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Viability and adipogenic potential of human adipose tissue processed cell population obtained from pump-assisted and syringe-assisted liposuction

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Summary

Background: Correcting soft tissue defects by autologous fat grafting has been a routine procedure in plastic surgery. Liposuction material for autologous fat grafting is normally obtained using a hand-held syringe. The pump-assisted liposuction technique is not used because of the belief that cells in the harvested fat tissue are necrotic from the physical forces created by the vacuum pump liposuction machine.
Objective: The metabolism and adipogenic potential of cultured mesenchymal precursor cells processed from pump and syringe lipoaspirates were studied.
Methods: Metabolic estimates were determined with alamarBlue™ assay. These cells were also induced along the adipogenic lineage with adipogenic induction factors. The extent of adipogenic differentiation was measured using a digital photo counting software.
Results: The cells obtained by pump-assisted liposuction are viable, have comparable metabolic activity and adipogenic potential which are comparable to cells using the syringe for aspiration.
Conclusion: The implications of this study are that pump-assisted liposuction might be a possible alternative to aspirating adipose tissue for reimplantation during reconstruction procedures.

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1. Introduction

Autologous fat transplants have been used to correct body contour deformity for the past century. The first known recorded case of autologous fat transplant was done by Neuber [1] in 1893 where fat from the upper arm was transplanted into a depressed facial scar. In the 1980s, Illouz [2] and Asken [3] developed techniques that redefined liposuction surgery and autologous lipoinjection.

The survivability of fat grafts is rather low. A number of studies reported autologous transplant of fat graft resorbed by 30—70% within a year [4,5]. Graft size reduction might be categorized into two processes. Initially, the wound healing process produced high contraction forces in the skin immediately above and surrounding the grafted adipose tissue. The graft also experienced a resurgence of angiogenesis from the surrounding tissue into the graft. Angiogenesis also carried along a whole host of growth factors. This angiogenic response, however, would not be immediately extensive resulting in some interior sections of the graft being apoptotic, leading to cell death and ultimately tissue necrosis. Therefore, the graft underwent remodeling with a reduction in size as illustrated by an in vivo rat study which reported survival rate of autologous fat transplantation to be 30% [6]. Survivability of grafted adipose tissue thus clearly depended on various factors, of which, the initial factor would be the aspiration technique.

Presently, aspirating adipose tissue for autologous transplantation has been largely restricted to the syringe procedure, as vacuum pump was considered to be unsuitable for aspirating fat for autologous lipoinjection. As 90% of the adipocyte cytoplasm are lipids, under the negative pressure of the vacuum pump, adipocytes were lysed with foam observed in the tubing connecting the cannula to the pump. This issue seemed to work against the paradigm of aspirating fat with a vacuum pump. However, this lysis effect is also present in syringe aspiration, thus resulting in low numbers of surviving adipocytes. Compounding the problem is that adipocytes may have limited proliferative potential. These characteristics further contributed to poor graft survivability and reduction in the tissue amount aspirated from either procedure. Rethinking, an alternative strategy is to liberate the adipocytic precursor cell populations from within the graft tissue and use a more potent cellular mixture. Although these adipocytic precursors are present within the graft, these cells are trapped and surrounded by necrotic tissues within the graft. There is also decreased metabolites diffusion within the graft, further aggravating the necrosis of the graft. Instead, adipocytic precursors like preadipocytes and mesenchymal precursor cells have high proliferative potential and are capable of adipocytic repopulation. These indigenous characteristics would be unlocked and could contribute to eventual survivability of the implanted graft. Leading from this, the knowledge of cell types in the heterogeneous population that did survived both the aspiration processes, both syringe and pump liposuction, therefore becomes clinically relevant.

Therefore, this study compared the metabolic profile and adipogenic potential of the putative adult precursors populations which were capable of adipogenic differentiation obtained from both methods of liposuction.

2. Materials and methods

The syringe- (s) and pump-assisted (p) liposuction refer to aspirating with a syringe and a vacuum pump, respectively. The experiments were conducted with the approval by the Ethics Committee of the National University Hospital (NUH), Singapore, and the full informed consent of the patients. Eight patients were entered in the study.

2.1. Liposuction procedures

In the NUH liposuction protocol, epinephrine in normal saline solution (1:1,000,000) cooled to 4 °C was used [7]. This fluid was first infiltrated into the site to be aspirated, via stab incisions. The epinephrine/saline solution infused caused vasoconstriction to minimize blood loss. All the specimens in this study group were obtained from the abdomen.

After 15—20 min, the liposuction cannula was inserted through the previous stab incisions in the abdomen. Adipose tissue was aspirated from the same patient with syringe liposuction preceding the pump-assisted liposuction.

The syringe liposuction procedures were performed with a 15-cm long, 2-mm diameter, Triport III cannula (Byron, USA) fitted by Luerlock to a 50-cm^3 syringe (Terumo®, Tokyo, Japan). The plunger of the syringe was drawn out and its position maintained by an appropriately sized 'Snapper' (Bryon, USA), to generate the negative pressure in its lumen. The fat aspirated was then emptied into a 70-ml sterile container (Sarstedt, Austria).

The pump-assisted liposuction procedures were performed with a power-assisted Lipoplasty device, PAL-200® (Microaire, VA, USA) fitted with a size 4 Triport III tip cannula. The maximum negative pressure of −100 kPa (−30 mmHg) was created with a Hercules® liposuction machine (Well Johnson, AZ,