Mammographic Assessment of Fat Graft Retention Volume in Aesthetic Breast Cases: A Quantitative and Qualitative Tool

Ahmed Nawar[1], Waleed Reda[1], Ahmed Safwat[1], Sahar Mansour[2]
[1] Department of Plastic Surgery, Faculty of Medicine, Cairo University, Egypt
[2] Department of Radiology, Faculty of Medicine, Cairo University, Egypt

ABSTRACT

Introduction: *Fat grafting to the breasts has gained popularity for both aesthetic and reconstructive indications. Various refinements in the techniques of autologous fat grafting have been proposed, aimed to increase fat retention volume. However, assessment of fat graft survival has been mostly subjective, expensive or unavailable. This study aims to investigate the role of mammography as an objective tool for assessment of the fat retention volume in aesthetic cases.* ***Patients and Methods:*** *Patients who were indicated for aesthetic fat grafting to the breasts between December 2014 and July 2016 were included in this prospective study. Mammography was used to calculate the retention volume 3 months after fat grafting by subtracting the preoperative from the postoperative volumes. Areas of fat necrosis or oil cyst formation were also identified.* ***Results:*** *Fat grafting was performed to 49 breasts in 26 patients. The mean fat graft volume was 322cc, while the mean fat graft survival rate was 54% (range 37-67%) as assessed by mammography after 3 months. Six percent of breasts developed complications in terms of fat necrosis/oil cysts. There was also a positive correlation between the volume of fat graft injected and the fat graft survival rate.* ***Conclusion:*** *Mammography can be used as an objective tool for assessment of the quantity and quality of fat graft retention volume in aesthetic cases. Large volume fat grafting to the breasts may have high graft survival rates with few complications.*

Keywords: *Fat graft survival – mammography – autologous fat transfer – breast augmentation*

INTRODUCTION

Autologous fat grafting to enhance breast contour has gained popularity for both aesthetic and reconstructive indications, however the results are very much dependant on the protocol used [(1)]. Multiple studies have suggested refinements in the techniques used for harvesting, processing, and injection of fat[(2-6)]. These refinements aimed to increase the rate of fat graft survival, in addition to limiting the incidence of fat necrosis. Evaluation of these methods in terms of fat graft retention volume has been attempted by anthropometric measurements and photography, but this was found to be highly subjective. A reproducible and objective assessment is therefore necessary to evaluate the effectiveness of the different techniques in terms of fat graft survival [(6)].

Volumetric analyses using magnetic resonance imaging (MRI) and 3D surface scans have been found to be accurate in assessment of breast volume; however they are limited by expense and availability[(7)]. Mammography, on the other hand, is a readily available investigation frequently used for breast cancer screening and diagnosis. Several studies have been conducted to investigate different methods of mammographic evaluation of breast volume [(8-10)]. This study aims to investigate the use of mammography in the assessment of the quantity and quality of the retention volume after fat grafting to the breast for aesthetic purposes.

PATIENTS AND METHODS

All patients who were indicated for autologous fat grafting to the breast for aesthetic purposes between December 2014 and July 2016 were enrolled in this prospective case series. Exclusion criteria included patients with known or treated breast cancer, suspicious findings upon preoperative mammography, breasts requiring mastopexy, post traumatic/burn defects, unavailability of donor fat sites, heavy smokers and uncontrolled medical conditions or autoimmune disease.

Preoperative Workup:

After thorough history taking, all patients were subjected to breast examination for detection of any masses; and for the assessment of size, breast mound dimensions, shape, ptosis, asymmetry, and skin quality. Particular attention was directed towards identifying areas with volume deficit. Suitable fat donor areas were assessed for harvesting after discussion with the patient. Mammography was performed to detect any suspicious masses or calcification, and to calculate the preoperative breast volume in the craniocaudal view using the equation suggested and recommended by Kalbhen et al.[9]:

$$V(ml) = 0.785 \times H(cm) \times W(cm) \times C(cm)$$

where V is the breast volume, H is the breast height, W is the width and C is the compression thickness between the two plates of the mammogram machine in the craniocaudal view (Fig. 1).

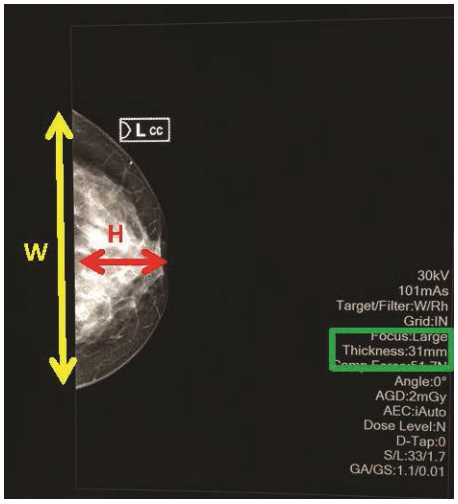

Fig. (1): Calculation of breast volume. W=width(cm), H=height(cm), Compression thickness (cm) is provided by the mammography machine in the craniocaudal view.

