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FACIAL LIPOSTRUCTURE: AN OVERVIEW

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ABSTRACT

Aim: Facial lipostructure (FLS) is not a new procedure. In the past, many surgeons steered clear of it because the results were poor and unpredictable . In the 80's however FLS emerged with precise indications, improved techniques, foreseeable and stable results. Its use has become widespread because it produces natural, long-lasting outcomes with minimal donor site morbidity . FLS usually represents the last procedure or retouch in many reconstructive procedures and protocols. Moreover adipose-derived stems cells (ADSCs) represent a promising source of autologous cells for tissue repair and regeneration.

Methods: In the maxillofacial area, FLS is indicated primarily to restore and rejuvenate the zygomas, periorbital region, cheeks, nose, lips, chin, mandible and jawline. Recently, it has been applied to correct localized tissue atrophy, burns, hemifacial atrophy (Parry-Romberg syndrome, scleroderma, anophthalmic orbit), and loss of substance resulting from trauma, tumor excision, and congenital craniofacial deformity sequelae.

Orthognathic surgery and fat grafting represent a new application and an appropriate indication. It is well known that this surgery moves the skeletal bases (maxilla, mandible, chin) but often this leads to a lack of soft tissue coverage. Some patients, particularly women, complain about this lack of soft tissue volume after bony surgery.

Conclusion: FLS was launched as a means to improve volumes and facial aesthetics. Recently, it has been applied in more complex reconstructive and regenerative procedures. It can especially be used on any facial area lacking soft tissue due to posttraumatic outcomes, post tumor deformities, and as a refinement in for many acquired and congenital maxillofacial deformities. The proposed uses for ADSCs in tissue repair and regeneration are quite impressive. Recent works on ADSCs would suggest that adult cells may prove to be an equally powerful regenerative tool in treating congenital and acquired maxillofacial disorders. More importantly, physicians, researchers and international associations need to work to inform clinicians about what practices are evidence based and to encourage support of additional research. Today tissue engineering and regenerative medicine are a multidisciplinary science that is evolving along with biotechnologic advances.

Keywords: Facial lipostructure, Coleman technique,lipoaspirate, facial fat grafting, facial augmentation, adipose tissue,stem cells,regeneration,engineering,fat grafting reserach

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INTRODUCTION

With attention focused on the face, Sydney R. Coleman systematized the technique in 1991 based on the belief that fat tissue could be an ideal filler, considering that it is natural, sturdy, and without the drawbacks of the earlier fillers [1]. Differently from other fat grafting techniques, the delicate aspiration involved in structural fat grafting allows us to protect fragile adipocytes, purify the material, and reinsert fat using injections to redefine facial contours and create a more congenial and esthetically appealing facial symmetry [1].

Human adipose tissue represents a rich source of mesenchymal stem cells because they exhibit multilineage potential and secrete angiogenic and antiapoptotic factors.The main indications for FLS are restoration and soft tissue facial reconstruction after trauma, tumor resection, in congenital deformities and clefts, Parry-Romberg syndrome and sclero-derma, orbital-periorbital surgery, facial palsy sequelae, burns, scars.

FLS is also used for total facial rejuvenation, including zygomas, lips, nose and mandibular recontouring [2].

METHODS

PREPARATION

Planning is always done with the collaboration of the patient, who must be fully informed about overall procedures. For maxillofacial patients, the ideal position during surgery is supine where the head can be moved in different directions. Anesthesiologic intubation must allow movements of the tube, in particular when injection into the oral and perioral areas is being done. The surgeon must be able to evaluate the patient's contours three-dimensionally throughout the procedure. Preoperative photos are displayed on the walls of the operating room or on a monitor.

