(Jurnal Plastik Rekonstruksi, 2025; Vol 12, No 1, 48-57) RECONSTRUCTIVE

Review

EXPLORING THE ROLE AND SAFETY OF AUTOLOGOUS FAT GRAFTING FOR BREAST AUGMENTATION: A LITERATURE REVIEW

Beta Subakti Nataatmadja[1], Loelita M Lumintang[2], Aryunidya Asmaradianti[3], & Pascalis Fabian[3]

1. *Department of Plastic Reconstructive and Aesthetic Surgery, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia*
2. *Department of Reconstructive and Aesthetic Plastic Surgery, Sanjiwani General Hospital, Faculty of Medicine, Universitas Warmadewa, Denpasar, Indonesia*
3. *Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia*

ABSTRACT

Breast augmentation, a commonly sought cosmetic procedure, has shifted towards autologous fat grafting (AFG) as an alternative to implants, primarily due to long-term complications associated with implants. This review aims to provide a comprehensive summary of the autologous fat grafting (AFG) application in breast augmentation surgery. A systematic search strategy was developed for the MEDLINE database and additional articles were identified by reviewing the references. AFG involves harvesting, processing, and injecting the patient's fat into the breast, providing natural results and fewer complications compared to implants. The procedure's success depends on the surgeon's skill. There are challenges and considerations associated with AFG, including volume limitations, variable retention rates, and potential complications such as infections and cyst formation. Uncertainties in fat retention rates influenced by various factors like fat content, processing methods, injection techniques, and patient characteristics, emphasizing the need for further research and careful patient selection.

***Key words**: Autologous fat grafting; Breast augmentation; Adipose tissue; Lipotransfer; Breast surgery*

Augmentasi payudara merupakan prosedur bedah kosmetik yang banyak diminati, dengan tren yang beralih ke cangkok lemak autologus (autologous fat grafting/AFG) sebagai alternatif implan akibat komplikasi jangka panjang yang terkait dengan penggunaan implan. Tinjauan ini bertujuan untuk memberikan ringkasan komprehensif mengenai aplikasi AFG dalam augmentasi payudara. Strategi pencarian sistematis dikembangkan untuk basis data MEDLINE, serta artikel tambahan diidentifikasi melalui penelusuran referensi. AFG melibatkan tahapan pengambilan, pemrosesan, dan penyuntikan lemak pasien ke dalam payudara, yang menghasilkan tampilan alami serta risiko komplikasi yang lebih rendah dibandingkan dengan implan. Keberhasilan prosedur ini sangat bergantung pada keterampilan ahli bedah. Meskipun demikian, terdapat berbagai tantangan dan pertimbangan dalam AFG, termasuk keterbatasan volume, tingkat retensi lemak yang bervariasi, serta potensi komplikasi seperti infeksi dan pembentukan kista. Ketidakpastian dalam tingkat retensi lemak dipengaruhi oleh berbagai faktor, seperti kandungan lemak, metode pemrosesan, teknik injeksi, serta karakteristik pasien, yang menekankan perlunya penelitian lebih lanjut dan seleksi pasien yang cermat.

***Kata kunci:** Cangkok lemak autologus; Augmentasi payudara; Jaringan adiposa; Lipotransfer; Bedah payudara*

Conflicts of Interest Statement:
The author(s) listed in this manuscript declare the absence of any conflict of interest on the subject matter or materials discussed.

INTRODUCTION

Breast augmentation is a widely performed cosmetic procedure for women globally, with breast implants being among the most popular types of plastic surgery prostheses[(1)]. However, there has been a significant shift in surgical techniques for breast augmentation. There has been a gradual move away from relying solely on biomaterials as implants and towards less invasive procedures that exclusively use autologous fat grafting[(2)]. This change can be attributed to high revision rates associated with breast implants postoperatively (approximately

Received: 30 April 2024, Revised: 04 February 2025, Accepted: 31 March 2025

 P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380

24%-36%) in 10 years. Despite initial favorable outcomes observed with breast implant, several long-term complications have been documented. These complications include but are not limited to capsular contracture formation occurring in approximately 10-20 % of cases, mal positioning of the implant(s), implant rupture or leakage, infections, breast implant-associated anaplastic large cell lymphoma (BIA-ALCL), and reduced sensitivity during mammographic visualization [3][4].

Autologous fat grafting (AFG) has gained prominence as a modality that addresses various limitations in breast surgery techniques, providing an alternative to traditional breast augmentation with implants and witnessing a growing popularity in aesthetic surgery procedures. As fat grafting becomes increasingly popular, there is a potential trend toward supplementing or entirely replacing implants with fat [5][6][7].

Fat is a highly favorable substance for enhancing soft tissue due to its compatibility with the body and its abundance. When compared to implant placement, autologous fat transfer offers several advantages such as quicker recovery time and reduced risk of long-term complications. However, the main challenge in utilizing this technique lies in ensuring the durability of the transplanted fat cells[8]. For abovementioned reasons, this review aims to offer an updated and comprehensive summary of the utilization of autologous fat grafting (AFG) in breast augmentation surgery.

