Chapter

The Versatility of Autologous Fat Transplantation in Abnormalities of the Craniofacial-Complex and Facial Esthetics

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Abstract

In the historical pursuit of soft tissue augmentation, fat has seemed a natural choice for plastic surgeons. The use of fat transfer to replace volume or camouflage soft tissues is an increasingly popular method in craniofacial surgery and facial esthetics. Craniofacial malformations undoubtedly have a certain psychosocial effect. Children of early age are particularly vulnerable to comments, teasing, and harassment related to their appearance; therefore, improving the facial image is of great importance. We believe that volumetric lipoinjection represents an excellent alternative to obtain greater facial esthetic harmony, which directly increases patient self-esteem in children and adults.

Keywords: adipose stem cells, lipoinjection, lipofilling, craniofacial malformations, facial profiling

1. Introduction

Many procedures have been described throughout history in an attempt to increase lost tissue volume: dermo-fat grafts, omental free flaps, and musculoskeletal flaps, to name a few.

The history of autologous fat transfer began in Europe with Neuber presenting his first fat transfer work at the 22nd Congress of the German Society of Surgery in 1893 [1], followed by Mojallal [2], Lexer [3], and Rehn [4] who described its use in a variety of procedures including thoracic and abdominal surgeries, breast surgeries and the field of neurosurgery and orthopedics, within the so-called "open-air" era - before liposuction (1889–1977).

Brunning was the first, in 1911, to inject fat into the subcutaneous tissue for augmentation [5]. This technique continued to be promoted as an alternative to resolve depressive areas. Without a doubt, its incorporation into the field of plastic surgery is where it has had its maximum development.

The first attempts consisted of excising fatty tissue and placing it in small pockets in the subcutaneous layer. In the 50s, Peer observed that by placing small

portions, at least 50% of their initial volume was lost in the long term and that this would depend mainly on early anastomosis of the recipient and donor vasculature, thus describing the theory of survival of fatty tissue grafts. It was established that the number of viable adipocytes at the time of graft placement directly correlates with the final volume that survives [6].

The concept of absorption of fat grafts began practically from the moment of its use. Due to this, throughout its development, different theories arose that tried to explain what happened with transplanted fat [7, 8].

For some time, fat transfer lost popularity. This led to the search for other alternatives, such as silicone, polymers, and hydroxyapatite crystals. It was in 1980 with the appearance of liposuction when the trend of obtaining fat for grafting was renewed [9]. From our perspective, we consider that different stages have contributed to the boom in autologous fat transfer in the field of cosmetic and reconstructive surgery. Ironically, during the development and refinement of liposuction techniques, the collected fat was thrown away. The question soon arose, *why not use it in other areas of the body to provide volume and solve depressions?*

In 1986, Fournier [10] and Illouz [11] presented modifications in the technique for obtaining fat through aspiration syringes. Coleman in 1994 introduced his technique, perfectly describing the steps for sampling, purification by centrifugation, and transfer (reinjection), which he later called: Lipostructure®, warning that any traumatic act to obtain fat should be avoided, thus dividing the times: "unpurified" (With the discovery of liposuction 1977–1994), and "purified or atraumatic" (after the descriptions of Roger Coleman from 1994 to date). The literature has described that fat tissue grafts can cause a lasting correction; however, it has also been documented that fat undergoes multiple manipulations in its reinjection process, which affects its survival [12].

Verderame described that the surgeon had to compensate for this "shrinkage" by transplanting a greater amount of fat than required, hoping that the initial desired result with this "overcorrection" would equalize with subsequent reabsorption [13].

This natural evolution on the improvement of the liposuction technique included improvements in equipment (suction machines and cannulas) and scientific bases to better understand the metabolism of adipocytes, their viability, and performance, and permanence over time [14–16].

There are reports in the literature that compare the benefits of centrifugation, decantation, and washing of fat tissue, in an attempt to ensure the best viability of adipocytes and, therefore, better permanence.

