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Cosmetic

Histological Properties of Adipose Tissue as an Autologous Tissue Filler Harvested from Different Donor Areas and Impact of Centrifugation

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Background: As a burgeoning technique in reconstructive and aesthetic surgery, lipofilling's success is hindered by the unpredictability of graft integrity and quality. This study addresses the critical need to enhance consistency and reproducibility by exploring the clinical utility of adipose tissue from specific body areas, considering the influence of patient-specific factors and mechanical processing on fat graft integrity and morphology.

Methods: In a prospective, randomized, single-blind study, 52 patients undergoing surgical reconstruction due to significant deformities were enrolled. Lipoaspiration from four areas was performed. Adipose tissue was compared using five parameters of tissue damage and 10 parameters of graft integrity, assessed immediately postcollection and after centrifugation. The study aimed to evaluate the structural integrity and clinical applicability of adipocytes.

Results: Morphological assessment revealed no significant differences in adipose tissue quality across donor sites, suggesting consistent graft quality regardless of the harvesting location. Centrifugation induced more morphological damage than noncentrifuged samples, but the overall graft integrity was maintained due to increased cell density. Higher graft acceptance parameters were noted in noncentrifuged samples compared with centrifuged ones.

Conclusions: Despite centrifugation-induced morphological changes, adipose tissue integrity remains relatively unaffected, supporting a flexible approach to donor site selection. The consistent quality of adipose tissue underscores the potential for autologous fat transplantation across various clinical scenarios. Optimizing graft processing techniques is crucial for enhancing the predictability and efficacy of lipofilling. *(Plast Reconstr Surg Glob Open 2024; 12:e5912; doi: 10.1097/GOX.0000000000005912; Published online 19 June 2024.)*

INTRODUCTION

In reconstructive and aesthetic surgery, lipofilling stands out for its ability to utilize autologous tissue, despite challenges in achieving consistent graft integrity and quality, which can lead to unpredictable outcomes.[1–5] Efforts to improve lipofilling outcomes have focused on refining the collection, processing, and administration of adipose tissue, considering factors such as donor site selection, patient body mass index (BMI), and fat processing methods as crucial determinants of graft success.[6–11] Although existing literature suggests uniform adipose tissue integrity across various donor sites,[12,13] these studies primarily assess short-term cell integrity without fully addressing long-term tissue integrity or the effect of mechanical processing techniques.

This research aims to fill these gaps by conducting an in-depth evaluation of adipose tissue from different donor sites to ascertain its quality and integrity as a graft filler, both immediately after harvest and following processing. Through this analysis, the study seeks to enhance the strategic selection of donor sites and optimize processing methods, thus advancing lipofilling's predictability and effectiveness. By examining the interplay between donor site characteristics and processing techniques, this

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investigation will provide critical insights into improving lipofilling practices, contributing to a more reliable and patient-centric approach.

MATERIALS AND METHODS

A prospective, randomized, single-blind study was conducted between July 2015 and February 2016. Authors obtained a positive opinion from the Bioethics Committee at the Mother's Poland Memorial Hospital-Research Institute in Lodz, Poland. The study was conducted in individuals, who were selected for the surgical reconstructive treatment with autologous fat cell transplantation. The inclusion of patients in the study included the following criteria: lipoaspiration for all of the analyzed body areas: abdominal region (I), lumbar region (love handles) (II), thigh anteromedial surface (III), thigh posterolateral surface (breeches) (IV). The exclusion criteria were any chronic diseases or state after previous liposuction. Figure 1 shows a diagram of the way in which the groups were prepared to carry out the management and study of the harvested fat.

Surgical technique involved the standard therapeutic method of fat grafting, the Coleman method. Fat from the above areas was collected by manual syringe aspiration (10-mL syringes from BD, 3.0 mm Sforza and Tonnard cannulas, 20 cm long, super LuerLock from Tulip), after previously injecting the subcutaneous tissue with a solution of 0.9% NaCl with the addition of 1% lidocaine (10 mL per 500 mL), 10% sodium bicarbonate (10 mL per 500 mL), and adrenaline (1/4 ampoule per 500 mL) (Figs. 2 and 3). Lidocaine was intended to provide local tumescent infiltration anesthesia of the operated area. The adipose tissue aspirate was then prepared to create the final graft by processing, that is, using the Coleman method by centrifugation for 3 minutes at 3000 rpm (Figs. 4 and 5). The obtained autologous filler was then administered to the areas requiring correction in the form of a transplant.