METHOD

A systematic search strategy was implemented for the MEDLINE database, utilizing a range of terms including breast augmentation, autologous fat graft, lipomodelling, and fat transfer, incorporating specific Medical Subject Headings (MeSH) terms. The exploration covered various aspects, including the application of autologous fat grafting in breast surgery, procedural details, and an examination of the associated benefits and drawbacks.

RESULTS AND DISCUSSION

A total of 56 articles were considered to be relevant for this review. The findings are conveyed in a narrative format, delineating the role of autologous fat grafting, including its procedures, advantages, disadvantages, and complications.

Breast Augmentation

Breast augmentation is a surgical procedure aimed at increasing breast size, usually accomplished through the insertion of implants or, in some cases, via fat transfer. A surgeon may have numerous options when it comes to choosing implants, selecting incisions, deciding on the pocket plane, and employing surgical techniques. And recently, factors like the utilization of autologous fat have broadened the range of options for surgeons to meticulously consider[9]. It is highly sought after in plastic surgery and remains one of the most frequently carried out procedures by plastic surgeons, with approximately 2.2 million procedures reported in 2022[10][11].

In breast augmentation, there are ongoing difficulties despite advancements in implant technology and surgical methods. The deficiency of breast tissue and subcutaneous fat can compromise cosmetic results, even though there may be successful volume and projection enhancement. This situation could lead to problems such as visibility of edges, rippling, and palpability, which raise concerns for both patients and surgeons. Incorporating primary fat grafting into breast augmentation became a valuable method for preserving a natural breast shape while increasing breast size[6].

Autologous Fat Grafting in Breast Augmentation

Autologous fat transfer, also known as fat grafting, is becoming a popular choice for breast augmentation. This procedure involves transferring the patient's own adipose tissue to enhance the breasts, has gained popularity as an alternative to breast implants[12]. Adipose tissue is widely used since it is readily accessible and devoid of immune response triggers or substantial donor site morbidity upon extraction. Its utilization may offer a versatile solution. In the realm of reconstruction, fat grafting serves as an adjunct to implant-based and autologous breast reconstruction, correcting hypoplastic breasts, congenital irregularities, and reconstructing

P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380

breasts after mastectomy[13]. In aesthetic breast surgery, fat grafting serves purposes in primary breast augmentation without the need for prosthetic devices, restoring volume post-implant removal, and concealing rippling or visible step-offs when simultaneously injected with breast implants. Moreover, fat grafting enhances cleavage appearance by diminishing the intermammary distance through grafting to the medial chest. The success of this technique largely depends on the skill of the surgeon [14][15][16][17].

Autologous Fat Grafting Procedure

Harvesting

There are multiple natural fat reservoirs in the body. It is recommended to use fresh fat tissue, as stored adipocytes may have decreased viability, potentially affecting the success of grafting. Typically, fat tissue was commonly taken from the patient's thigh and/or abdomen [18][19][20]. The success of autologous fat grafting procedures relies on the techniques employed in harvesting, processing, and injecting the graft. It is widely recognized that less invasive approaches to fat harvesting result in increased viability of adipocytes and enhanced graft survival. Different methods, such as vacuum aspiration, syringe aspiration, and surgical excision, have been proposed for fat harvesting. Manual aspiration typically involves a 10-mL syringe connected to a 3-mm diameter cannula with two holes. When opting for vacuum liposuction, using low-pressure suction is recommended to minimize adipocyte damage. Low negative-pressure lipoaspiration may yield fat faster compared to syringe aspiration, making it suitable for procedures requiring a large volume of fat such as breast surgery. Conventional liposuction's high vacuum pressures may cause damage to around 90% of adipocytes[21].

Processing

Fat transfer techniques have significantly progressed over the past two decades, moving from simple adipose tissue transfers to more advanced strategies involving composite fat-cell transplantation. Various techniques including sedimentation, filtration, washing, and centrifugation are utilized in the preparation of fat grafts. It is crucial to process the lipoaspirate as it contains collagen fibers, blood, and debris that can lead to inflammation at the recipient site. The obtained fat graft, referred to as the stromal-vascular fraction (SVF), includes a variety of cells, notably adipose-derived stem/stromal cells (ASCs), recognized for their significant contribution to graft outcomes. ASCs, which are a type of mesenchymal stromal/stem cells, promote new blood vessel formation and have the potential to develop into different types of cells[22].

Sedimentation helps optimizing the preservation of viable adipocytes through gravity separation or decantation. During this process, lipoaspirate settles into layers based on density, similar to centrifugation. Nevertheless, while sedimentation is effective in maintaining mesenchymal fat components, it falls short in isolating stromal components and stem cells, which could potentially impact graft survival[20]. Combining filtration and washing techniques optimizes the removal of contaminants and inflammatory components while preserving the viability of mature adipocytes and mesenchymal stem cells. Filtration methods, known for their efficiency, are commonly utilized in large-volume fat transfers[23].