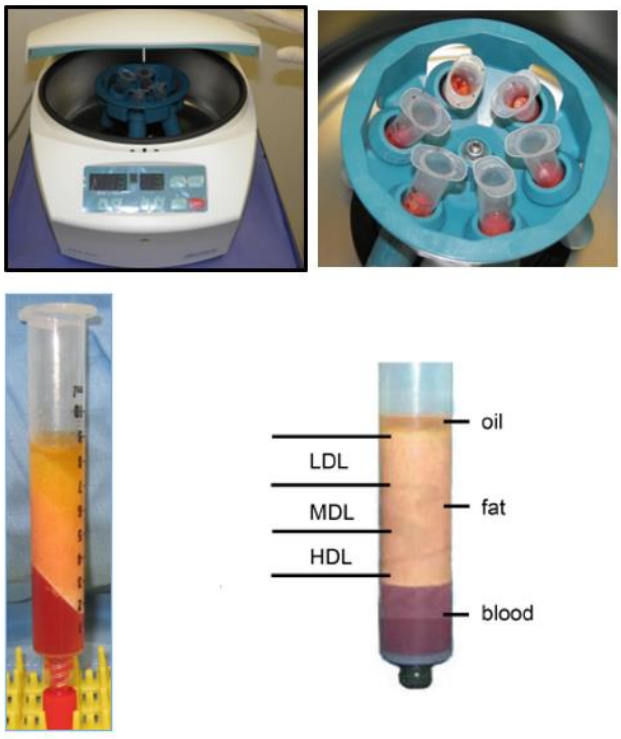


Figure 1 A, B,C,D Coleman's procedure. (A,B) After centrifugation for 3 min at 1300 rpm The fat sample is separated into three layers(C): an upper yellow layer of oil, a middle layer of adipose tissue, and a bottom layer of blood. The top and bottom layers are discarded. The middle layer is divided into three distinct layers: a low-density layer (LDL), a middle-density layer (MDL), and a high-density layer (D). The middle layer of fat, pure fat with stem cells, is used for facial placement-injections.

PREOPERATIVE PLANNING AND FACIAL MARKINGS

Coleman's guidelines prescribe a preoperative plan which includes a photographic setup. Pencils of different color are used on these photos to define both the areas to be injected and those not to be injected. If necessary, also the areas from which excessive fatty tissue needs to be removed. Before surgery, these pencil markings are duplicated on the patient's face [3].

ANESTHESIA

Patients receive sedation or if necessary general anesthesia .A local anesthesia with lidocaine 0.5 % and epinephrine 1:200,000 is infiltrated in the donor and receiving areas . For local anesthesia, calcium carbonate is added to reduce pain.

FAT HARVESTING TECHNIQUE

Common donor sites include the periumbilical area,abdomen, the lateral, anterior, and medial thigh, the "love handles." The buttock is an available source for children. Fat is–removed from those areas by way of two or three small incisions (2 to 3 mm) that are large enough to permit insertion of the tip of the cannula. .The fat is aspirated using a 12-gauge Coleman cannula, usually 15 cm in length, attached to a 10 cc syringe. Cannulas for fat grafting must be atraumatic with a blunt tip to the grafted tissue during the harvesting and the placement as well . The best site for fat harvesting appears to be the abdomen

REFINEMENT AND TRANSFER

Fat processing and purification follows the classically described Coleman technique. We use centrifugation at 1300 rpm for 3 minutes. After centrifugation, only concentrated fat is used for injection (Figure 1).