In a recent systematic review, Zhou et al. evaluated graft survival based on technique. The authors reported a statistically significantly higher facial fat graft survival rate of 71% in the cell-assisted lipotransfer group compared to 52% in the control group (standard fat grafting) [17].

From the beginning of stem cells obtained from adipose tissue, their potential therapeutic use was already envisioned at the level of tissue engineering and cell biology [18]. Matsumoto et al. in 2006, [19] described a technique called cell-assisted transfer (CAL). This technique consists of autologous transplantation of adipocytes enriched with stem cells derived from fatty tissue. Enzyme digestion is achieved using collagenase. With favorable culture media and different centrifugation steps, the stromal vascular fraction (SVF) is obtained. The SVF contains; stromal cells, endothelial progenitor cells, preadipocytes, ASCs, etc. In an adipogenic environment, ASCs can directly differentiate into adipocytes and contribute to volumetric restoration. They also promote graft survival through angiogenesis and the release of growth factors [20]. Yoshimura [21] described the use of this technique in cases of facial lipoatrophy and post-reconstruction breast augmentation and described the technique for obtaining the ASCs.

The current use of fat transfer to replace volume or camouflage soft tissues is an increasingly popular method in plastic surgery, especially in craniofacial surgery. Due to our current globalized and increasingly competitive environment, it is undeniable that in the field of esthetic surgery, volumetric lipoinjection with adipose stem cells as facial profiling or combined with facial rejuvenation surgical procedures has great acceptance.

2. Diagnosis/patient presentation

The ideal patient for this procedure is one with a volume deficit due to soft tissue atrophy. Multiple pathologies have soft tissue hypoplasia as a common characteristic. Hemifacial microsomia is one of the most frequent abnormalities of the craniofacial complex [22]. Progressive hemifacial atrophy or Parry-Romberg syndrome is characterized by a progressive deformation and reduced soft tissue volume on one side of the face. It is also accompanied by trigeminal neuralgia, alopecia areata, and eye alterations. This condition can benefit from the transfer of stem cell-enriched fatty tissue [23, 24].

We have recently described an alternative for postoperative cranioplasty for craniosynostosis. A specific population of these patients develops asymmetries categorized as depressions, particularly in the frontoorbital and temporal region, which are camouflaged using volumetric lipoinjection of adipose stem cells. This maneuver provides a volumetric effect and improves the inherent characteristics of the skin. All this contributes to a more harmonious facial appearance [25].

Its use has also been described in mild volumetric deficits of the middle and lower facial third secondary to skeletal fractures [26], even a camouflage option in patients with mild orthognathic alterations, such as micrognathia and microgenia [27]. We have used this alternative technique for more than a decade in our Craniofacial Surgery Clinic. In general, we use volumetric adipose stem cells in a wide range of disorders of the craniofacial complex, such as syndromes with a common characteristic, soft tissue hypoplasia, asymmetries secondary to facial skeletal trauma sequelae, and asymmetries due to craniosynostosis sequelae. Logically, this technical variant is also widely used to complement facial rejuvenation procedures or as an isolated facial profiling procedure.

Craniofacial malformations have a certain degree of psychosocial involvement, and children, particularly at an early age, are vulnerable to comments, ridicule, and harassment related to their appearance. Therefore, we consider it essential to provide an esthetic balance that promotes better facial symmetry. This is highly relevant since children at this stage are in the full development of their image, identity, and personality; hence, we consider that it is a priority to favor an adequate environment that facilitates greater self-esteem and better psychosocial development and integration. In some instances, it has a positive result in school performance [28].

3. Treatment/surgical technique

The surgical protocol should always include a complete medical history and an analysis of the degree of deformity to estimate the volume to be replaced. Also, photographic controls to assess its evolution in the medium and long term. Informed consent must be obtained.

Before starting the procedure, a tracing is made on the preoperative images to better estimate the required volume, the mini-approaches necessary for its application, and a projection of the desired result.

The lower abdomen of each patient is evaluated as the donor area of choice. Other areas may be the lower back and thighs since, in pediatric patients, the availability of abdominal fat may be limited.