Centrifugation by Coleman technique is a commonly advised technique for processing fat grafts before injection, usually conducted at 3,000 rpm for 3 minutes within the harvest syringe. This process aids in separating fat from substances that could potentially break down adipocytes[24][25]. Nevertheless, certain research indicates that centrifugation might not substantially improve fat graft viability, and surpassing 3,000 rpm could result in heightened adipocyte mortality. Research indicates that higher speeds during centrifugation may result in increased fluid portion, reduced tissue volume, and increased oil portion which could potentially harm adipocytes[26][27][28]. Selecting an ideal processing method is vital for maximizing viable cells and improving the engraftment and long-term retention of fat. Precautions during processing are crucial to prevent contamination, air exposure, and mechanical damage to maintain adipocyte survival[18].

Injection

Various viewpoints exist regarding the locations for fat placement, such as subcutaneous, sub-glandular, intraglandular, or retropectoral

P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380

spaces. The decision is influenced by factors like blood supply and aesthetic objectives. Subcutaneous space is a viable site for fat grafting due to its natural affinity for adipose tissue growth; nevertheless, it may not provide sufficient space to contain ample lipoaspirates required for augmentation. On the other hand, the retromammary and retropectoral spaces offer more capacity and are commonly utilized in breast augmentation procedures involving implants. The retromammary space was initially described as a primary plane in implant-based breast augmentation and continues to be frequently employed[29].

Studies have shown that it is important to inject small amounts of fat at different depths in the tissue during the withdrawal of the cannula, avoiding excessive pressure and overcrowding. It is crucial to avoid delivering a large amount of fat at once to prevent poor blood supply and fat necrosis. The targeted area should be slightly overfilled to accommodate partial absorption but not excessively to cause inadequate blood supply. Additionally, it's important not to deposit fat in the same tunnel multiple times; instead, a different plane in that location should be utilized[21].

The fat transfer is performed through a small incision matching the cannula diameter at the affected anatomical region. The use of smaller gauge cannulas aims to minimize trauma, reducing potential risks like bleeding, hematoma formation, and inadequate graft oxygen diffusion. It's recommended to administer the fat in multiple small-volume sessions rather than in a single injection due to longer ischemic time at the center of the graft where revascularization begins from the periphery. The volume of injected fat typically ranges from 50 to 150 mL per breast, with slight overcorrection advised due to postoperative resorption. Mega-volume fat grafting involves transplanting over 300 mL, and repeated sessions may be spaced 1 to 3 months apart[18].

Advantages of Autologous Fat Grafting

Natural Results

Patients who are not suitable for prosthetic implants, experiencing issues with implant reconstruction, wishing to avoid the risks of flap-based reconstruction, or deemed high-risk for free-tissue transfer may choose to undergo fat transfer procedures. This method has the potential to yield a natural appearance and feel through the administration of autologous fat grafting typically to specific regions of the breast[30][31]. Importantly, fat grafting yields symmetrical outcomes between the augmented breast and its contralateral counterpart. Another notable advantage is the possibility of simultaneous liposuction during the procedure, allowing for effective contouring and shaping of surrounding areas[32]. Moreover, the efficacy of this procedure was affirmed by a meta-analysis evaluating satisfaction rates, revealing substantial figures of 94.3% for patient satisfaction and 95.7% for plastic surgeon satisfaction during a follow-up period of 1.9 and 1.8 years, respectively[33].

Individuals with limited subcutaneous fat or breast tissue may consider integrating composite breast augmentation, which combines AFG with primary breast augmentation using implants. This approach offers advantages such as improved implant coverage and concealment of implant edges. It was demonstrated from a study by Groen et al., that AFG for cosmetic breast augmentation, whether composite or not, shows remarkably high satisfaction rates among patients (92%) and surgical teams (89%). This research supports AFG as a practical method to enhance or replace implant-based breast augmentation, conceal the implant, achieve aesthetically-pleasing outcomes, and intensify satisfaction for patients and surgeons[16].

Fewer Complications

Graf et al reported an event of rupture of breast implant in 26.9% of the participants and 19.2% experienced capsular contracture, thus compelled them to remove their implant and convert it to fat graft augmentation[34]. Summa et al., 13-year study revealed that when comparing fat grafting and implant surgery as standalone techniques, the data indicated a notably superior long-term outcome with fat grafting (80% vs. 69% satisfaction). Notably, patients in the implant group experienced higher complication rates, with 26% reporting implant-related complications. This potentially explains the need for more procedures to achieve symmetry in this cohort. Conversely, those treated with fat grafting encountered an 18% complication rate which could be effectively managed conservatively[35].

