Fat Graft Application

Mauricio Raigosa and Tai-Sik Yoon

Introduction

Autologous fat grafting has become a great tool in all fields of plastic surgery. Fat grafting involves transfer of nonvascularized but viable fat cells from one location to another within the same individual. Although fat grafting is generally successful in many circumstances, the results can be unpredictable in terms of volume maintenance. It does transfer fat and stroma in a single setting, although it usually requires multiple stages to achieve satisfactory clinical results, especially when larger contour defects are treated.

Since Coleman formalized the technique in 1997 [1], many authors have focused their effort to improve graft viability in terms of processing of the harvested fat and graft transfer or injection technique [2, 3].

Autologous fat grafting possesses many of the most ideal properties desirable to work as a filler throughout the body. Unfortunately, transplanted graft survival can be highly inconsistent [1, 4, 5]. Atraumatic harvesting, handling, and transfer are key points to maximize fat cell viability during fat grafting. However, the most decisive step in the success of fat grafting procedure is the last step: the injection of the fat once processed into the target area.

As many efforts have been focused on harvested fat processing in order to improve graft survival, little evidence exists about the role of fat injection.

Instruments and Materials

Instruments for fat grafting must be efficient and cause minimal trauma to the grafted tissue during injection.

Cannulas

A blunt 17-gauge cannula with one distal aperture just proximal to the tip is the most commonly used cannula for fat injection in our practice. The injection cannulas vary in length and shape. The most useful lengths are from 7 to 9 cm for facial procedures and from 9 to 15 for body contouring procedures. Cannula tips also come in various sizes and shapes for individualized treatment (Fig. 1). The proximal end of the cannula has a hub that is connected to a Luer-Lock syringe.

Coleman [6] developed three different types of blunt-tip cannulas:

M. Raigosa · T.-S. Yoon (✉)
Department of Plastic and Reconstructive Surgery, Hospital Clinic, Barcelona, Spain
e-mail: tyoon@clinic.cat

© Springer Nature Switzerland AG 2019
H. Pinto, J. Fontdevila (eds.), *Regenerative Medicine Procedures for Aesthetic Physicians*,
https://doi.org/10.1007/978-3-030-15458-5_9

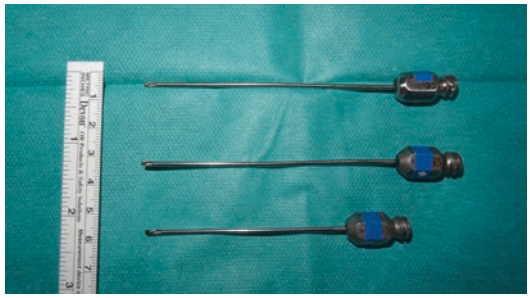

Fig. 1 17-gauge injection cannulas developed by Coleman, type I completely capped (above), type II partially capped, and type III with flat end

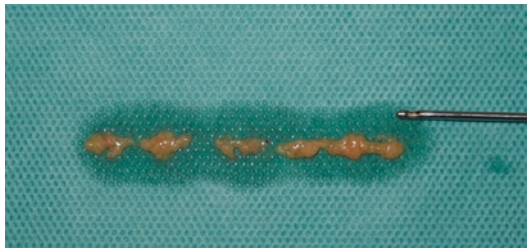

Fig. 2 Small aliquots of fat graft are delivered through the injection cannula to maximize graft contact with surrounding tissues and its survival

- Type I is completely capped on the tip with a lip that extends 180° over the distal aperture.
- Type II is similar to type I but it is not completely capped and has a lip that extends over the distal aperture only about 130°–150°.
- Type III is flat at the end to allow dissection of the tissues in specific situations. It makes easier to push through scars or fibrotic tissues.

Coleman introduced the principle of "microdroplets" [6] (Fig. 2). It is generally accepted nowadays since Carpaneda [7] that a "tiny" fat graft surrounded by vascularized tissue enhances graft survival through revascularization. Mashiko and Yoshimura [8] recommended the diameter of fat graft particles to be as small as 2 mm. Khouri developed the concept of "microribbons" [9] as small units of fat that can survive acute transfer to subcutaneous plane. According to this theory, if we set a conservative limit of 0.1 cm^2 for the area of the base of a cylinder, the maximum volume of fat delivered by a 10-cm-long injection should be 1 cc. Khouri et al. stated fat injections larger than 0.16 cm in radius will have an area of central necrosis through a mathematical model [10]. Del Vecchio and Rohrich stressed the importance of placing fat within 2 mm of an arterial supply to survive, but fat placed beyond that distance will undergo necrosis [2]. We believe following the microdroplet principle is mandatory to achieve a significant fat graft survival rate, and thus a good clinical result. In our opinion, one condition necessary to guarantee microdroplet principle is that grafted fat tissue must flow easily through the injection cannula without clogging to avoid "huge" fat lobules deposits. To do so, we agree with Del Vecchio and Rohrich that hole size of the injection cannula matters and should match closely the hole size of the aspiration cannula [2] (Fig. 3).