For analysis, two samples containing 10 mL of excess fat aspirate were used from each of the donor areas, both immediately after collection (subgroup *a* of groups I–IV) and after processing by centrifugation (middle fraction) (subgroup *b* of groups I–IV), in the amount of 10 mL each. In other words, subgroup *a* acts as a comparative baseline to assess the impact of subsequent mechanical treatments on the tissue's morphological and integrity attributes. Subgroup *b* consists of the same set of adipose tissue samples from the four body areas, but these samples undergo additional processing through centrifugation before analysis, to evaluate the effects of this mechanical processing on tissue integrity. Freshly collected samples of adipose tissue fragments and lipoaspirate (10 mL) were immediately fixed in 10% neutral buffered formalin for 24 hours and embedded in a paraffin wax block.

The histological analysis of the middle layer consisting of centrifuged adipose tissue was performed in the department of pathology. Clinical usefulness of selected body areas, such as as donor sites for lipofilling, was assessed precisely by examining the morphological features of adipose tissue, determining the degree of tissue damage (group A: parameters of tissue damage 1–5), and describing the structural stability of the collected adipose tissue (group B: parameters of graft survival potential 6–15).[12] The study uses a comprehensive set of 15 parameters to ensure a thorough and multifaceted evaluation of adipose tissue's morphological characteristics and graft integrity, thereby providing a robust and detailed assessment of its clinical utility as an autologous filler. In detail, the following morphotic features of adipose tissue were assessed, determined in the study by appropriate parameters: Group A included parameters of tissue damage [parameter 1: necrosis; parameter 2: vacuolar degeneration of adipocytes; parameter 3: inflammatory infiltrates (Fig. 6A); parameter 4: fibrosis (Fig. 6B); parameter 5: hemorrhages (Fig. 6C)]. Group B included parameters of graft survival potential [parameter 6: preserved tissue fragments containing 10 adipocytes (Fig. 7A); parameter 7: preserved tissue fragments containing 100 adipocytes; parameter 8: damaged cell membranes in fragments (Fig. 7B); parameter 9: number of partitions damaged between two adipocytes; parameter 10: number of partitions damaged between three adipocytes; parameter 11: number of partitions damaged between a larger number of adipocytes; parameter 12: preserved vessels in fragments (Fig. 7C); parameter 13: average diameter of the adipocyte; parameter 14: average diameter of the smallest fragment; parameter 15: average diameter of the vacuole in the adipocyte; parameter 16: location of the vacuole in the adipocyte (central, pericentral, lateral)].[5,12] Each parameter was assessed using a simplified scale: – (none), + (minimal intensity), ++ (moderate intensity), and +++ (significant change), including specific statistical tests and software used.

In the study, the following statistical tests were employed using the Statistica 8.0 software: chi-square independence test (χ^2), test for difference of proportions, homogeneity of samples test, Spearman rank correlation coefficient with the significance test of the coefficient, chi-square test for normality distribution (χ^2), Wilcoxon test for comparing distributions of two characteristics in the case of

Takeaways

Question: How do different donor sites and the process of centrifugation impact the adipose tissue used in autologous fat grafting, and how can these findings enhance the lipofilling outcomes?

Findings: Morphological assessments of adipose tissue harvested from various body areas showed no significant differences in quality, indicating that graft quality is consistent regardless of the harvesting location. Although centrifugation induced morphological changes, the overall integrity and potential for intake remained largely unaffected, highlighting the importance of optimizing graft processing techniques.

Meaning: Autologous fat grafting can use adipose tissue from various donor sites, and although centrifugation alters tissue morphology, it does not significantly compromise graft viability.

Fig. 1. Schematic representation of group preparation for fat management and analysis.

correlated pairs of observations, and Pearson correlation coefficient along with its significance test. Dichotomous variables necessitated the use of nonparametric methods for analysis, whereas other methods were applied to analyze measurable parameters. The employment of both nonparametric and parametric methodologies allowed for a robust and nuanced analysis, accommodating the varied nature of the data and yielding insights that are both statistically significant and clinically relevant.