P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380

Cost-effectiveness

Fat grafting for breast augmentation tends to be associated with higher costs and typically necessitates multiple procedures to attain the desired size and contour[36]. However, a recent study comparing the cost-effectiveness of fat transfer in contrast to implant-based reconstruction found that although fat transfer is initially more costly, it demonstrates greater cost-effectiveness over the medium and long term (10 and 30 years). This is attributed to a reduced need for subsequent surgeries, contributing to its overall economic advantage[37][38]. Autologous fat grafting has increasingly become a valuable option, especially for individuals seeking to avoid implants or encountering issues with implant-based procedures. In comparison to other surgical alternatives for addressing breast asymmetry, fat transfer emerges as a more economical choice, readily accessible to patients[39].

Disadvantages of Autologous Fat Grafting

Volume Limitations

There is widespread agreement that small-volume grafting is repeatable and foreseeable; the larger the volume transferred, the less predictable it becomes. Excessive injection volumes of fat grafts may lead to central necrosis in vivo, resulting from inadequate diffusion of essential nutrition and insufficient neo-angiogenesis. Fat grafting less than 100 mL is considered small-volume; whereas large-volume grafting spans from 100 to 300 mL and mega volume grafting exceeds 300 mL per breast. Outcomes for breast augmentation also showed a significant correlation with the total amount of injected fat. In the past, there were constraints in the maximum transfer volumes for breast fat grafting, often limited to 200 mL per stage to reduce fat necrosis and improve graft success. Nowadays, advancements in external tissue expansion, notably using devices like the Brava, have extended this limit. Studies indicate that successfully grafted volumes of up to 300 mL per breast in a single operation are achievable through preoperative and postoperative application of external suction forces with Brava, resulting in higher graft survival rates (up to 70 to 80%).

This advancement has improved autologous fat graft efficiency by enhancing the vascularity of recipient tissue and increasing blood supply to grafted fat for both reconstructive and aesthetic purposes[14][40]. Generally, fat grafting has been showing considerable cosmetic improvement in patients with small breasts through two or three sessions of fat grafting with sufficient adipose deposits. Patients experiencing a subsequent round of fat transplantation displayed a notable enhancement in cosmetic outcomes, attributed to improved vascularization stemming from the survival of previously transplanted fat tissue[41].

There are fundamental principles and concepts to comprehend large-volume fat grafting for augmentation or reconstruction. These include the graft-to-capacity ratio, ideal injection plane, stromal vascular fraction (SVF), and external soft tissue expansion. A primary concern associated with large-volume fat grafting is the potential occurrence of fat necrosis, making it crucial to consider these principles to minimize risks. Studies have shown that autologous fat grafting exceeding 100 mL per breast can be safe and successful when these principles are followed. However, determining the optimal volume for injection depends on the original breast volume and the graft-to-capacity ratio, making further prospective studies essential to validate long-term success[42].

Variable Retention Rates

Autologous fat grafting presents a significant challenge due to uncertainties surrounding the duration of grafted fat. Assessing AFG's efficacy involves examining the retention volume and its integration after injection using imaging techniques, with volumes ranging from 30% to 60% for breast procedures. Various factors such as fat content, processing methods, injection techniques, BMI, and menstrual cycle phase can influence the volume gain[29][34,43,44].

Centrifugation and slow injection are supported as methods that lead to higher retention rates. The use of a gradual fat injection technique has been found to produce lower shear stress compared to rapid injection, which improves the viability of fat grafts during preparation and injection[45][46]. Larger volumes of grafted fat also tend to last longer, stabilizing around 4-8 months post-grafting and persisting for 5 to 6 years. Choi et al.'s proposal emphasizes

P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380

that fat retention depends on both time and volume; higher volumes lead to quicker stabilization [47][44,48]. A study conducted by Abboud et al measured 80 patients who had breast implant removal and converted to fat which was grafted with a volume range of 300-600 ml experienced resorption around 40.6% at 6 months postoperatively[49]. Special attention is needed for megavolume AFG, which involves 300 cc or more per breast, in order to prevent fat necrosis. Innovative solutions have been suggested to address concerns regarding the survival rate of large-volume fat grafts in a restricted breast space. These include creating additional space through fibrous band release and tunnel creation, similar to the Brava system, which facilitated the placement of large-volume fat with approximately 500 mL per side in a single-session fat volume (increases of 2 to 2.5-cup sizes). The advancements are attributed to highly purified fat processing and additional space creation, providing a resolution for mega-volume breast augmentation challenges in one session while ensuring stable outcomes and optimal size[40] [50][51].

Volume retention calculation has imperfections, considering unknown fluid percentages in initially injected fat and factors like patient weight changes. Breast augmentation with AFG typically involves 1 to 5 sessions, where the sustainability and uptake of transplanted adipocytes are influenced by various variables. Patient weight stability plays a crucial role; post-surgery weight loss decreases transferred fat volume, while weight gain may positively affect follow-up session resorption rates [52].