An oral dose of cephalexin is indicated the day before surgery and will continue for 4 days after. In pediatric patients, the procedure is performed under general anesthesia.

3.1 Tumescence and fat aspiration

The lower abdomen is infiltrated with a tumescent solution (0.25 mg of epinephrine in 250 mL saline solution) to perform fat aspiration. The ratio of infiltration is 1 mL of solution per 1 mL of harvested fat. We perform fat collection using a blunt-tipped #20 1-mm sharpened holes cannula 10 cm long and 2.5 mm in diameter attached to a 10-mL Luer-lock syringe. According to the areas to be treated and their degree of deformity, the average number of syringes usually collected is 2 to 3. In adults, for facial esthetics, it varies from 3 to 6.

3.2 Fat processing technique and isolation of ASCs

The extracted fat is separated into two samples, one is used for the isolation of ASCs, and the other will be enriched with the ASCs. The second sample is processed according to the Coleman protocol [12]. The isolation of the ASCs is carried out according to the technique described by Yoshimura [20]. It is important to point out that, in our beginning, the protocol for obtaining and isolating stem cells was in accordance with what was previously described. We currently treat fat in a simple way. In this way, we obtain 3 types of fat grafts: Mini-fat grafts (where adipocytes provide an average of 85% of the cell volume), Micro-fat grafts (average volume 50%), and Nano-fat grafts (virtually no adipocytes and a higher cell concentration of elements of the stromal vascular fraction), very similar to that described by Tonnard et al., however, with some variants [29].

Once the fat has been collected with 10 ml syringes for mini-grafts, it is centrifuged for 1 min at 3000 rpm, and the infranatant fluid (composed mainly of tumescence fluid, blood, detritus, free fatty acids, etc.) is eliminated. We then connect a 2.5 mm diameter female-to-female transfer device at one end of the syringe, and on the other end, we connect 1 and 3 mL Luer lock syringes, ready to be filled and injected.

For micro-grafts, the centrifugation and obtention process is similar. Afterward, the syringes are connected to another 10 ml Luer lock connector through the transfer device and are passed to the empty syringe "round trip" 5 times. The product is centrifuged again for 1 min at 3000 rpm, the infranatant is eliminated, and the cell conglomerate is transferred to 1- and 3-mL syringes ready to be injected.

Mini and micro-fat injections are performed with short and long malleable fine cannulas, 1.5 to 2 mm in diameter. The process to obtain nano-fat is also similar to the previous one, with the difference that the fat is emulsified by making 30 "round trip" passes, with a 1.5 mm transfer. The syringes are then centrifuged for 1 min at 3000 rpm. Injections are performed with short and long, fine malleable cannulas, 1.5 to 2 mm in diameter.

Logically, we use mini-graft and micro-graft for volumetric increases. In nano-grafts, adipocytes are practically destroyed; therefore, they do not provide volume, and it has been shown that they have a higher concentration of ACSs with a vast potential for cell regeneration [30]. We use them to enrich the mini and micro-graft, and for injection into the subcutaneous and intradermal stratum (with 23-to-27-gauge needles) and to improve the inherent characteristics of the skin such

Figure 1.
Intraoperative view of the lipoinjection of adipose stem cells. (A) Glabellar approach. (B) Temporal approach (behind the hairline).

as shine and texture due to the thickening of the dermis, moisturizing, and better contraction quality. It even better unifies the natural tone of the skin. All this provides a more youthful appearance of facial expression. We have recently also used nano-grafts to improve the appearance of tear trough, dark circles of the eyelids, and camouflage scars in general.

3.3 Volumetric lipoinjection technique

We use 3-mL syringes and a 2-mm blunt-tipped cannula for lipoinjection. The micro-approaches to be made will depend on the area to be injected. We make these incisions initially with a 22-gauge needle. The area to which we will have access should be considered when performing our approaches to achieve a uniform "fan-shaped" distribution of the entire area to be lipoinjected and keep the cannula tip in mind (**Figure 1**).