RESULTS

In this study, 112 patients were screened, 54 were initially enrolled, and 52 ultimately participated. The demographic composition was predominantly female patients (94.23%), with an average age of 39.6 years, detailed in Table 1. A comprehensive analysis involved 416 samples from four body areas per patient, divided equally before and after centrifugation. The investigation spanned multiple parameters to evaluate adipose tissue's morphological integrity for grafting.

Parameters assessing cellular damage revealed sporadic necrosis and vacuolar degeneration (parameters 1 and 2), with slight prevalence postcentrifugation and in certain areas, as detailed in Table 2 and Figures 8 and 9. Inflammatory infiltrates (parameter 3) and fat fibrosis (parameter 4) were common, differing across donor sites without significant impact from mechanical processing. Inflammatory infiltrates, labeled as parameter 3, were absent in only 10 participants within the study. Parameter

Fig. 2. Cannulas used for fat harvesting.

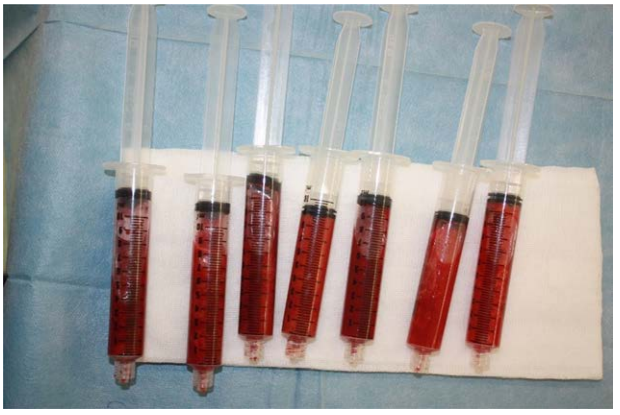

Fig. 3. Centrifugation of the harvested adipose tissue.

Fig. 4. Adipose tissue aspirate immediately after extraction.

Fig. 5. Adipose tissue aspirate after centrifugation.

4 (fat fibrosis) occurred in all patients examined. In only four patients, it was in one sample, and in six, it was in two samples. All others had fat fibrosis in more than two samples. Hemorrhages (parameter 5) showed variability, particularly in samples subjected to centrifugation, indicating processing-related stress. Parameter 5 (hemorrhages) was not detected in the samples of 10 patients. There were no patients with hemorrhages in all eight samples. Nine people had this parameter in only one of the groups. It can be seen that this was most common in group IIIb (thigh, anteromedial surface, fat subjected to centrifugation).

Graft integrity assessment underscored widespread preservation of adipose tissue structure, with parameter 6 (preserved tissue fragments with 10 adipocytes) universally observed. The occurrence of larger tissue fragments (parameter 7) and intact vascular structures (parameter 12) highlighted a robust potential for successful grafting, albeit with a notable reduction in mechanically processed samples. Parameter 7 was observed in only 14 of the patients and not in all eight groups of donor sites. Cell membrane and septum integrity (parameters 8–11) varied significantly with centrifugation, underscoring its impact despite a lack of significant correlation with graft integrity. Parameter 8 (damaged cell membranes in fragments) occurred in all groups and in almost all patients. Parameter 9 (septum damage between two adipocytes) occurred in all patients and groups. Parameter 10 (septum damage between three adipocytes) occurred in 30 of the examined subjects in all samples. Parameter 11 (septum damaged between more than three adipocytes) was absent in only two subjects, and it was seen least