Although shear stress has proven to be harmful to fat [11, 12] and flow rates on the order of 0.5–1 cc of fat graft/s have been recommended to optimize fat viability during injection [12], no significant differences have been reported on following injection with 14-, 16-, and 20-gauge needles [13, 14]. Technique described by Coleman uses a 17-gauge cannula (1.20 mm external diameter) but does not enable direct reinjection at a subdermal level nor in inextensible tissue such as fibrotic dermis. The smallest transfer cannula used in the Coleman procedure is a 22-gauge blunt cannula [6], which clogs very often during reinjection. Nguyen et al. presented micro-fat injection with a 20-, 23-, and 25-gauge cannula after harvesting fat with a multiperfo-

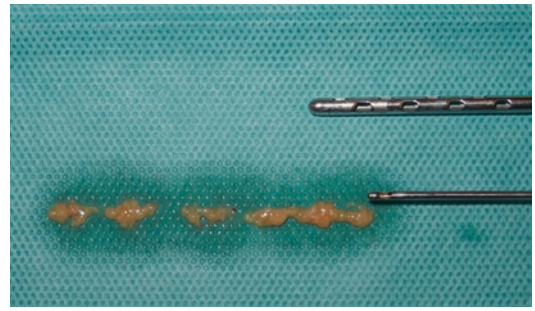

Fig. 3 Size of the holes of liposuction cannula should be very similar to the size of the hole of injection cannula to provide smooth delivery of fat avoiding clogging and bolus injection

rated cannula with holes of 1 mm in diameter [15]. In our daily practice, 17-gauge cannula is used. We strongly believe this cannula caliber works really well in a great variety of receptor tissues like breast, buttock, and even face. We agree when dealing with periorbital fat grafting, especially upper eyelid and lower eyelid tear-trough deformity, a thinner cannula is advisable to avoid complications [16].

Smith suggests using cannulas to inject the fat is less harmful to fat than using needles [17]. For some authors, blunt-tip cannulas cannot be manipulated easily inside the tissue, and the cannula must be pushed with high pressure in order to reach a target point [18]. On the other hand, sharper-tipped cannulas have higher risk of penetrating blood vessels causing vascular damage and hematoma, being described blindness due to retinal artery injury or embolism, stroke, and skin necrosis [19]. Yazar et al. presented a pointed-tipped cannulas, which are blunted to a certain degree that can be applied easily through the tissues avoiding such complications [18]. Based on our experience, blunt-tip cannulas are our first choice. They are safe, with low risk of blood vessel penetration and vascular damage. A severe hematoma during postop, even when dealing with highly vascularized areas such as the face, is extremely rare. It is true that blunt-tip cannula manipulation can be sometimes difficult inside the tissue, especially in irradiated or scar tissues. But with the help of the opposite hand bound-ering the tip and exerting a controlled pressure on the cannula, this problem can be overcome easily, avoiding sharp tips.

When fat grafting is indicated to treat scared or fibrotic tissues, these should be released prior to fat injection. "Rigottomy" [20, 21] or three-dimensional ligamentous band release consists in "meshing" the scar tissue using a needle or a pointed or even a blunt cannula. Meshing the scar makes it spread. Fat grafting after the release acts as a filler and a spacer, filling the gaps in the "mesh" avoiding tissue collapse and further scarring [9, 10].

Syringes

Basically two types of syringes are used in our clinical practice. We use 1 cc syringes when applying fat grafting in the face and 10 cc syringes for the rest of the body contouring (Fig. 4).