FAT PLACEMENT PROCEDURE

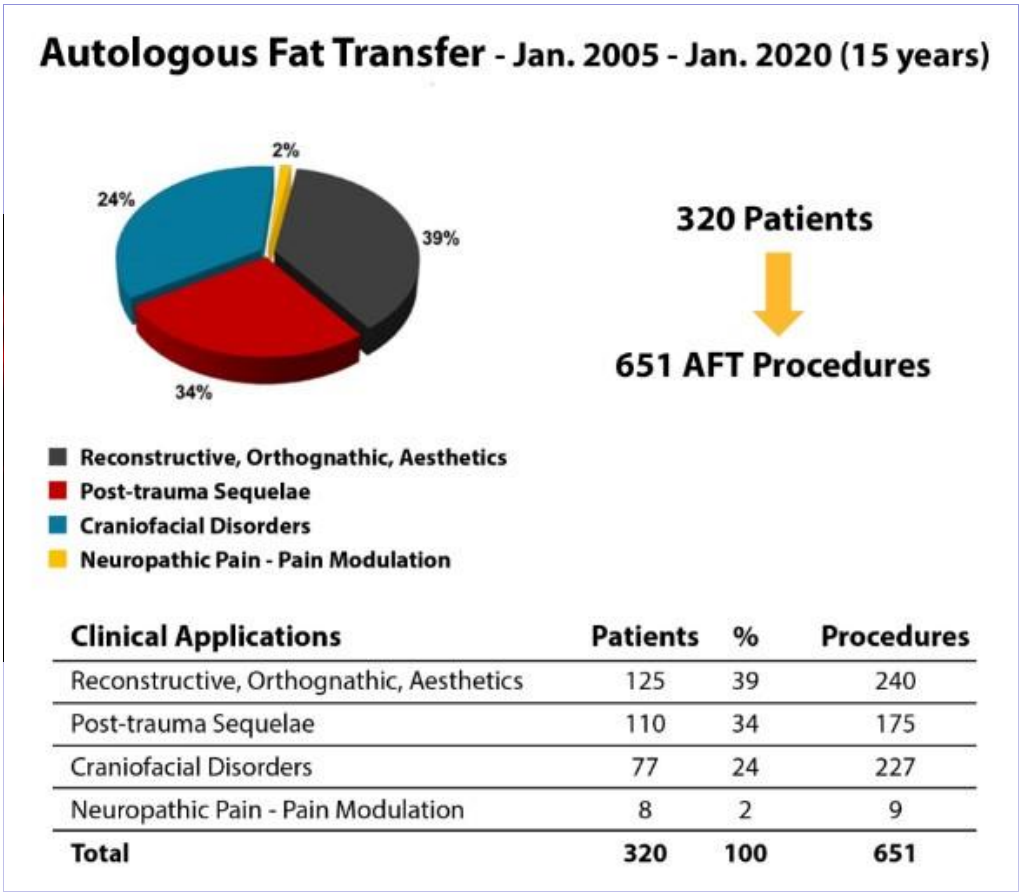
Coleman's technique of FLS is different from other fat grafting techniques for both fat harvesting and fat placement. The procedure is performed delicately: the harvested fat cells are gently centrifuged, thus resulting in a greater percentage of surviving tissue. Keeping in mind the goal of minimal trauma to the adipocytes, different types of cannulas have been used for harvesting and placement.The Coleman cannulas are excellent in terms of volume of collected fat parcels. The surgeon gently grasps the skin and lifts the subcutis away from the underlying structures.Quickly moving the syringe and needle in the subcutaneous plane allows the collection of fat without trauma and blood loss. The cannula is inserted through small incisions made with a No. 11 blade or an 18-gauge needle. With linear deposition, the fat is layered into the area to be enhanced, working from the underlying bone up to the skin surface. With each insertion, a very small quantity of fat is deposited as the cannula is withdrawn. The fat must be gently woven in several layers from the periosteum to the subdermis to optimize the potential for neovascularization, allowing the fat cells to survive and maintain the filamentous architecture. Some of the fat is slowly absorbed by the body, although the amount of resorption is unpredictable.The percentage varies from patient to patient , usually from 20% to 30%. If a significant amount of fat is resorbed, a second or third procedure may be considered to improve the final result. Indeed, using more fatty tissue in a single-step corrective procedure can cause poor vascularization and more resorption, particularly in areas covered by a thin layer of soft tissue, such as the maxillofacial area giving the so-called choke effect and the possible formation of cysts and fibrosis. In fat grafting, overcorrection, overgrafting, and the choke effect must be avoided [4]. The donor sites are marked according to the classic Coleman protocol. Local infiltration is performed with 0.5% lidocaine with 1:200,000 epinephrine. Then blunt cannulas are inserted, and with a gentle negative pressure controlled with the hand, the fat is harvested from the periumbilical area, abdomen, thighs, and knees. Today, disposable cannulas for aspiration and injection are available.After harvesting, donor areas should be massaged witha fibrinolytic ointment. Strips of Microfoam tape are meticulously placed on the infiltrated areas and left in place for five to

seven days. This provides a protective barrier to reduce the formation of edema and prevents the patient from touching the skin. The patient cannot massage the infiltrated areas for approximately three weeks.During surgery and in the early postoperative period ,as in all other liposuction procedures, it is essential to use antithrombotic socks.

POSTPROCEDURAL CARE

The Coleman procedure prescribes that light compression tapes be applied around the infiltrated areas and that, if the fat is harvested from the abdomen, the patient should wear an abdominal binder for approximately seven to ten days, because the harvesting involves different layers of the abdomen, with consequent laxity of muscles and fasciae.Early ambulation is suggested. Cool packs are applied to all recipient sites for 24 to 36 hours postoperatively. Antibiotics and anti-inflammatory medications are administered for several days . Patients must be instructed that postoperative swelling can last for three to four weeks. Only when the swelling has resolved can the results be evaluated. The recovery time will depend on the extent of the procedure and on the type of pathology.

Table 1:Record of cases from 2005 to 2020(15 years): number of patients, total fat grafting procedures, and clinical distribution.