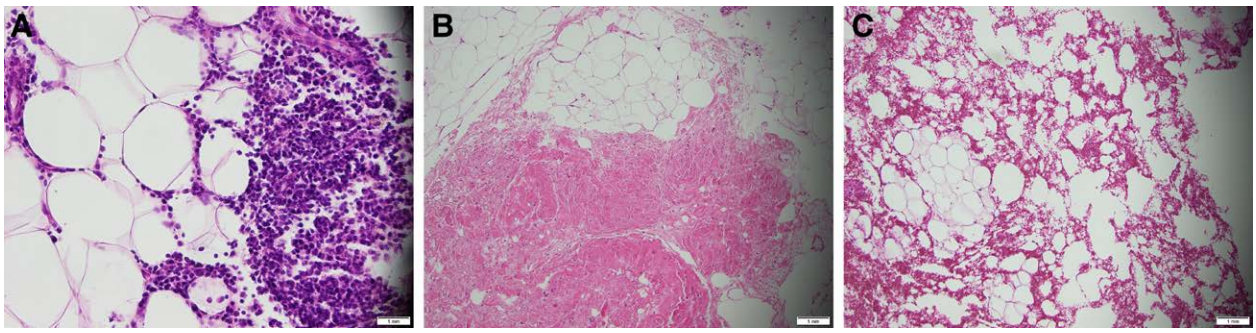

Fig. 6. Parameters of tissue damage detected in samples. A, Fragment of adipose tissue with diffuse inflammatory infiltrate consisting mainly of mature lymphocytes. Hematoxylin and eosin stain (H&E), original magnification ×400. B, Fragment of adipose tissue with extensive fibrosis and mild damage of the cell membranes. H&E, original magnification ×100. C, Fragments of adipose tissue with damaged cell membranes between adjacent adipocytes and extensive extravasation of erythrocytes (hemorrhage). H&E, original magnification ×100.

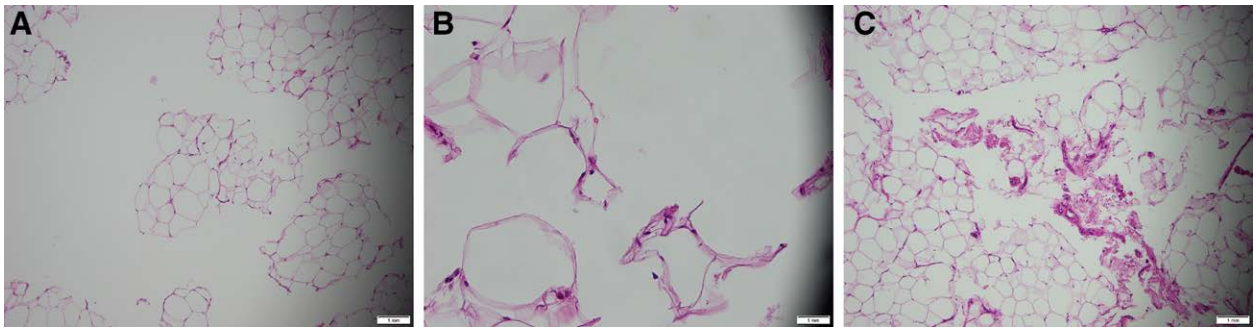

Fig. 7. Parameters of graft survival potential detected in samples. A, Fragments of adipose tissue of different size. Many of fragments with well-preserved cell membranes between adjacent adipocytes. H&E, original magnification ×100. B, Fragment of adipose tissue with extensive damage of the cell membranes between adjacent adipocytes. H&E, original magnification ×400. C, Fragments of adipose tissue of different size. In the central part of the image, there is an area rich in preserved blood vessels. H&E, original magnification ×100.

Table 1. Demographics of the Studied Population

Parameter	Data Arranged in Groups				
Age (y)	19–30	31–40	41–50	51–60	61–70
%	17.31	42.31	23.08	15.38	1.92
Body mass (kg)	50–60	61–70	71–80	81–90	
%	32.69	36.54	25	5.77	
Height (cm)	150–160	161–165	166–170	171–175	176–180
%	19.23	34.62	30.77	9.62	5.77
BMI, kg/m²	<18.5	18.5 ≤ 25	25 ≤ 30		>30
%	1.92	67.31	28.85		1.92

BMI, body mass index.

frequently in the IVa group and is much less common when fat samples were tested after collection without centrifugation.

Notably, mechanical processing distinguished the occurrence of preserved blood vessels (parameter 12), a crucial component for graft survival. Parameter 12 (preserved blood vessels in fragments) occurred very frequently—in 370 cases of 416 samples. Morphometric analyses, including the mean adipocyte diameter (parameter 13) and the size of the smallest adipocyte fragment (parameter 14), underwent significant shifts due to centrifugation, as elucidated through statistical tests, yet without definitive impacts on graft success. The value of the Kruskal–Wallis test for the average adipocyte diameter (samples subjected to centrifugation) is $H = 7.06$, $P = 0.06$; that is, individual areas do not differ statistically significantly. Parameter 14 (average diameter of the smallest fragment) with Wilcoxon pairs tests revealed significantly different distributions for all pairs in the groups without treatment and with centrifugation.