Preoperative Markings:

This started with marking the midsternal line, breast meridian, breast mound/base, and suprasternal notch-nipple line. The breast mound was then divided into quadrants centred on the nipple areolar complex to assess volume deficits, and to facilitate intraoperative fat graft allocation. Areas of fat to be harvested were also marked in preparation for liposuction.

Fat Harvesting:

Under a general anaesthetic, the procedure started with tumescent liposuction of the donor areas. For this we used a 3mm multihole harvesting canula connected to a closed system lipofilter apparatus set at a pressure of 375mmHg. The lipoaspirate was then allowed to settle for 15 minutes to separate the fat from the excess fluid and blood by decanting. The fat was then aspirated into 10ml luer lock syringes ready for injection. The fat graft was not washed at any of the preparation stages.

Graft Placement:

Small incisions were made in the areolar circumference and in the inframammary line in positions to allow for fat placements in a criss-cross, fanning pattern thus creating a 3-dimensional lattice. We used 2mm single hole blunt cannulas connected to the 10ml luer-lock syringes, and adopted the concept of pretunnelling. Fat aliquots were injected under gentle pressure by the threading technique in a fanning pattern, and were placed in the subcutaneous and subglandular planes while avoiding direct injection into the breast parenchyma. We also avoided creating localised collections of fat, and the volume injected was limited by continuous assessment of tissue turgor.

Postoperative management and Follow up:

All patients were discharged on the day of surgery, and were instructed to wear a supportive bra for one week and to avoid being in a cold temperature environment. The first follow up visit was scheduled after 10 days for detection of any early complications. Patients were then seen at 3 months for their postoperative mammography, and for the assessment of any late complications.
The 3 month postoperative breast volume was calculated using the same formula used preoperatively, and the volume difference was expressed as the fat graft retention volume. Mammography was also used to identify areas of fat necrosis and oil cyst formation.

Statistical Analysis:

Correlation between the preoperative breast volume, volume of fat injected, and fat graft

retention volume was performed using Pearson correlation test. SPSS computer program (version 16 windows) was used for data analysis. P value ≤ 0.05 was considered significant.

RESULTS

Demographics and Indications:

Twenty six female patients were included in this study, with a mean age of 33 years (range 26 to 44 years). Twenty three patients had bilateral fat grafting for breast augmentation, while 3 patients had unilateral fat grafting for correction of breast asymmetry. The mean preoperative breast volume was 329cc (range 230-417cc), and a mean of 322ml fat graft was injected (range 200-402ml). Fat was harvested from the abdomen in all cases, in addition to the anterior thigh in 5 cases. All cases had undergone only one session of fat grafting within the scope of this study (Fig. 2).

Fig. (2): A 32 year woman had autologous fat grafting for breast augmentation in a single session - 380ml and 400ml of fat were injected into the right and left breasts respectively, with an average fat graft survival rate of 63% at 3 months. Above: preoperative views. Below: 3 months postoperative views.

Radiological Assessment of Retention Volume:

The fat graft retention volume per breast was calculated by a single radiologist by subtracting the preoperative breast volume from the postoperative breast volume as derived from mammographic measurements using the formula described previously (Fig.3). The mean retention volume was calculated to be 182cc (range 95-256cc) at 3 months postoperative. This was expressed as a percentage of the volume of fat graft injected which ranged from 37% to 67%, with a mean of 54.4% fat graft survival. The percentage fat graft retention volume was noted to be higher in larger volume fat grafts. By statistical analysis, this correlation was found to be significant (Fig. 4).

Fig. (3): Mammographic images of the case presented in Figure 2: a) left preoperative, b) left 3 months postoperative with retention volume 256/400cc, c) right preoperative, d) right 3 months postoperative with retention volume 232/380cc

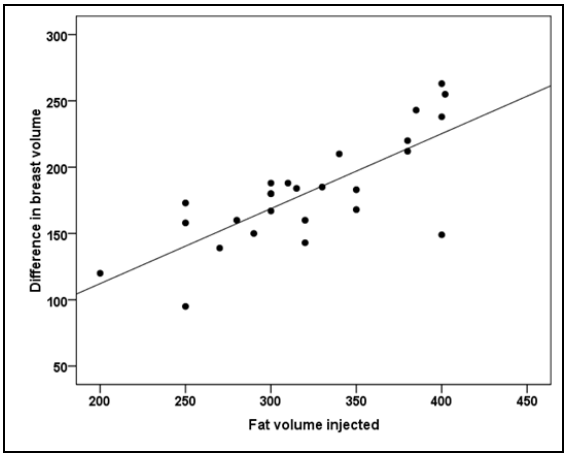

Fig. (4): Correlation between fat volume injected (ml) and retention volume (cc) in the studied group (r= 0.768; p= 0.001).

