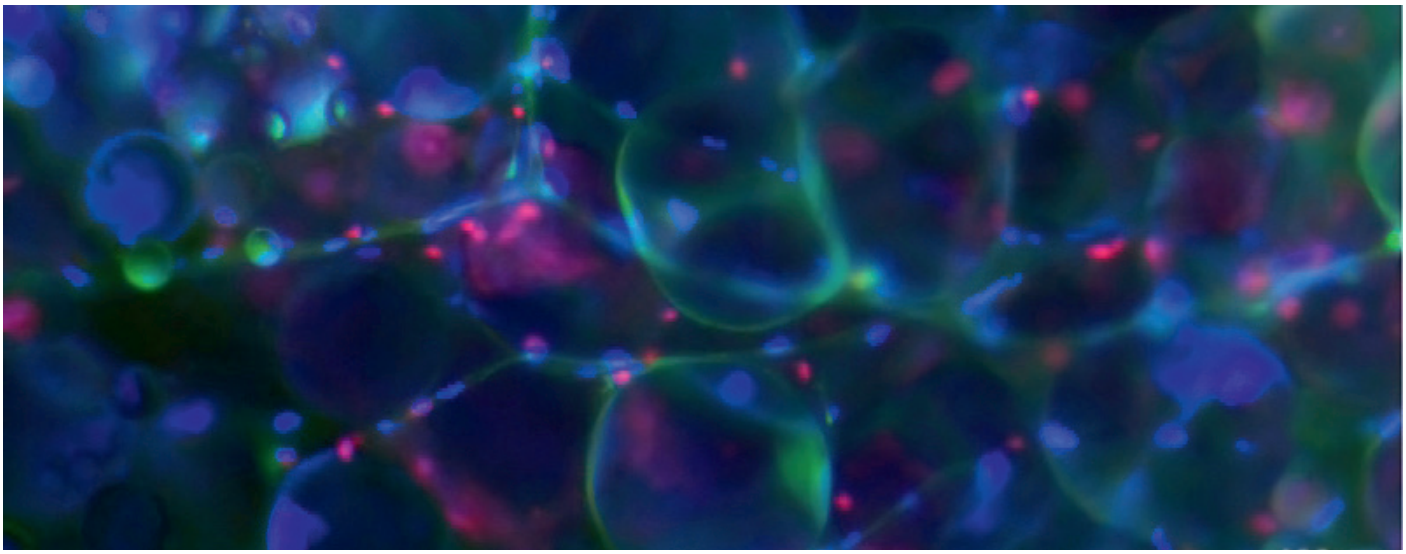
News from science and research
Special Edition

Adipose tissue viability

and yield of mesenchymal stem cells



With the strong rise of fat grafting and lipofilling procedures, the scientific discussion and research about the viability of adipose tissue from different liposuction and fat grafting methods has provided new relevant findings.

Mesenchymal stem cells with water-jet assisted liposuction (WAL) – Commentary by Peter Rubin and N. Vial

In a recent paper published in Aesthetic Surgery Journal 2015*, J. Peter Rubin and Ivan N. Vial (Department of Plastic Surgery, University of Pittsburgh, USA), comment on the article "Isolation and Differentiation Potential of Human Mesenchymal Stem Cells from Adipose Tissue Harvested by Water Jet-Assisted Liposuction, by Meyer et al..

Vial and Rubin "applaud the authors on this well conducted study validating the quality of fat harvested by WAL, including a favorable MSC yield and cell function. WAL harvested fat has been applied successfully for total breast reconstruction, and this study provides data to support the tissue quality for this application."

Peter Rubin explains in his commentary that

- "WAL uses simultaneous infiltration and suction to dissect and extract fat during liposuction. Using water to dissect tissues is an idea that evolved in the last century and was later geared towards the dissection of fat in 2001."
- "Since that time, a number of studies have suggested advantages to the use of WAL, including decreased pain, decreased intraoperative swelling, better contouring, and decreased need for anesthesia. The gentle nature of WAL has been utilized in the treatment of lipoedema, where clinicians noted that this aspiration method may induce less trauma to lymphatics."
- "With the evolution of fat grafting, the utility of WAL for fat harvest has been explored. The Harvest method can certainly impact graft healing and affect the characteristics of the graft. In this study, the authors sought to characterize the mesenchymal stem cell (MSC) content of fat grafts harvested by WAL, including yield and plasticity. Additionally, they assessed the viability of the graft material using a live/dead assay."