Overall, although centrifugation modified certain morphological aspects, the core integrity and structural integrity of the adipose tissue remained largely unaffected, affirming its suitability for grafting. The comprehensive

Table 2. Occurrence of the Parameters of Tissue Damage (Group A): Parameter 2 (Vacuolar Degeneration of Adipocytes), Parameter 3 (Inflammatory Infiltrates), Parameter 4 (Fat Fibrosis), and Parameter 5 (Hemorrhages) [Areas of the Body Subjected to Fat Aspirate Collection: I, II, III, IV, Condition before (a) and after (b) Centrifugation of the Fat Aspirate]

		Donor Site				
Parameter	Type of Sample	I	II	III	IV	Overall
2	a	1	2	0	0	3
	b	2	2	1	0	5
3	a	16	16	14	16	62
	b	12	17	17	10	56
4	a	37	31	37	29	134
	b	30	24	29	24	107
5	a	14	12	17	16	59
	b	21	21	26	26	94

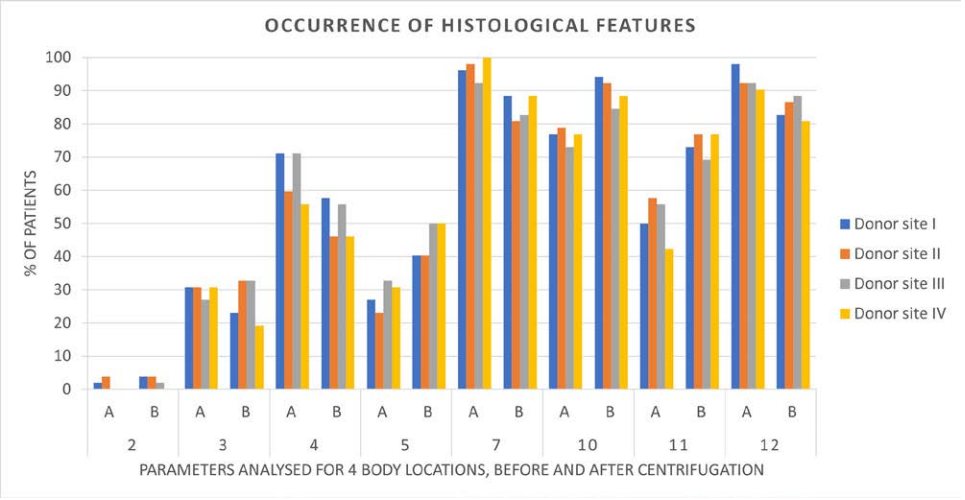

Fig. 8. Distribution of histological parameters across donor sites, before and after centrifugation; parameters of tissue damage (group A): parameter 2 (vacuolar degeneration of adipocytes), parameter 3 (inflammatory infiltrates), parameter 4 (fat fibrosis), and parameter 5 (hemorrhages) and parameters of graft survival potential (group B): parameter 7 (preserved tissue fragments containing 100 adipocytes), parameter 10 (septum damage between three adipocytes), parameter 11 (septum damaged between more than three adipocytes), and parameter 12 (preserved blood vessels in fragments); [body areas subjected to fat aspirate collection: I, II, III, IV, condition before (a) and after (b) centrifugation of the fat aspirate].

results, including statistical correlations and differences across donor sites and processing techniques, are summarized in Tables 3 and 4, providing a detailed insight into adipose tissue's behavior and potential in autologous fat grafting.

DISCUSSION

The presence of cells with undisturbed morphology determines the possibility of their use as an autologous tissue filler. The integrity of fat cells harvested in adipose tissue grafting has been assessed in many studies, analyzing various individual parameters suggesting the integrity of the preparation.[1,3,13–16] In the current work, it was concluded that known morphotic indicators of cell damage, but also morphotic indicators indicating the stability of adipose tissue, will be reliable determinants indicating the usefulness of fat graft as a tissue filler.