Clinical Applications	Patients	%	Procedures
Reconstructive, Orthognathic, Aesthetics	125	39	240
Post-trauma Sequelae	110	34	175
Craniofacial Disorders	77	24	227
Neuropathic Pain - Pain Modulation	8	2	9
Total	**320**	**100**	**651**

POTENTIAL PROBLEMS AND COMPLICATIONS

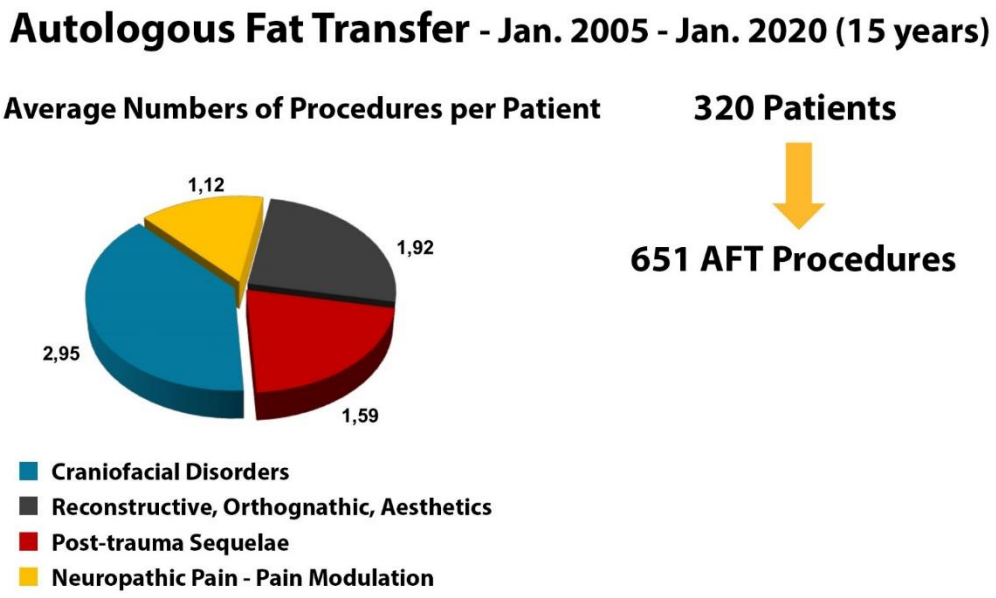
FLS may involve aesthetic complications which include the placing of either too much or too little fat, surface irregularities, lumps and bumps, and fat migration. To ensure volume stability, the patient should be reevaluated a few months after the initial procedure. One can plan touchups to inject additional fat so as to correct irregularities or remove lumps and bumps [4,5,6].Other complications in the maxillofacial region include damage to underlying structures such as nerves,muscles, glands, and blood vessels. However, permanent injuries are extremely rare.

When fat grafting is performed in the nasal and periorbital areas, the nasolabial folds, and even in the lower lip, perhaps the most devastating potential complication is embolization after inadvertent intravascular injection. To avoid such complications, the use of sharp needles is forbidden. Additionally, the size of the fat parcel injected must be limited, digital pressure avoided, the syringe size should be small (only 1 mm syringes are used in the face), and ratcheting guns should not be used. Injection of vasoconstrictors is helpful. Irregularities and deformities may occur in the donor areas, as happens in liposuction. Moreover, the abdominal binder reduces the possibility of donor site irregularity. This will be particularly evident in thin patients [7,8,9,10,11].

RESULTS

Facial recontouring can greatly benefit from the FLS .It has recently been proven that human adipose tissue is a rich source of mesenchymal ADSCs with multilineage potential and featuring the secretion of angiogenic and antiapoptotic factors in animals. As the field of regeneration biology progresses, new strategies are being developed to treat various facial soft tissue defects and craniofacial disorder sequelae (Table 1,Table2).These craniofacial disorders are unique in that they affect multiple tissues simultaneously and occur across the full spectrum of patient age and development . Preliminary research investigated if autologous ADSCs injections could relieve neuropathic pain. ADSCs have also been shown to reduce chronic neuropathic pain, working as a painkiller

Table 2:Record of cases from 2005 to 2020(15 years): number of patients, number of procedures, type of clinical application, average number of procedures per patient depending on the primary pathology.