It is acknowledged by Rubin and Vial that

- “Meyer et al present strong evidence in a well-conducted study that WAL harvested fat has favorable characteristics for fat grafting. They show preserved graft architecture with highly viable grafts as assessed by live/dead staining.”

- “The yield of stromal vascular fraction (SVF) from WAL harvested fat is reasonably high, with an average of 6.1×105 cells per gram of tissue and a high fraction of CD34 positive cells. The MSCs isolated from WAL harvested fat are adherent to tissue culture plastic and proliferate in culture. The authors further show MSC functional benchmarks including calcium deposition and accumulation of intracellular lipid when the cells are cultured in a defined differentiation medium. A clear strength of the study is the use of multiple human subjects for tissue collection.”

Also it is noted that “the authors compare their results to previously published methods of isolation, noting a higher yield of cells in the SVF per milliliter of lipoaspirate using WAL.”

(*Ivan N. Vial, MD; and J. Peter Rubin, MD: Commentary on: Isolation and Differentiation Potential of Human Mesenchymal Stem Cells From Adipose Tissue Harvested by Water Jet-Assisted Liposuction. Aesthetic Surgery Journal 2015, Vol 35(8) 1040–1041)

WAL of adipose tissue is well suited for autologous fat grafting because it retains tissue viability. Furthermore it is a valid source for the subsequent isolation of adMSC with multipotent differentiation potential.

This is the conclusion of the article **“Isolation and Differentiation Potential of Human Mesenchymal Stem Cells From Adipose Tissue Harvested by Water Jet-Assisted Liposuction”** by J. Meyer et al. (published in Aesthetic Surgery Journal 2015*).

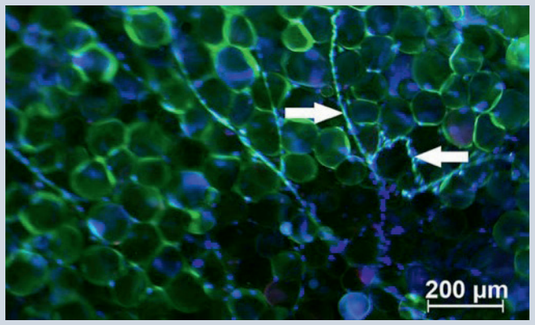
The authors characterize the content, viability and differentiation potential of mesenchymal stem cells in WAL fat. They summarized that

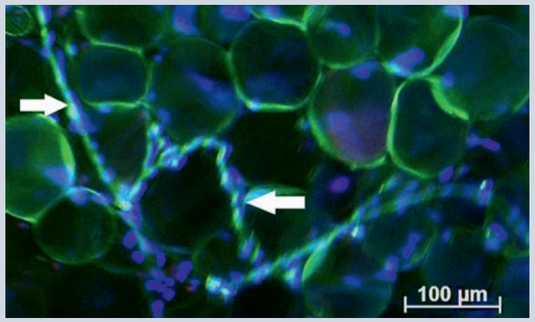
- “In recent years the therapeutic application of extracted adipose tissue for autologous fat grafting and the application of adipose tissue-derived mesenchymal stem cells (adMSC) isolated thereof has progressed. Water-jet assisted liposuction (WAL) is one procedure for harvesting adipose tissue and provides a favorable aesthetic outcome combined with high tissue protection. Tissue aspirated by WAL has been successfully applied in grafting procedures.

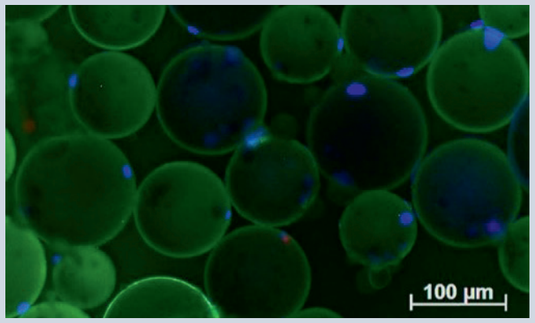
- “The aims of this study were to confirm the tissue viability and to understand the abundance and mesenchymal differentiation capacity of stem cells within the tissue.