In this study, our investigative lens was primarily focused on the role and integrity of mature adipocytes within autologous fat grafts. This focused approach derives from the fundamental role adipocytes play in the immediate structural and volumetric outcomes of autologous fat transfer procedures. Adipocytes, constituting the bulk of the adipose tissue's cellular composition, are directly responsible for the graft's palpable volume and contouring properties. The survival rate of these cells post-transplantation is, therefore, a critical determinant of the graft's initial success and longevity. Moreover, mature adipocytes, due to their larger size and distinctive morphology, offer a more feasible parameter for histological and morphological assessment of graft integrity. The pathological changes such as necrosis, vacuolar degeneration, and membrane integrity are more conspicuously observed and quantified in mature adipocytes. Such morphotic features provide pragmatic endpoints for assessing the immediate

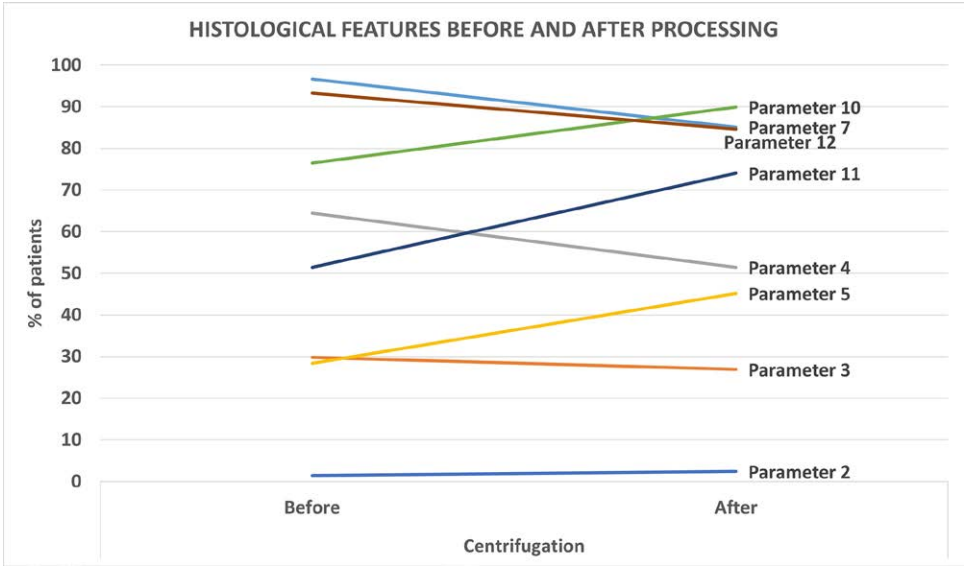

Fig. 9. Comparison of summarized histological parameters before and after centrifugation; parameters of tissue damage (group a): parameter 2 (vacuolar degeneration of adipocytes), parameter 3 (inflammatory infiltrates), parameter 4 (fat fibrosis), and parameter 5 (hemorrhages) and parameters of graft survival potential (group B): parameter 7 (preserved tissue fragments containing 100 adipocytes), parameter 10 (septum damage between three adipocytes), parameter 11 (septum damaged between more than three adipocytes), and parameter 12 (preserved blood vessels in fragments).

Table 3. Occurrence of Parameters of Graft Survival Potential (Group B): Parameter 7 (Preserved Tissue Fragments Containing 100 Adipocytes), Parameter 10 (Septum Damage between Three Adipocytes), Parameter 11 (Septum Damaged between More Than Three Adipocytes), and Parameter 12 (Preserved Blood Vessels in Fragments) (Body Areas Subjected to Fat Aspirate Collection: I, II, III, IV, Condition before (a) and after (b) Centrifugation of the Fat Aspirate)

		Donor Site				
Parameter	Type of Sample	I	II	III	IV	Overall
7	a	50	51	48	52	201
	b	46	42	43	46	177
10	a	40	41	38	40	159
	b	49	48	44	46	187
11	a	26	30	29	22	107
	b	38	40	36	40	154
12	a	51	48	48	47	194
	b	43	45	46	42	176

Table 4. Correlations among Parameters of Tissue Damage (Group A): Parameter 3 (Inflammatory Infiltrates), Parameter 4 (Fat Fibrosis), Parameter 5 (Hemorrhages), and Parameters of Graft Survival Potential (Group B): Parameter 7 (Preserved Tissue Fragments Containing 100 Adipocytes), Parameter 10 (Septum Damage between Three Adipocytes), Parameter 11 (Septum Damaged between More Than Three Adipocytes), and Parameter 12 (Preserved Blood Vessels in Fragments) (Spearman's Rank Correlation Coefficients: *r*, *P*)

