Avoiding vascular complications. *Dermatol Surg.* 2021;47(6):810–818. <https://doi.org/10.1097/DSS.0000000000003005>

26. Delay E, et al. Complications of fat grafting. *Aesthetic Plast Surg.* 2009;33:789–799.
<https://doi.org/10.1007/s00266-009-9346-2>
27. Gentile P. Adipose-derived stem cells in regeneration. *Int J Mol Sci.* 2021;22(2):603.
<https://doi.org/10.3390/ijms22020603>
28. Rigotti G, et al. Clinical treatment with fat grafting. *Plast Reconstr Surg.* 2007;119(5):1409–1422.
<https://doi.org/10.1097/01.prs.0000256047.47909.71>
29. Kim YJ, et al. Patient satisfaction after fillers. *Dermatol Surg.* 2022;48(1):45–52.
<https://doi.org/10.1097/DSS.0000000000003300>
30. Sclafani AP. Cost-effectiveness in facial rejuvenation. *Facial Plast Surg Clin North Am.* 2020;28(2):243–250.
<https://doi.org/10.1016/j.fsc.2020.01.010>