Fat grafting in the face needs to be very precise and for that reason extreme control over the amount of fat that is delivered is mandatory. To do so, 1 cc syringes offer the best control and the exact amount of desired volume can be delivered [1, 16]. When facing body contouring, we still have to be precise but higher fat volume is delivered. For that reason 10 cc syringes are preferred. However, for those starting in fat grafting tech-

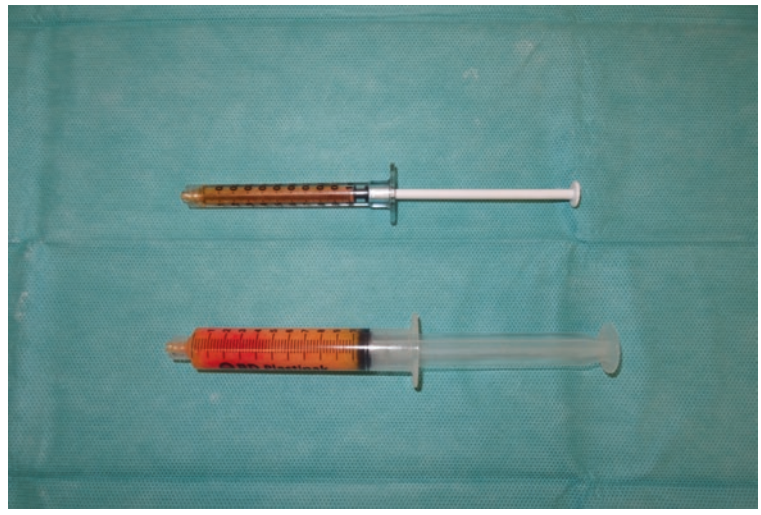

Fig. 4 1 cc syringes with Luer-Lock hub are used in face contouring and 10 cc syringes with Luer-Lock hub are used in body contouring

niques, even out of the facial area, we recommend to start with lower volume syringes (3 or 5 cc) until they become familiar with the technique.

All syringes must have a Luer-Lock hub at the distal end to be connected to different type of cannulas. This kind of tight connection is very convenient to avoid leaks and sudden cannula unplugging.

Injection Technique

Incisions

Small stab incisions are made in the skin at the previously designed entering points with a 16-gauge needle. These incisions are so small that do not need to be sutured and become inconspicuous after healing takes place.

Holding the Syringe

There are different ways of holding the syringe [16]. If the end of the plunger is held with the thumb, we lose fine control over speed of fat delivery through the syringe, but if the plunger is held with the palm, the grade of control over the injection speed increases greatly (Figs. 5 and 6). Not only the speed but holding the syringe in that way gives more control over the direction of the cannula toward the target area and the plane in which the surgeon wants to inject.

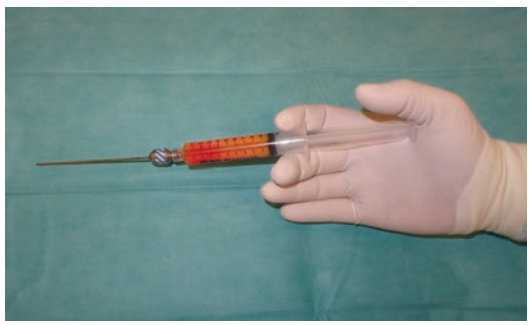

Fig. 5 Holding the end of the plunger with the palm provides greater control over the injection speed and the volume you want to inject and at the same time allows better control over the direction and the plane you want to inject in

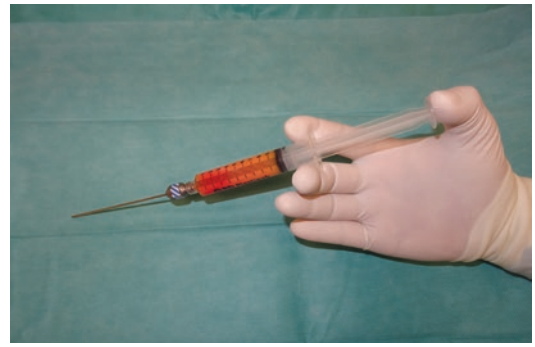

Fig. 6 Holding the end of the plunger with the thumb, we lose fine control over speed of fat delivery through the syringe

Cannula Movements

There are currently two established methods of fat grafting: mapping technique and the reverse liposuction technique [9, 10, 16, 22]. Reverse liposuction refers to a constant motion of the injection cannula back-and-forth while fat is being injected. Generally, soft pliable non-scarred tissues without underlying implants can be treated more efficiently with reverse liposuction technique. In the mapping technique, fat is injected during axial withdrawal of the cannula only in a retrograde manner. This technique is preferred when grafting scarred, or irradiated beds, or over implants, when a more precise and cautious fat deposition is required.

When performing fat grafting, it is important to place fat in a fan-shape mode from a given injecting point and with a crosshatched pattern using long radial passes from multiple entering points. This helps to avoid placing an excess of fat in a single place or line [9, 10, 16].