Complications

Despite its effectiveness, autologous fat grafting has certain considerations. Complications in fat grafting for breast procedures fall into categories of donor site, recipient area, and systemic concerns, which are influenced by the surgical approach. Early post-procedural issues (within 4 weeks) may entail infections (0.6%) at the harvesting or grafted sites, ranging from mild surface-level infections to severe abscesses requiring drainage procedures. Late-onset complications occurring more than 4 weeks after the procedure may consist of common issues in radiologic changes, such as cysts formation; which can be effectively addressed through drainage procedures., calcifications, and fat necrosis which are then summarized in Table 1[53][54]. Radiologic changes in breasts following fat grafting are crucial to monitor, as initial concerns about potential breast malignancy obstruction led to the prohibition of fat grafting, with only a small percentage (3.2%) may necessitate additional procedures like biopsies. This indicates that the majority of radiographic changes associated with autologous fat grafting can be differentiated from true malignancies[32][53].

Table 1. Summary of pooled analysis[53].

Complications	Rate % (95% CI)
Infection	0.6 (0.3–1.0)
Hematoma	0.5 (0.1-1.0)
Seroma	0.1 (0.0-0.3)
Palpable cysts	2.0 (0.26-3.8)
Radiologic changes	
Oil cysts	6.5 (3.7-9.2)
Calcifications	4.5 (2.1-6.9)
Fat necrosis	1.2 (0.5-1.8)

Note: CI, Confidence interval

However, concerns persist regarding the potential risk of breast cancer linked to fat transfer for breast augmentation. Scientific investigations have suggested that transplanted preadipocytes and mature adipocytes might have potential carcinogenic effects in the breast, possibly attributed to the local estrogen production through stromal-epithelial interactions involving adipocytes' aromatase or adipokines. Furthermore, a recent systematic review has refuted these claims on patients who have undergone autologous fat transfer for breast augmentation after lumpectomy or mastectomy. The study found no indication of any increase in local recurrence of breast cancer even after 10 years[18][55]. Another research by Orbay et al concluded that fat grafting is considered safe for postmastectomy and oncologic breast reconstruction. Nevertheless, it is advisable to be cautious when utilizing fat grafts enriched with adipose-derived stem cells until cancer remission is firmly established. Individuals opting for autologous fat transfer should undergo baseline mammography and regular screening, in addition to being educated in proper breast self-examination[56].

P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380

CONCLUSION

AFG treatment may hold the potential to substitute the need for implants in breast augmentation. Utilizing fat grafting offers several advantages: a natural appearance, biocompatible, cost-effective, and can be sourced from various donor sites in the human body suitable for fat harvesting. Another advantage is the ability to repeat fat grafting procedures at specific intervals. Furthermore, the lipo-contouring of the donor site may be seen as a cosmetic benefit, making the procedure attractive for patients. However, fat grafting may possess challenges in volume limitation and volume retention rates. And potential complications may be arising such as infections and cyst formation. The review emphasizes the need for skilled surgeons, comprehensive patient assessment, and adherence to recommended guidelines to ensure the success and safety of AFG procedures. Additionally, ongoing research and the establishment of international standards are essential to further validate the efficacy and safety of AFG in breast augmentation surgery.

Correspondence regarding this article should be addressed to:
Aryunidya Asmaradianti. Faculty of Medicine, Universitas Airlangga. Jl. Mayjen Prof. Dr. Moestopo No.47, Surabaya, East Java, 60115, Indonesia. E-Mail: aryunidya.asmaradianti-2018@fk.unair.ac.id
aryunidya@gmail.com

ACKNOWLEDGEMENT

We thank the authors of articles included in this review for the advancement of science.