The final step consists of manual manipulation and remodeling of the injected fat, and in some cases, removal of excess grafted fat through the entry site. We use a 6–0 nylon suture to close the micro-approaches and 4–0 nylon for the scalp. The sutures are removed on the 4th or 5th postoperative day.

4. Clinical cases

4.1 Case 1 – Parry Romberg syndrome

The patient is a 35-year-old man with no previous medical history, diagnosed with progressive right hemifacial atrophy of 10 years evolution and 5 years with a stabilized condition. On examination, alopecia was found in the parietal and temporal region, together with subcutaneous tissue atrophy of the temporal region and the right midface, tooth loss, decreased range of motion of the temporomandibular joint, and trigeminal neuralgia. Three-dimensional (3D) reconstruction computed tomography showed the absence of the temporomandibular joint and a significant reduction of tissue volume in the affected side.

Infiltration with enriched autologous fat containing ASCs reduced the severe depression of the frontotemporal region and provided better volume and symmetry. An acceptable improvement of the malar prominence and cheek was also achieved, with greater volume and projection on the front view and profile. From its angle to the chin, the mandibular contour was redefined, achieving a better balance; even the neck base benefitted volumetrically. It is important to point out the

permanence of the fat graft in the lips, which allowed the teeth to be hidden because of increased lip volume. The graft's permanence remained stable in all the injected areas, even in the nasolabial folds and lips, which are areas of maximum mobility and reabsorption [24] (**Figure 2**).

4.2 Case 2 - Craniosynostosis

A 4-year-old male diagnosed with anterior plagiocephaly, which was initially treated with cranioplasty and frontal bandeau at the age of 12 months. A defect is observed in the frontal glabellar region. A fat transfer was performed to achieve symmetry in both regions through a minimally invasive approach [31] (**Figure 3**).

4.3 Case 3 – Congenital constriction band syndrome

Congenital bands are compressive rings with a groove of different depths that can be partially or wholly circular at one end.

Its etiology remains unknown. Its rupture has been described through the use of Z- and W-plasty and excision and primary closure; However, new alternatives to its treatment have recently been described.

A 36-year-old woman with no relevant medical history presents a simple congenital constriction band in the distal part of both legs, without functional impairment (Type 1 Patterson Classification). The right leg had an incomplete circumferential constriction band with minimal depth, and the left leg a circumferential constriction band of moderate depth. The left leg was treated. The procedure was performed under epidural anesthesia with intravenous sedation [32] (**Figure 4**).

Three approaches (2 mm) that were remote to the constriction band were marked. Initially, the fibrous band was released from the deep tissues with a flat-grove blunt-tipped 2-mm Toledo cannula, 10 cm in length. Afterward, with this same cannula, multiple perpendicular cuts were made in the inner surface of the

Figure 2.
(A, C, E) preoperative view. (B, D, F) postoperative view 12 months after lipoinjection enriched with stem cells and elements of the stromal vascular fraction.

Figure 3.
Intraoperative view. (A) Glabellar lipoinjection was performed in a fan shape until adequate symmetry was achieved. (B) the treated left area. (C) both treated areas.

Figure 4.
Preoperative images of the left leg. (A) Lateral view, (B) frontal view, (C) medial view.

fibrous ring leaving a 1 cm gap between each cut until completing the circumference of the band.

Lipoinjection was performed in the virtual subcutaneous space from a deep to a superficial plane with a 2-mm blunt cannula with 5-ml syringes. We injected the amount of fat needed to reverse the appearance of depression without overcorrecting (**Figure 5**).

4.4 Case 4 – Facial esthetics

A 27-year-old female with no significant history requested a facial profiling procedure.

The patient presented adequate skin quality; however, she was not satisfied with the definition of her facial frame and neck. Today, patients come to our consultation with a lot of Internet information, and in many cases, they request specific procedures. It is always good to listen to them, and in this way, know how to properly advise our patients. After an adequate clinical evaluation, we suggested carrying out the following procedures: Bichectomy, neck liposculpture, and enhance the definition of the entire lower facial frame by volumetric lipoinjection with adipose stem cells, in addition to a slight increase in projection on the upper lip in the philtrum region.