Plane of Placement

When injecting fat into a target area, we should keep in mind the principle that the key to successful application of adipose tissue is to maximize

the contact area between the grafts and the recipient vascularized tissue [9]. The grafts should be small enough to increase this contact area while maintaining the original architecture of the fat. According to that principle, fat should be placed with multiple passes developing a single layer of fat and avoiding bolus injection. Each injection will be made into a new tunnel, creating multiple levels in a three-dimensional manner. Usually the fat graft is placed just under the dermis, but all available vascularized tissues should be grafted in order to gain volume. If a bolus injection occurs, it can be flatten with digital manipulation, but this can lead to fat necrosis so the best is to avoid bolus injection.

Speed of Placement

How fast we inject and how much pressure we apply onto the syringe are important issues. Advancement and withdrawal of the injection cannula is made slowly by beginners or when dealing delicate areas (periorbital, periprosthesis, etc.). When experience is gained, these movements are made quicker and steady. According to Marten [16], with rapid and constant movement, intravascular injury is less likely to happen and fat is infiltrated in a more uniform manner. The pressure over the plunger should be gentle and constant, which will indicate the fat delivery is homogeneous and uniform. If higher pressure is needed, the cannula may be blocked. In that case it is better to remove and check the cannula. Exerting higher pressure will end up in bolus injection.

Assisted Manual Injection

Manual injection is the most popular injection technique among surgeons performing fat grafting. As mentioned before, a learning curve is necessary to deliver the grafts uniformly and in tiny droplets in order to maximize graft survival.

Several devices are available in the market in order to guarantee the procedure is performed in the correct way and make it easier.

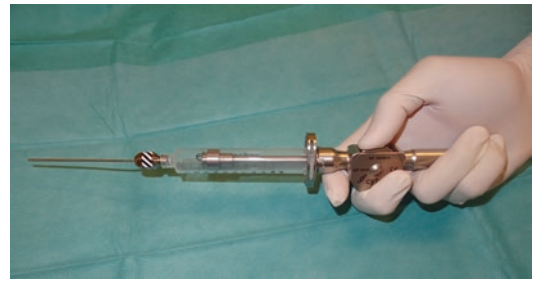

Fig. 7 Stainless steel device for precise delivery of microdroplets. A simple brush of the thumb permits accurate control over the content of the syringe, delivering a small volume of fat with every movement

- Lipografter TM [23]. It is a sterile, single-use disposable kit that is used in harvesting, and transferring of autologous fat. It provides minimal manipulation of the fat, and its patented atraumatic tissue valve allows for harvesting, processing, and reinjection in a closed system. The graft is delivered using a 1 cc syringe.
- Celbrush TM [24]. It is a stainless steel device for precise delivery of microdroplets. A simple brush of the thumb permits accurate control over the content of the syringe, delivering a small volume of fat with every movement. The "10 mL Celbrush is designed to deliver approximately 0.50 mL of tissue for each full brush of the operator's thumb" (Fig. 7). Another advantage of this system is that minimizes clogging and overfilling.

Volume of Graft

When to finish injection is a question all beginners ask when performing this technique. It is important to feel some resistance during advancement of the cannula [16]. It indicates the new tunnel is surrounded by non-touched tissue, and the fat infiltrated will have maximum exposure to vascularized tissue. Once you feel large open space with each pass, probably it is good to stop. Sometimes, especially for beginners, it is difficult to decide when to stop injecting. Overcorrection, especially in face contouring, must be avoided. Blanching or stiffness of the treated areas due to high pressure after injection must be avoided as

stated by Khouri [9, 10]. We recommend injecting until contour deformity is corrected (completely or partially) keeping the injected tissue soft and turgid.

Complications

The two most significant complications are intravascular injection [17, 19] and overgrafting [1, 4, 5]. Fortunately, these phenomena are very rare. Using blunt cannula, low-pressure injection, moving constantly the cannula, and placing epinephrine to achieve vessel contraction, vascular injury can be avoided.

On the contrary, overgrafting is becoming an increasing problem due to large volume injection, as practitioners become more familiar and confident with fat grafting techniques. This is seen more frequently in younger patients who have had superficially placed injections. Unfortunately, weight gain causes all fat grafts to enlarge, which, in the face, can result in significant contour distortion. The treatment of overgrafting requires microliposuction with only limited improvements and risks of excessive scar formation. Therefore, even for experienced surgeons, it is recommended to use small to moderate amount of grafts in the face with minimal overfilling.