REFERENCES

1. International Society of Aesthetic Plastic Surgery. *Aesthetic/cosmetic procedures* performed in. 2021;1–57. Available from: https://www.isaps.org/discover/about-isaps/global-statistics/reports-and-press-releases/
2. Gentile P, Sterodimas A, Calabrese C, De Angelis B, Trivisonno A, Pizzicannella J, et al. Regenerative application of stromal vascular fraction cells enhanced fat graft maintenance: clinical assessment in face rejuvenation. *Expert Opin Biol Ther* [Internet]. 2020;20(12):1503–13. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85090142029&doi=10.1080%2F14712598.2020.1815703&partnerID=40&md5=f80b3cd19912ba2980c5bdcf0819b8f8
3. Abboud MH, Dibo SA. Immediate Large-Volume Grafting of Autologous Fat to the Breast Following Implant Removal. *Aesthet Surg J. 2015 Sep*;35(7):819–29.
4. Eaves III F, Nahai F. Anaplastic large cell lymphoma and breast implants: FDA report. *Aesthet Surg J* [Internet]. 2011;31(4):467–8. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-79955874660&doi=10.1177%2F1090820X11407872&partnerID=40&md5=be88d38a36f0e415215df95a12bda747
5. Hidalgo DA, Sinno S. Current Trends and Controversies in Breast Augmentation. *Plast Reconstr Surg*. 2016;137(4):1142–50.
6. Salibian AA, Frey JD, Bekinz JM, Choi M, Karp NS. Fat Grafting and Breast Augmentation: A Systematic Review of Primary Composite Augmentation. *Plastic and reconstructive surgery-global open*. 2019;7(7).
7. Bayram Y, Zor F, Karagoz H, Kulahci Y, Afifi AM, Ozturk S. Challenging breast augmentations: The influence of preoperative anatomical features on the final result. *Aesthet Surg J*. 2016;36(3):313–20.
8. Chen CL, Shore AD, Johns R, Clark JM, Manahan M, Makary MA. The impact of obesity on breast surgery complications. *Plast Reconstr Surg*. 2011;128(5):395–402.
9. Heidekrueger PI, Sinno S, Hidalgo DA, Colombo M, Broer PN. Current Trends in Breast Augmentation: An International Analysis. *Aesthet Surg J*. 2018;38(2):133–48.
10. International Society of Plastic Surgery (ISAPS). *Plastic surgery statistics: global plastic surgery statistics for the year 2022*. 2023;1–56. Available from: www.isaps.org
11. Denney BD, Cohn AB, Bosworth JW, Kumbla PA. Revision Breast Augmentation. *Semin Plast Surg*. 2021;35(02):98–109.
12. Abu-Ghname A, Perdanasari AT, Reece EM. Principles and Applications of Fat Grafting in Plastic Surgery. *Semin Plast Surg* [Internet]. 2019;33(3):147–54. Available from: https://www.scopus.com/inward/record.

P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380

uri?eid=2-s2.0-85070359308&doi=10.1055%2Fs-0039-1693438&partnerID=40&md5=ed1154ac3d76422d09cfbd884a1781e1
13. Juhl AA, Redsted S, Engberg Damsgaard T. Autologous fat grafting after breast conserving surgery: Breast imaging changes and patient-reported outcome. *Journal of Plastic, Reconstructive & Aesthetic Surgery* [Internet]. 2018;71(11):1570–6. Available from: https://www.sciencedirect.com/science/article/pii/S1748681518302973
14. Davis MJ, Perdanasari AT, Abu-Ghname A, Gonzalez SR, Chamata E, Rammos CK, et al. Application of Fat Grafting in Cosmetic Breast Surgery. *Semin Plast Surg.* 2020;34(1):24–9.
15. Bayram Y, Sezgic M, Karakol P, Bozkurt M, Filinte GT. The use of autologous fat grafts in breast surgery: A literature review. *Arch Plast Surg* [Internet]. 2019;46(6):498–510. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85075237594&doi=10.5999%2Faps.2019.00416&partnerID=40&md5=ce0398cd65608177bb544fbb3d5079e4
16. Groen JW, Negenborn VL, Twisk D, Rizopoulos D, Ket JCF, Smit JM, et al. Autologous fat grafting in onco-plastic breast reconstruction: A systematic review on oncological and radiological safety, complications, volume retention and patient/surgeon satisfaction. *Journal of plastic reconstructive and aesthetic surgery.* 2016;69(6):742–64.
17. Seitz AJ, Asaad M, Hanson SE, Butler CE, Largo RD. Autologous Fat Grafting for Oncologic Patients: A Literature Review. *Aesthet Surg J* [Internet]. 2021;41:S61–8. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85106626199&doi=10.1093%2Fasj%2Fsjab126&partnerID=40&md5=ceefcc7a0e8813684d43dd7b8826ed8a
18. Al Sufyani MA, Al Hargan AH, Al Shammari NA, Al Sufyani MA. Autologous fat transfer for breast augmentation: A review. *Dermatologic Surgery.* 2016;42(11):1235–42.
19. Fontes T, Brandão I, Negrão R, Martins MJ, Monteiro R. Autologous fat grafting: Harvesting techniques. *Annals of Medicine and Surgery* [Internet]. 2018;36:212–8. Available from: https://www.sciencedirect.com/science/article/pii/S2049080118302541
20. Shauly O, Gould DJ, Ghavami A. Fat Grafting: Basic Science, Techniques, and Patient Management. *Plast Reconstr Surg Glob Open.* 2022;10(3):E3987.
21. Simonacci F, Bertozzi N, Grieco MP, Grignaffini E, Raposio E. Procedure, applications, and outcomes of autologous fat grafting. *Annals of Medicine & Surgery* [Internet]. 2017 Aug;20:49–60. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85021284707&doi=10.1016%2Fj.amsu.2017.06.059&partnerID=40&md5=cce54fa349df9f510a9f3f80f71aafa0
22. Moustaki M, Papadopoulos O, Verikokos C, Karypidis D, Masud D, Kostakis A, et al. Application of adipose-derived stromal cells in fat grafting: Basic science and literature review. *Exp Ther Med* [Internet]. 2017;14(3):2415–23. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85026652684&doi=10.3892%2Fetm.2017.4811&partnerID=40&md5=e9e2b36d27b3e6592c0139b731f5cc2d
23. Xue EY, Narvaez L, Chu CK, Hanson SE. Fat Processing Techniques. *Semin Plast Surg.* 2020;34(1):11–6.
24. Coleman SR. Structural Fat Grafting. *Aesthet Surg J.* 1998;18(5):386–8.
25. Canizares O, Thomson JE, Allen RJ, Davidson EH, Tutela JP, Saadeh PB, et al. The effect of processing technique on fat graft survival. *Plast Reconstr Surg.* 2017;140(5):933–43.
26. Kurita M, Matsumoto D, Shigeura T, Sato K, Gonda K, Harii K, et al. Influences of centrifugation on cells and tissues in liposuction aspirates: Optimized centrifugation for lipotransfer and cell isolation. *Plast Reconstr Surg.* 2008;121(3):1033–41.
27. Ferraro GA, De Francesco F, Tirino V, Cataldo C, Rossano F, Nicoletti G, et al. Effects of a new centrifugation method on adipose cell viability for autologous fat grafting. *Aesthetic Plast Surg.* 2011;35(3):341–8.
28. Hoareau L, Bencharif K, Girard AC, Gence L, Delarue P, Hulard O, et al. Effect of