For seven years, we have developed an innovative alternative for nasal modeling. In this case, we also use fat and stem cells (in our practice, we have named this RINO-CELL®).

To a large extent, we consider that the success of any procedure in facial esthetics lies in obtaining an adequate definition of the full jaw contour. In this way, it is possible to visualize the border between the face and the neck, and it is also our objective to redefine the cervicofacial angle. All these characteristics represent a clear sign of beauty and youth (**Figure 6**).

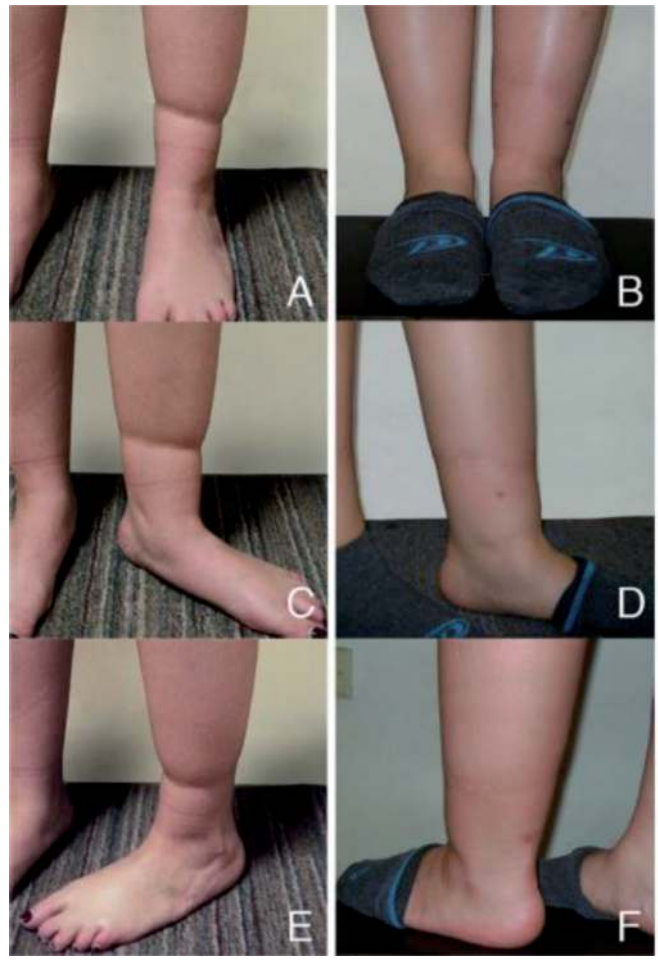

Figure 5.
Change in the concave surface ("hourglass sign") for a homogeneous surface. (A, C, E) preoperative view. (B, D, F) postoperative view 18 months after the procedure (note the three approaches with some degree of hyperpigmentation).

5. Post-surgical care/complications

In a recent systematic analysis, Gornitsky et al. describe 2.2% complications in facial fat transfer procedures, with asymmetry being the most common. Other complications are skin irregularities, prolonged edema, hypertrophy, fat necrosis, infection, telangiectasia, and acne reactivation [33].

Cases of emboli following autologous fat grafting to the glabella and nose have been attributed to retrograde arterial injection, facilitated by the abundant vascular supply in these regions; notably, the frontal and dorsal nasal arteries that are supplied by the ophthalmic artery [34].

In our experience, we have found a reabsorption percentage of 49% of the injected volume. We have concluded that when the results are not favorable, the volume of fat calculated and injected was insufficient or to other particularities that increase reabsorption in the specific area. These situations may be resolved with secondary or re-touch procedures.

Most parents reported feeling happier with their children's facial appearance. An important factor to consider is the variability of reabsorption of the injected fat. However, if necessary, the fat injection can be repeated as an isolated procedure.