Complications and follow up:

No early complications were encountered during the first 10 days postoperatively in the form of infection or hematoma. On the 3 month follow up visit, 5 cases showed hyperpigmented scars of fat injection sites, 3 breasts showed mammographic evidence of fat necrosis/calcifications or oil cysts that were not clinically evident and did not require any intervention, and 2 cases presented with contour irregularities at the fat harvest site.

DISCUSSION

Fat grafting to augment the breast and to enhance breast contour has gained popularity in recent years. Accordingly, multiple studies have investigated the techniques used in the different steps of the procedure in an attempt to increase fat graft survival and to minimise complications such as fat necrosis and oil cyst formation [(1-6)]. However, these refinements were not coupled with objective measures of fat graft survival, and most studies relied on subjective techniques such as anthropometric measurements and photography.

Several modalities have been suggested for an objective assessment of breast volume including the Grossman-Roudner measuring device [(11-12)], cast imprints [(13-14)], water displacement [(15)], 3D surface imaging [(16-23)], breast ultrasound [(24,25)], computer tomography-based volumetry [(26)], and MRI volumetry [(27-30)]. Herold et al. have presented a systematic review on the use of these tools to estimate fat graft survival, and have concluded that MRI volumetry provided the most accurate method, whereas 3D surface imaging was the most useful for frequent follow up. However, they have also appreciated that these modalities can be limited by availability and financial restraints [(7)].

Mammography is a readily available investigation used frequently in breast cancer screening and assessment. Katariya et al. have described mammographic assessment of breast volume for breast cancer cases using a circular cone model [(8)]. Kalbhen et al. and Fung et al. have

expanded on this work using a half elliptical cylinder and elliptical cone model respectively. All these studies have used mastectomy specimens to verify their methods.

In their work, Kalbhen et al. have compared different methods of mammographic calculation of breast volume and have noted that measurements from the medial-lateral view were less reliable due to the presence of axillary tissue that would be subjected to interobserver variabilty. They have therefore proposed an accurate and reproducible formula using mammographic measurements taken from craniocaudal views [(9)]. Our study aimed to investigate the value of mammography in the assessment of retention volume after fat grafting to the breast in aesthetic cases, in addition to detection of complications.

Fat grafting was performed in 49 breasts in 26 patients using the same protocol for fat harvesting, preparation and injection. Fat graft retention volume was assessed by subtracting the preoperative breast volume from the 3 month postoperative breast volume derived from mammographic measurements using the formula supported by Kalbhen et al [(9)].

Fat graft survival rates have been reported by many studies. Yu et al. have reviewed the literature for survival rates after autologous fat grafting to different areas of the body and found them to range from 15% to 83% [(31)]. In a more recent review of breast fat grafting techniques, Hivernaud et al. reported a resorption rate that ranged from 15–40% at 3 months to 20–55 % at 6 months [(32)]. However, the studies reviewed had described different techniques for infiltration, harvesting, preparation and injection of the fat graft that included preexpansion of the breast and cell assisted lipostransfer [(33,34)]. Moreover, the tools used for measurement of retention volume of the fat graft were not standardised. Nevertheless, our fat graft survival rate of 54.4% was found to be comparable to the findings of several of these studies, although assessed by various tools and at different postoperative intervals [(33-38)].

Choi et al have compared fat graft survival in three groups of patients with different fat injection volumes for breast reconstruction [(39)]. They have concluded that fat graft survival is dependent upon volume and time, where patients with larger volume fat grafts had a larger retention volume that stabilised over a shorter time as compared to smaller volume injections. Khouri el al. have also reported the longevity of large volume fat grafting in the breast using their technique [(33)]. Our results have supported these findings regarding the correlation between fat graft volume and retention volume, that was found to be statistically significant. Complications of fat grafting to the breast in terms of fat necrosis and oil cysts were in the order of 6% using our protocol, and showed no correlation with the volume of fat injected. These results suggest that, with avoiding 'overgrafting', complications and fat graft survival are likely to be technique dependant rather than volume dependant as discussed in other studies [(40,41)].

This study has been limited by the number of patients enrolled, and by the absence of an alternative objective assessment technique such as MRI studies. The longevity of the retention volume was also not assessed beyond 3 months, although this was not the main aim of our study. However, longer follow up would be required to support our secondary outcome concerning large volume fat grafting.

We have concluded that mammography offers an affordable, quantitative and qualitative tool for assessment of fat grafting techniques in terms of objective calculation of retention volume, in addition to detection of fat necrosis and cyst formation. This might prove to be valuable in comparing different fat grafting techniques, and to provide more accurate information to patients regarding expectations. Further work is needed to confirm these findings in the form of larger case series, that would be compared to other objective modalities over a longer follow up period.

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