P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380

centrifugation and washing on adipose graft viability: A new method to improve graft efficiency. *Journal of Plastic, Reconstructive and Aesthetic Surgery* [Internet]. 2013;66(5):712–9. Available from: http://dx.doi.org/10.1016/j.bjps.2012.12.033

29. Li B, Quan YP, He YF, He YF, Lu F, Liao YJ, et al. A Preliminary Exploratory Study of Autologous Fat Transplantation in Breast Augmentation with Different Fat Transplantation Planes. *Front Surg.* 2022;9.
30. Stark RY, Mirzabeigi MN, Vonderhaar RJ, Bucky LP. Utilizing large volume fat grafting in breast reconstruction after nipple sparing mastectomies. *Gland Surg* [Internet]. 2018;7(3):337–46. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85048060174&doi=10.21037%2Fgs.2018.05.01&partnerID=40&md5=82f0137c841f18c4186b9ad85a8123cb
31. Lam JS, Walters JA, Khoobehi K. Multi-stage fat grafting for total breast reconstruction after mastectomy. *Annals of Breast Surgery.* 2019;3:16–16.
32. Delay E, Guerid S. The Role of Fat Grafting in Breast Reconstruction. *Clin Plast Surg* [Internet]. 2015;42(3):315–23. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84937524604&doi=10.1016%2Fj.cps.2015.03.003&partnerID=40&md5=c806ee162fef76abc9d7ea2ce3089902
33. Krastev T, Van Turnhout A, Vriens E, Smits L, Van Der Hulst R. Long-term Follow-up of Autologous Fat Transfer vs Conventional Breast Reconstruction and Association with Cancer Relapse in Patients with Breast Cancer. *JAMA Surg.* 2019;154(1):56–63.
34. Graf RM, Closs Ono MC, Pace D, Balbinot P, Pazio ALB, de Paula DR. Breast Auto-augmentation (Mastopexy and Lipofilling): An Option for Quitting Breast Implants. *Aesthetic Plast Surg.* 2019 Oct;43(5):1133–41.
35. di Summa PG, Osinga R, Sapino G, Glen K, Higgins G, Tay S, et al. Fat grafting versus implant-based treatment of breast asymmetry, a single surgeon experience over 13 years: A paradigm shift? *Gland Surg.* 2021;10(6):1920–30.
36. Rosing JH, Wong G, Wong MS, Sahar D, Stevenson TR, Pu LLQ. Autologous fat grafting for primary breast augmentation: A systematic review. *Aesthetic Plast Surg.* 2011;35(5):882–90.
37. Wederfoort JLM, Voeten N, Smeins NNPM, Hommes JE, Essers BAB, van der Hulst RRWJ, et al. A Dutch randomized controlled study shows autologous fat transfer with pre-expansion is more cost-effective in the long term than implants. *Journal of Plastic, Reconstructive and Aesthetic Surgery* [Internet]. 2023; 84:398–412. Available from: https://doi.org/10.1016/j.bjps.2023.06.013
38. Shaaban B, Guerrero D, De La Cruz C, Kokai L. Fat grafting in autologous breast reconstruction: applications, outcomes, safety, and complications. *Plast Aesthet Res.* 2023;10.
39. Spear SL, Coles CN, Leung BK, Gitlin M, Parekh M, Macarios D. The safety, effectiveness, and efficiency of autologous fat grafting in breast surgery. *Plast Reconstr Surg Glob Open.* 2016;4(8):1–11.
40. Khouri RK, Khoari RK, Rigotti G, Marchi A, Cardoso E, Rotemberg SC, et al. Aesthetic applications of brava-assisted megavolume fat grafting to the breasts: A 9-year, 476-patient, multicenter experience. *Plast Reconstr Surg.* 2014;133(4):796–807.
41. Katzel EB, Bucky LP. Fat Grafting to the Breast: Clinical Applications and Outcomes for Reconstructive Surgery. *Plast Reconstr Surg.* 2017 Nov;140(5S Advances in Breast Reconstruction):69S-76S.
42. Maurice Y Nahabedian. Large-Volume Autologous Fat Grafting to the Breast. *Aesthet Surg J* [Internet]. 2021;41(Supplement_1):S16–S24. Available from: https://academic.oup.com/asj/article/41/Supplement_1/S16/6277490#google_vignette
43. Groen JW, Negenborn VL, Twisk JWR, Ket JCF, Mullender MG, Smit JM. Autologous Fat Grafting in Cosmetic Breast Augmentation: A Systematic Review on Radiological Safety, Complications, Volume Retention, and Patient/Surgeon Satisfaction. *Aesthet Surg J.* 2016 Oct;36(9):993–1007.
44. Shuchun Hu HX. Volume retention rate after breast autogenous fat grafting and related influencing factors: a systematic review and meta-analysis. *Journal of Plastic, Reconstructive &Aesthetic Surgery* [Internet]. 2023; Available from:

P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380

https://www.sciencedirect.com/science/article/pii/S1748681523007829
45. Strong AL, Cederna PS, Rubin JP, Coleman SR, Levi B. The Current state of fat grafting: A review of harvesting, processing, and injection techniques. *Plast Reconstr Surg.* 2015;136(4):897–912.
46. Vyas KS, Vasconez HC, Morrison S, Mogni B, Linton S, Hockensmith L, et al. Fat Graft Enrichment Strategies: A Systematic Review. *Plast Reconstr Surg.* 2020;145(3):827–41.
47. Choi M, Small K, Levovitz C, Lee C, Fadl A, Karp NS. The volumetric analysis of fat graft survival in breast reconstruction. *Plast Reconstr Surg* [Internet]. 2013;131(2):185–91. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84873286345&doi=10.1097%2FPRS.0b013e3182789b13&partnerID=40&md5=41425ca861278fe7ec7d4648a0f5b63a
48. Tahseen H, Fayek M, Emara D, Taha AA. Implant to Fat: A Breast Augmentation Technique Validated by BREAST-Q. *Plast Reconstr Surg Glob Open.* 2020;1–5.
49. Abboud MH, Dibo SA. Immediate large-volume grafting of autologous fat to the breast following implant removal. *Aesthet Surg J.* 2015;35(7):819–29.
50. Khouri RK, Rigotti G, Cardoso E, Biggs TM. Megavolume autologous fat transfer: Part II. Practice and techniques. *Plast Reconstr Surg.* 2014;133(6):1369–77.
51. Hsiao CW, Zavala A, Shiau JP, Hsiao KY, Hsiao YW, Hsieh HY. Safety and Effectiveness of Single Session Mega Volume Fat Grafting for Breast Augmentation: A Space-Creating Concept and Clinical Experiences. *Aesthet Surg J.* 2022 Aug;42(9):NP579–88.
52. Moak TN, Ebersole TG, Tandon D, Tenenbaum M. Assessing Clinical Outcomes in Autologous Fat Grafting: A Current Literature Review. *Aesthet Surg J* [Internet]. 2021;41: S50–60. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85106580454&doi=10.1093%2Fasj%2Fsjab148&partnerID=40&md5=fffeacbd0e090649d66a1cfc9d34ccae
53. Ørholt M, Larsen A, Hemmingsen MN, Mirian C, Zocchi ML, Vester-Glowinski P V, et al. Complications after Breast Augmentation with Fat Grafting: A Systematic Review. *Plast Reconstr Surg.* 2020 Mar;145(3):530e–7e.
54. Hanson SE, Kapur SK, Hwang RF, Dryden MS. Autologous fat grafting in breast reconstruction: implications for follow-up and surveillance. *Gland Surg.* 2021;10(1):487–93.
55. Petit JY, Maisonneuve P, Rotmensz N, Bertolini F, Rietjens M. Fat Grafting after Invasive Breast Cancer: A Matched Case-Control Study. *Plast Reconstr Surg.* 2017;139(6):1292–6.
56. Orbay H, Hinchcliff KM, Charvet HJ, Sahar DE. Fat graft safety after oncologic surgery: Addressing the contradiction between in vitro and clinical studies. *Plast Reconstr Surg.* 2018;142(6):1489–99.

P-ISSN 2089-6492; E-ISSN 2089-9734 | DOI: 10.14228/jprjournal.v12i1.380