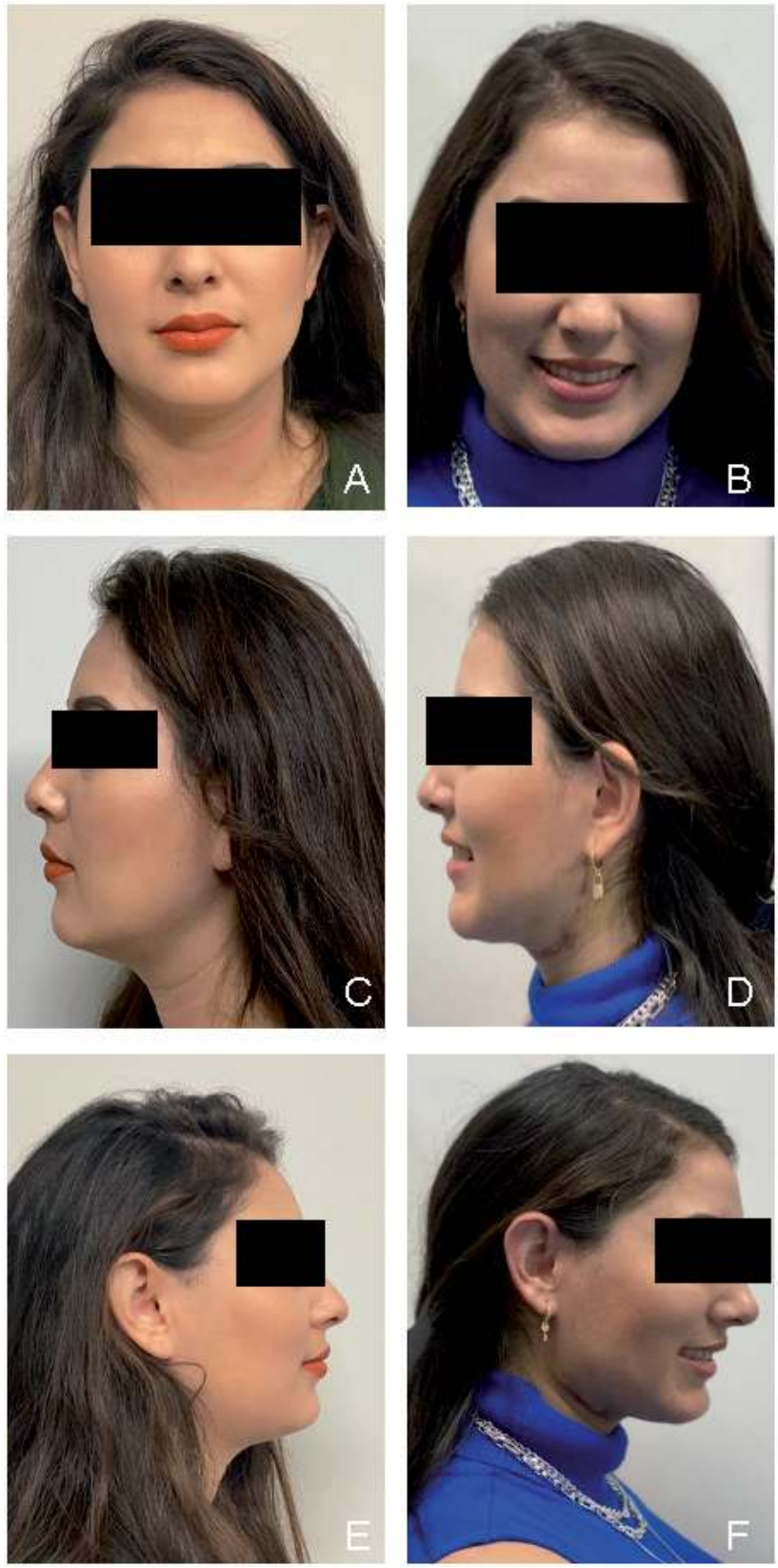

Figure 6.
(A, C, E) preoperative view. (B, D, F) postoperative view 10 days after the procedure.