Clinical Applications	Average Procedures per Patient
Craniofacial Disorders	2,95
Reconstructive, Orthognathic, Aesthetics	1,92
Post-trauma Sequelae	1,59
Neuropathic Pain - Pain Modulation	1,12

Figure 2 A, B (A) Severe left orbital trauma. The patient underwent different orbito-facial reconstructive surgeries. Then, three fat grafting procedures were carried out to add volume in the periorbital area, temporal fossae, zygomas. (B)

Figure 3 A, B (A) Right eyebrow palsy post-trauma with temporal fossae hollowness and infraorbital irregularities. (B) After different staged reconstructions, two fat grafts improved the residual temporo-frontal deformities

Figure 4 A, B (A) Severe panfacial trauma sequelae with shrinking of the facial soft tissue volumes. (B) After bony reconstruction the patient had three fat grafting procedures with global volumetric recovery

Figure 5 A, B (A) Crouzon disease . At age 17 the patient underwent a Le Fort 3 osteotomy plus a Le Fort 1 and wide genioplasty. (B) Due to the paucity of facial soft tissue volumes two fat grafts were planned in the midface and zygomatic area

Figure 6 A, B, C (A) Freeman-Sheldon Syndrome or Whistling-face: is a severe rare disease with general contractures (prevalence 1/1,000,000). (B,C) Fat grafting: in this case, as in patients with scleroderma, it is a reliable and non-invasive procedure that reduces disabilities and improves skin quality and texture, mouth opening, constriction and recovery of most facial movements

Figure 7 A, B (A) Right washboard effect after many craniofacial surgeries in childhood and adolescence for fibrous dysplasia . (B) Two fat grafting procedures were necessary to restore volume and to cancel the forehead irregularities with a quite stable outcome with regenerative effects

Figure 8 A, B (A) Labial and perioral scars sequelae of cleft lip surgeries . (B) Fat grafting was planned to fill and re-volumize the oral perioral area to reduce the scars.

Figure 9 A, B (A) A young patient operated at 12 months to correct craniostenosis with scaphocephaly. An hour-glass deformity became evident during growth . At the age of 10 years, fat was harvested from the buttocks. The entire forehead and temporal fossae were fat grafted. (B) Volume-increasing as well as the regenerating effects with improvement of skin quality are evident .

Figure 10 A, B (A) A 30-year-old patient with a severe form of Perry-Romberg syndrome . In progressive hemifacial atrophy different complex treatments have been proposed in the past. The use of fat grafting has greatly simplified soft tissue restoration and post recovery time. The patient underwent four main procedures and one touch up. (B) Two years after the last fat grafting there is a satisfactory and long-lasting recovery of the facial volumes

DISCUSSION

For the patient, facial and orbito-cranio-facial deformities typically have both great social impact and functional importance (Figures 2,3,4) . There are various surgical techniques that can be used to treat such pathologies, but often involving high morbidity and not allowing correction of smaller, more subtle contour irregularities (Figures 5,6,7,8). FLS by soft tissue augmentation is a technical revolution used increasingly worldwide. In recent years, it has evolved into more complex restoration procedures. Moreover, the advent of regenerative medicine promises repair or regeneration of oral and craniofacial structures that are absent or lost as a result of congenital anomalies, trauma, and various pathologic conditions [12,13,14,15]. Today tissue engineering and regenerative medicine are a multidisciplinary science that are evolving along with biotechnologic advances. The proposed uses for ADSCs in tissue repair and regeneration are quite impressive. Recent works on ADSCs would suggest that this adult stem cell might prove to be an equally powerful tool in treating congenital and acquired disorders. The availability of the processes for obtaining stem cells remain a challenge for surgeons and scientists pursuing regenerative medicine.Thus ADSCs are a promising source of autologous stem cells for numerous tissue engineering and regenerative medical applications.Soft tissue augmentation by FLS must be part of the armamentarium of any reconstructive surgeon, not only as an ancillary procedure, but also as a basic surgical technique for various facial and orbito-cranio-facial reshaping and restorations (Figures 9,10).

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DECLARATIONS

Authors' Contribution

Contributed equally to the drafting of manuscript, data collection and analysis:

Luigi Clauser, Maria Elena de Notariis ,Carolina Sannino,Antonio Lucchi

Availability of data and materials

Not applicable

Financial support and sponsorship

None

Conflicts of interest

All Authors declared that there are no conflicts of interest

Ethical approval and consent to participate

Not applicable

Consent for publication

Written informed consent was obtained for all patient images.

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