- The authors analyzed tissue integrity of WAL tissue particles via fluorescence microscopy. The adMSC content was determined by isolating the cells from the tissue. The mesenchymal differentiation capacity was confirmed with cytochemical staining methods.

Results: “The stromal vascular fraction of WAL tissue showed high viability and contained an average of 2.6 × 105 CD34-positive cells per milliliter of tissue. Thus WAL tissue contains a high number of stem cells. Furthermore adMSC isolated from WAL tissue showed typical mesenchymal differentiation potential.”

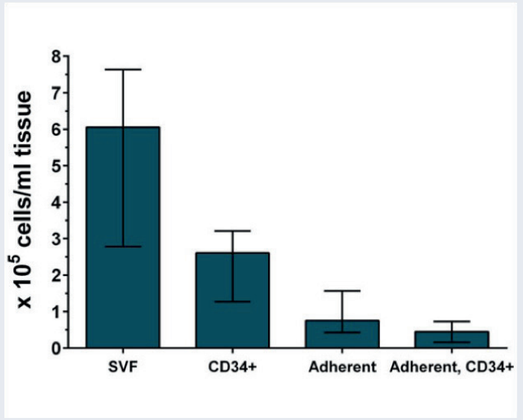






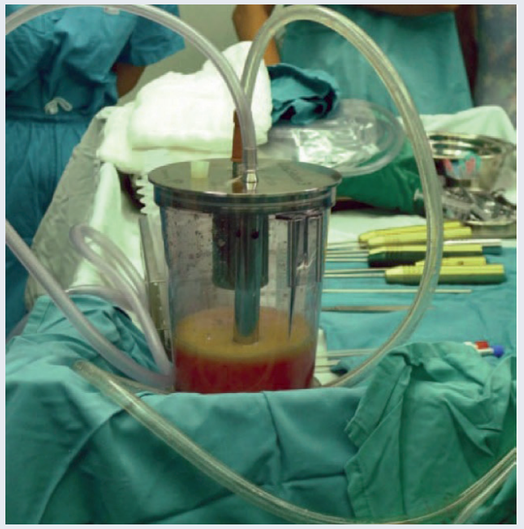
Picture 1-3: Intact blood vessels, adipocytes and stem cells in WAL aspirate

Reference: Aesthetic Surgery Journal 2015, 1–10



Picture 4: Quantification of cell amounts after different steps of isolation (cell concentration in the SVF; concentration of CD34-positive cells within the SVF; concentration of plastic-adherent cells after 24 hours of culture; concentration of plastic-adherent and CD34-positive cells after 24 hours of culture; n=7). The SVF on average contains 6.1×105 cells per ml harvested adipose tissue and an average of 2.6×105 cells per ml tissue was positive for CD34. After 24 hours of cultivation, an average of 0.8×105 cells per ml tissue was plastic adherent, and thereof 0.45×105 cells per ml tissue, on average, were positive for CD34.

Reference: Aesthetic Surgery Journal 2015, 1–10



Picture 5: LipoCollector water-jet system.
The LipoCollector is connected to the liposuction cannula and negative-pressure pump during the harvesting procedure and has a prefilter to eliminate the fibrous materials. Lipoaspirates were separated from fluid in the LipoCollector during the liposuction period.

Reference: Plast. Reconstr. Surg. 135: 127, 2015

Conclusions: “WAL of adipose tissue is well suited for autologous fat grafting because it retains tissue viability. Furthermore it is a valid source for the subsequent isolation of adMSC with multipotent differentiation potential.”

(*Juliane Meyer, MSc; Achim Salamon, PhD; Nicole Herzmann, MSc; Stefanie Adam; Hans-Dieter Kleine, MD; Inge Matthiesen, PhD; Klaus Ueberreiter, MD; and Kirsten Peters, PhD: Isolation and Differentiation Potential of Human Mesenchymal Stem Cells From Adipose Tissue Harvested by Water Jet-Assisted Liposuction. Aesthetic Surgery Journal 2015, 1–10)

More viable lipoaspirates and better fat survival with water-jet fat

The systematic, comparative, randomized, controlled study by Yin et al. **“Does Water-Jet Force Make a Difference in Fat Grafting? In Vitro and In Vivo Evidence of Improved Lipoaspirate Viability and Fat Graft Survival”** demonstrates the effect of the water-jet method on the vitality and postoperative fat survival of fresh lipoaspirates (published in Plastic & Reconstructive Surgery 2015*).