References

1. Coleman SR. Facial recontouring with lipostructure. Clin Plast Surg. 1997;24:647–547.
2. Del Vecchio D, Rohrich RJ. A classification of clinical fat grafting: different problems, different solutions. Plast Recon Surg. 2012;130:511–22.
3. Chung MT, Paik KJ, Atashroo DA, Hyun JS, McArdie A, Senarath-Yapa K, et al. Studies in fat grafting: part I. Effects of injection technique on in vitro fat viability and in vivo volume retention. Plast Reconstr Surg. 2014;134(1):29–38.
4. Fontdevila J, Serra-Renom JM, Raigosa M, Berenguer J, Guisantes E. Assessing the long term viability of facial fat grafts: an objective measure using computed tomography. Aesthet Surg J. 2008;28:380–6.
5. Coleman SR. Long term survival of fat transplants: controlled demonstrations. Aesthet Plast Surg. 1995;19:421–5.
6. Coleman SR, Mazzola RF. Fat injection from filling to regeneration. St Louis: Quality Medical Publishing; 2009.
7. Carpaneda CA, Ribeiro MT. Study of the histologic alterations and viability of the adipose graft in humans. Aesthet Plast Surg. 1993;17(1):43–7.
8. How does fat survive and remodel after grafting? Mashiko T, Yoshimura K. Clin Plast Surg 2015; 42(2): 181–90.
9. Khouri RK, Rigotti G, Cardoso E, Khouri RK Jr, Biggs TM. Megavolume autologous fat transfer: part I. Theory and principles. Plast Reconstr Surg. 2014;133(3):550–7.
10. Khouri RK, Khouri RR, Lujan-Hernanadez JR, Khouri KR, Lancerotto L, Orgill DP. Diffusion and perfusion: the key to fat grafting. Plast Reconstr Surg Global Open. 2014:1–9.
11. Atashroo D, Raphel J, Chung MT, Paik KJ, Parisi-Amoon A, McArdie A, et al. Studies in fat grafting: part II. Effects of injection mechanics on material properties of fat. Plast Reconstr Surg. 2014;134(1):39–46.
12. Lee JH, Kirkham JC, McCormack MC, Nicholls AM, Randolph MA, Austen WG. The effect of pressure and shear on autologous fat grafting. Plast Reconstr Surg. 2013;131:1125–36.
13. Ozsoy Z, Kul Z, Bilir A. The role of cannula diameter in improved adipocyte viability: a quantitative analysis. Aesthet Surg J. 2006;26:287–9.
14. Kirkham JC, Lee JH, Medina MA 3rd, McCormack MC, Randolph MA, Austen WG. The impact of liposuction cannula size on adipocyte viability. Ann Plast Surg. 2012;69:479–81.
15. Nguyen PSA, Desouches C, Gay AM, Hautier A, Magalon G. Development of micro-injection as an innovative autologous fat graft technique: the use of adipose tissue as dermal filler. J Plast Reconstr Surg. 2012;65:1692–9.
16. Marten TJ, Elyassnia D. Fat grafting in facial rejuvenation. Clin Plast Surg. 2015;42(2):219–52.
17. Smith P, Adams WP, Lipschitz AH, Chau B, Sorokin E, Rohrich RJ, et al. Autologous human fat grafting: effect of harvesting and preparation techniques on adipocyte graft survival. Plast Reconstr Surg. 2006;117:1836–44.
18. Yazar M, Yazar SK, Sevim KZ, Irmak F, Tekesin MS, Kozanoglue E, et al. How were lipofilling cannulae designed and are they as safe as we believe? Ind J Plast Surg. 2015;48(2):139–43.
19. Coleman SR. Avoidance of arterial occlusion from injection of soft tissue fillers. Aesthet Surg J. 2002;22:555–7.
20. Rigotti G, Marchi A, Galie M, Baroni G, Benati D, Krampera M, et al. Clinical treatment of radiotherapy tissue damage by lipoaspirate transplant: a healing process mediated by adipose-derived adult stem cells. Plast Reconstr Surg. 2007;119:1409–24.
21. Kakagia D, Pallua N. Autologous fat grafting: in search of the optimal technique. Surg Innov. 2014;21(3):327–36.

22. Thorne CH. Grabb and Smith's plastic surgery. 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2014.
23. Lipocosm. Lipografter [Internet]. Miami: Miami Web Company, 2010. [cited 2017 Mar 27]. http://www.lipografter.com/.
24. Cytori. Celbrush® [Internet]. [place, publisher, date unknown], 2015. [cited 2017 Mar 27]. http://www.cytori.com/wp-content/uploads/2016/08/RM-098-LIT-US_B-0615_CelbrushBrochure_LR.pdf.