6. Conclusion

It is important to comment that current evidence regarding lipoinjection with adipose stem cells suggests that they can increase the permanence of the grafted fat to a certain degree; however, it is essential to explain to patients that this procedure can be repeated to obtain a better result in the medium and long term.

We believe that lipoinjection alone or with adipose stem cells is an excellent alternative to improve appearance in patients suffering from a wide range of craniofacial malformations or sequelae.

The search for a more youthful appearance is constant; therefore, we consider that lipoinjection as facial contouring, or in combination with other rejuvenation techniques, currently constitute an excellent therapeutic resource in facial esthetics.

Finally, we consider that the facial image plays a significant role in psychosocial development and integration. We believe that volumetric lipoinjection with or without adipose stem cells represents an excellent alternative to obtain greater facial esthetic harmony, which directly contributes to the self-esteem of children and adult patients.

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Conflict of interest

The authors declare no conflict of interest.

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References

[1] Neuber, G. (1910). Asepsis und kunstliche Blutleere. Verhandl d deutschGesellsch F Chir (Berl), 22, 159.

[2] Mojallal, A., & Foyatier, J. L. (2004, October). Historique de l'utilisation du tissu adipeux comme produit de comblement en chirurgie plastique. In Annales de chirurgie plastique esthetique (Vol. 49, No. 5, pp. 419-425). Elsevier Masson.

[3] Lexer, E. (1910). Freie fettransplantation. Dtsch Med Wochenschr, 36(36), 340.

[4] Rehn, E. (1913). Die Verwendung der autoplastischen Fett-Transplantationen bei Dura-und Hirndefekten. Langenbecks Arch Chir, 101, 962-996.

[5] Brunning, P. (1919). Contribution à l'étude des greffes adipeuses (Vol. 28, Ser. 440). Bull Mem Acad R Med Belg.

[6] Peer, L. A. (1956). The neglected "free fat graft," its behavior and clinical use The American Journal of Surgery, 92(1), 40-47

[7] Peer, L. A. (1950). Loss of weight and volume in human fat grafts: with postulation of a "cell survival theory". Plastic and reconstructive surgery, 5(3), 217-230.

[8] Illouz YG. The fat cell "graft": a new technique to fill depressions. Plast Reconstr Surg. 1986;78(1):122-123.

[9] Guerrerosantos, J. (1996). Autologous fat grafting for body contouring. Clinics in plastic surgery, 23(4), 619-631.

[10] Fournier, P. F. (1985). Microlipoextraction et microlipoinjection. Rev Chir Esthet Lang Franc, 10(41).

[11] Illouz, Y. G. (1990). Fat injection: a four-year clinical trial. Lipoplasty: the theory and practice of blunt suction lipectomy. Boston: Little Brown, 239-246.

[12] Coleman, S. R. (1995). Long-term survival of fat transplants: controlled demonstrations. Aesthetic plastic surgery, 19(5), 421-425.

[13] Verderame, P. (1909). Ueber fettransplantation bei adharenten knochennarben am orbitalrand. Klin Monatsbl Augenheilkd, 47, 433-442.

[14] Zhu M, Zhou Z, Chen Y, et al. Supplementation of fat grafts with adipose-derived regenerative cells improves long-term graft retention. Ann Plast Surg 2010;64:222-228.

[15] Chen X, Yan L, Guo Z, et al. Adipose-derived mesenchymal stem cells promote the survival of fat grafts via crosstalk between the Nrf2 and TLR4 pathways. Cell Death Dis 2016;7: e2369.

[16] Eto H, Suga H, Matsumoto D, et al. Characterization of structure and cellular components of aspirated and excised adipose tissue. Plast Reconstr Surg 2009;124:1087-1097.

[17] Zhou Y., Wang J., Li H., et al. Efficacy and safety of cell-assisted lipotransfer: a systematic review and meta-analysis. Plast Reconstr Surg, 137 (1) (2016), pp.44e-57e)

[18] Zuk PA, Zhu M, Mizuno H, et al. Multilineage cells from human adipose tissue: Implications for cell-based therapies. Tissue Eng. 2001;7:211-228.)