The authors Shilu Yin et al. compare water-jet assisted liposuctin (WAL) versus manual fat harvesting:

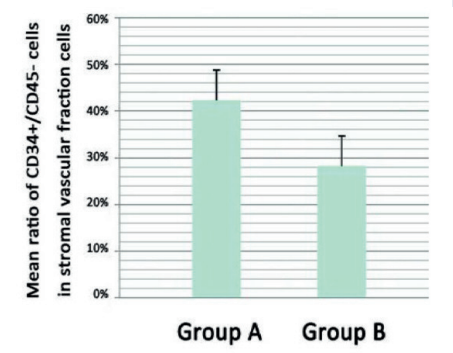
“Human lipoaspirates were obtained from healthy Chinese female volunteers for body shaping. Lipoaspirates were harvested by a single surgeon using the same material and machine; water-jet assistance was the only variance in this study. At the beginning of surgery, the authors randomly performed conventional manual liposuction without water-jet assistance for one side to obtain 50 ml of lipoaspirate (group B). At the corresponding area of the other side, the authors used water-jet–assisted liposuction to obtain another 50 ml of lipoaspirate (group A). All of the harvested lipoaspirates were used in the in vitro and in vivo experiments to evaluate the effect of water-jet force on the vitality and postoperative fat survival of fresh lipoaspirates.”

The authors investigate the

1. Adipocyte viability by histological analysis and glucose transport tests in fresh lipoaspirates,
2. Multidirectional differentiation ability of the SVF fraction/adipose stem cells,
3. Fat survival in a nude mice model,
4. Vascularization of the fat graft,
5. Apoptosis (cell death) in grafted adipose tissues.

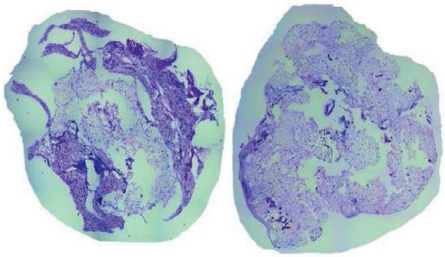
All results are in favor of the water-jet assisted fat.

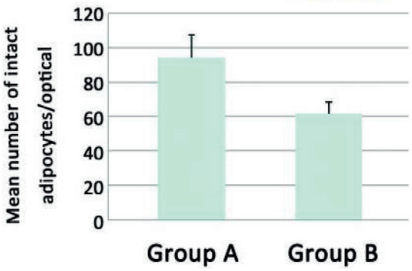
Results: “Fresh lipoaspirates from group A had greater viability and a higher percentage of CD34+/CD45− cells than group B. Grafted lipoaspirates in group A had better weight retention, less apoptosis, and greater angiogenesis.”



Picture 6: Mean content of adipose stem cells (CD34+ and CD45- cells); Group A: water-jet; Group B: manual aspiration.

Reference: Plast. Reconstr. Surg. 135: 127, 2015





Picture 7-8: Mean number of intact adipocytes. Group A: water-jet; Group B: manual aspiration

Reference: Plast. Reconstr. Surg. 135: 127, 2015

Conclusions: "The fate of grafted lipoaspirates was affected by water-jet force. With the assistance of water-jet force during the harvesting procedure, the authors could obtain more viable lipoaspirates and achieve better fat survival."

(*Shilu Yin, M.D., Jie Luan, M.D., Su Fu, M.D., Qian Wang, M.D., Qiang Zhuang, M.D.: Does Water-Jet Force Make a Difference in Fat Grafting? In Vitro and In Vivo Evidence of Improved Lipoaspirate Viability and Fat Graft Survival. Plast. Reconstr. Surg. 135: 127, 2015)

Autorisierter Sonderdruck der **human med AG**
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