		Parameter						
Correlation		3	4	5	7	10	11	12
Parameter	3	—	−0.13, $P = 0.74$	−0.09, $P = 0.81$	−0.22, $P = 0.59$	−0.04, $P = 0.90$	−0.11, $P = 0.78$	0.30, $P = 0.45$
	4	−0.13, $P = 0.74$	—	−0.66, $P = 0.06$	0.53, $P = 0.17$	−0.63, $P = 0.09$	−0.65, $P = 0.07$	**0.81, $P = 0.01$**
	5	−0.09, $P = 0.81$	−0.66, $P = 0.06$	—	**−0.80, $P = 0.01$**	0.56, $P = 0.14$	0.70, $P = 0.05$	**−0.81, $P = 0.01$**
	7	−0.22, $P = 0.59$	0.53, $P = 0.17$	**−0.80, $P = 0.01$**	—	−0.67, $P = 0.06$	**−0.82, $P = 0.01$**	0.61, $P = 0.10$
	10	−0.04, $P = 0.90$	−0.63, $P = 0.09$	0.56, $P = 0.14$	−0.67, $P = 0.06$	—	**0.84, $P = 0.008$**	**−0.81, $P = 0.01$**
	11	−0.11, $P = 0.78$	−0.65, $P = 0.07$	0.70, $P = 0,05$	**−0.82, $P = 0.01$**	**0.84, $P = 0.008$**	-	**−0.80, $P = 0.01$**
	12	0.30, $P = 0.45$	**0.81, $P = 0.01$**	**−0.80, $P = 0.01$**	0.61, $P = 0.10$	**−0.81, $P = 0.01$**	**−0.80, $P = 0.01$**	—

Boldface indicates $P < 0.01$.

outcome of the fat grafting procedure. Additionally, the historical precedence and extensive literature focusing on adipocyte integrity in fat grafting provide a robust framework for methodological and comparative analysis. It enables the study's findings to be contextualized within the broader scientific discourse, facilitating a more nuanced understanding of the specific conditions that favor adipocyte survival and, by extension, graft integrity.

However, it is acknowledged that regenerative cells, including preadipocytes and adipose-derived stem cells, play a pivotal role in the long-term integration, maintenance, and functional adaptation of the grafted tissue. These cell populations are instrumental in angiogenesis, immune modulation, and adipogenesis, contributing to the graft's durability and quality. The exclusion of these cellular components from the primary analysis was a strategic decision, rooted in the study's objective to provide a focused, in-depth understanding of the immediate post-transplantation phase, which predominantly reflects the fate of mature adipocytes. The delineation of this study's scope should not be misconstrued as a diminution of the regenerative cells' importance. Rather, it underscores a phased approach to dissecting the complex interplay of cellular components in fat grafting. Future investigations are warranted to elucidate the synergistic role of regenerative cells, exploring how these elements can be optimized alongside mature adipocytes to enhance the holistic success of autologous fat transfer procedures.

To ensure the validity of our findings, it is critical to consider the comprehensive healing processes postgrafting, beyond individual cell evaluation. Prior research, including Rohrich's colorimetric cell proliferation studies, indicated uniform adipocyte integrity across various donor sites without significant impact from centrifugation.[17] Similar findings were reported in smaller studies[18,19] and reinforced by Geissler et al,[10] who found no variance in adipocyte integrity based on donor site or patient BMI. Our extensive morphological assessment of adipose tissue broadens the scope of analysis, encompassing both tissue damage and structural integrity, presenting the graft as a holistic biological product. This approach revealed no notable differences in tissue damage or graft stability across all tested regions, aligning with the theory that graft volume retention is directly related to the initial quantity of viable cells. These observations are consistent with earlier findings,[10,17,18] underscoring a lack of significant difference in adipocyte integrity or tissue quality due to donor site selection or the centrifugation process, thereby supporting the potential uniformity of adipose tissue use in lipofilling.