[19] Matsumoto D, Sato K, Gonda K, et al. Cell-assisted lipotransfer: supportive use of human adipose-derived cells for soft tissue augmentation with lipoinjection. Tissue Eng 2006;12:3375-3382.

[20] Rigotti G, Marchi A, Sbarbati A. Adipose-derived mesenchymal stem cells: past, present, and future. Aesthetic Plast Surg 2009;33:271-273.

[21] Yoshimura K, Sato K, Aoi N, et al. Cell-assisted lipotransfer for facial lipoatrophy: efficacy of clinical use of adipose-derived stem cells. Dermatol Surg 2008;34:1178-1185.

[22] Tanikawa DY, Aguena M, Bueno DF, et al. Fat grafts supplemented with adipose-derived stromal cells in the rehabilitation of patients with craniofacial microsomia. Plast Reconstr Surg 2013;132:141-152.

[23] Inigo F, Jimenez-Murat Y, Arroyo O, et al. Restoration of facial contour in Romberg's disease and hemifacial microsomia: experience with 118 cases. Microsurgery. 2000;20:167-172.

[24] Castro-Govea Y, De La Garza-Pineda O, Lara-Arias J, et al. Cell-assisted lipotransfer for the treatment of parry-Romberg syndrome. Arch Plast Surg 2012;39:659-662.

[25] Y Castro-Govea, O De La Garza-Pineda, A Salazar-Lozano. Mini–Temporal and Perilobular Approach to Facelift: Mini-TAPA-Facelift Facial Plastic Surgery 29 (03), 244-252

[26] Matthew R. Endara, MD, Lindsay Jones Allred, BS, Kevin D. Han, MD, Stephen B. Baker, MD, DDS, Applications of Fat Grafting in Facial Aesthetic Skeletal Surgery, Aesthetic Surgery Journal, Volume 34, Issue 3, March 2014, Pages 363-373, https://doi.org/10.1177/1090820X14525964

[27] Laurent F, Capon-Degardin N, Martinot-Duquennoy V, et al. Role of lipo-filling in the treatment of sequelae in craniosynostosis surgery. Ann Chir Plast Esthet 2006;51:512-516.

[28] Versnel SL, Plomp RG, Passchier J, et al. Long-term psychological functioning of adults with severe congenital facial disfigurement. Plast Reconstr Surg 2012;129:110-117.

[29] Tonnard P, Verpaele A, Peeters G, Hamdi M, Cornelissen M, Declercq H. Nanofat grafting: basic research and clinical applications. Plast Reconstr Surg. 2013 Oct;132(4):1017-1026. doi: 10.1097/PRS.0b013e31829fe1b0. PMID: 23783059.

[30] Tonnard P, Verpaele A, Carvas M. Fat Grafting for Facial Rejuvenation with Nanofat Grafts. Clin Plast Surg. 2020 Jan;47(1):53-62. doi: 10.1016/j.cps.2019.08.006. Epub 2019 Oct 28. PMID: 31739897.

[31] Y Castro-Govea, A Vela-Martinez, LA Treviño-Garcia. Volumetric lipoinjection of the fronto-orbital and temporal complex with adipose stem cells for the aesthetic restoration of sequelae of craniosynostosis. Archives of plastic surgery 45 (2), 128

[32] Y Castro-Govea, A Vela-Martinez, LA Trevino-Garcia. Lipoinjection and multiple internal cuts for congenital constriction bands: a new treatment approach. Aesthetic plastic surgery 41 (2), 375-380

[33] Gornitsky, J., Viezel-Mathieu, A., Alnaif, N., Azzi, A. J., & Gilardino, M. S. (2019). A systematic review of the effectiveness and complications of fat grafting in the facial region. JPRAS Open, 19, 87-97. doi:10.1016/j.jpra.2018.12.004

[34] N.G. Dreizen, L. Framm. Sudden unilateral visual loss after autologous fat injection into the glabellar area Am J Ophthalmol, 107 (1989), pp. 85-87