This study investigates the integrity and utility of adipose tissue in lipofilling, focusing on how factors affect adipocyte size both in situ and postextraction. Adipocyte size varies due to body area, health, age, and BMI, affecting cell size diversity. These variabilities are critical for understanding changes postliposuction. During lipoaspiration, adipocytes face stress that can alter their size and integrity, influenced by the cannula size and applied mechanical force. Smaller cannulas, thought to cause less trauma, may preserve cell integrity better but could prolong the procedure or require more fat harvesting passes, potentially increasing tissue trauma.

Centrifugation significantly impacts adipocyte size during lipoaspirate processing, aiming to purify fat by removing impurities but potentially harming cell integrity. This study analyzed lipoaspirate pre- and postcentrifugation to evaluate these impacts, emphasizing the need for a balance between purification and preserving viable adipocytes for graft success. Despite the absence of a universally accepted method for fat cleansing, this research utilized low-pressure syringes for collection and centrifugation for purification, aligning with methods that have been shown to maintain fat cell integrity similarly with or without mechanical treatment.[20–22] Previous studies, such as those by Rohrich et al[17] and Geissler et al,[10] have explored cell integrity post-centrifugation with varying outcomes, whereas work by Yin et al[23] using a water-jet device suggested that centrifugation does not necessarily reduce fat tissue integrity, challenging previous notions of centrifugation-induced cell damage.[24–26] Our work assessed both the parameters of damage to individual cells and the parameters describing the structural stability of the collected adipose tissue. The results of the above parameter sets demonstrate in detail the potential of adipose tissue to be used as a viable donor material for filling defects or for soft-tissue augmentation. To sum up, the results of the current study indicate that centrifugation causes a greater concentration of adipocytes (living and damaged) in the adipose tissue aspirate compared with a noncentrifuged sample, and therefore, the integrity of adipose tissue in the same volumes of centrifuged and noncentrifuged aspirate is similar. Therefore, despite a noticeable increase in damage to the structures of adipose tissue in the aspirate subjected to the centrifugation process, its survival (when comparing the same volume of centrifuged and noncentrifuged samples) is similar to that of noncentrifuged tissue due to the higher density of adipocytes. According to other works, its value is additionally increased by the higher content of biologically active elements (adipose derived stem cells and stromal vascular fraction) and the separation of pollutants.[27,28]

This study, while providing valuable insights into the integrity and clinical utility of adipose tissue as an autologous tissue filler, is not without its limitations. First, the patient cohort, predominantly female and within a specific age range, may limit the generalizability of the findings across a more diverse population. The study's conclusions might not be fully applicable to male patients or individuals outside the examined age and BMI parameters, potentially affecting the wider applicability of the results. The single-blind nature of the study, while methodologically sound, does not eliminate all potential biases. The surgeons' and pathologists' prior knowledge of the procedure and their expertise might inadvertently influence the graft handling and morphological assessments, respectively. Although efforts were made to standardize the evaluation criteria, subjective interpretations in morphological assessment are inevitable and could introduce variability in results. The study's focus on the immediate postoperative period, while providing crucial insights into early graft and adipocyte integrity, does not account

for long-term outcomes. The durability of the graft; the longevity of the adipocytes; and the role of regenerative cells, such as preadipocytes and adipose-derived stem cells, in the long-term integration and maintenance of the graft were not within the scope of this study. As such, the long-term aesthetic and functional outcomes, crucial for patient satisfaction and clinical success, remain unaddressed. Although the study makes significant strides in understanding the impact of donor site selection and processing methods on graft integrity, the findings are based on the specific techniques and protocols used, such as the Coleman method and manual syringe aspiration. Variations in technique, equipment, and operator skill are likely to influence the outcomes and, thus, the replicability of the results in different clinical settings.

CONCLUSIONS

The uniformity in adipose tissue quality across different sites supports its use in diverse clinical applications. Key indicators, such as adipocyte membrane integrity, vascular structure condition, and adipocyte cluster density, are essential for evaluating graft viability. This insight empowers surgeons to tailor donor site choices to patient preferences and anatomical suitability without compromising the graft's viability. Our study confirms that despite the structural changes caused by centrifugation, adipose tissue's integrity largely remains intact, allowing for versatile donor site selection without affecting graft quality.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

PATIENT CONSENT

Informed consent was obtained from all individual participants included in the study.

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ETHICAL APPROVAL

A positive opinion from the Bioethics Committee at the Mother's Poland Memorial Hospital-Research Institute in Lodz, Poland (No. 42/2016).

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