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A Paradigm Shift in Metabolic Surgery: Targeted Source Removal via Endoscopic Visceral Lipectomy

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ABSTRACT

Background: *Intra-abdominal visceral adipose tissue (VAT) functions as an active pathological cytokine gland, releasing a continuous stream of metabolically noxious molecules (resistin, IL-6, angiotensinogen) directly into the hepatic portal circulation, initiating insulin resistance and type 2 diabetes. Traditional interventions such as restrictive and bypass bariatric surgeries exhibit significant long-term undesirable effects, while pharmaceutical therapies (GLP-1 receptor agonists) suffer from extremely high patient discontinuation rates, triggering weight rebound and permanent lean muscle loss. Direct surgical visceral fat removal represents a targeted solution. Pre-clinical feline and baboon studies established initial proof-of-safety, but the technology (high-pressure water liquefaction) used in them mandated a semi-open procedure with extensive manual exenteration of the small bowel with significant risk of complications such as adynamic ileus and peritoneal adhesions. This study introduces Endoscopic Visceral Lipectomy (EVL®) utilizing Twin Cannula Assisted Liposuction (TCAL) as a strictly laparoscopic, closed-cavity milestone in metabolic surgery to minimize those risks.*

Methods: *We evaluate the longitudinal metabolic outcomes of a human pilot trial (Baskoy et al. 13, 2025) of mesenteric visceral lipectomy and present the technical mechanism of the coaxial TCAL platform specifically designed to overcome historical safety constraints within the small bowel mesentery.*

Results: *Human pilot trial data [13] demonstrated a dramatic reduction in Fasting Plasma Glucose (FPG) from 211 ± 12 mg/dL at baseline to 140 ± 4 mg/dL at 6 months ($p < 0.01$), with HbA1c falling from 8.9% ± 0.6% to 7.7% ± 0.3% ($p < 0.01$). Continuous Glucose Monitoring (CGM) Time-in-Range surged 3.4-fold from 22% ± 3% to 74% ± 6% ($p < 0.001$). Liver-targeted stabilization was evidenced by a substantial drop in hepatic fat content from 23.9% ± 3.7% to 19.1% ± 3.4% ($p < 0.004$) at 12 months, and an increase in hepatic EGP suppression from 29% ± 4% to 43% ± 4% ($p < 0.05$).*

Conclusions: *While early trials verified the therapeutic potency of visceral fat removal, the coaxial TCAL system provides the necessary safety paradigm. By employing a completely stationary outer shield, TCAL protects bowel walls, blood vessels and nerves from physical or thermal damage, permitting a strictly laparoscopic intra-abdominal procedure that completely eliminates the need for manual bowel exenteration, reducing the likelihood of postoperative adynamic ileus and peritoneal adhesions.*

Keywords

Mesenteric Visceral Lipectomy (MVL), Endoscopic Visceral Lipectomy (EVL®), Twin Cannula Assisted Liposuction (TCAL), Type 2 Diabetes, Metabolic Syndrome.

Research Highlights

- Direct physical removal of pathogenic mesenteric visceral fat treats the primary anatomical source of metabolic syndrome and insulin resistance.

- Early higher-mammal pilot trials (NOTES feline omentectomy[11], 2011) proved safety and net weight trajectory modification.
- Clinical trials using high-pressure saline liquefaction (Baskoy et al.[13], 2025) demonstrated profound hepatic insulin sensitivity and glycemic correction.
- The non-coaxial fluid dynamics of early liquefaction devices mandated a semi-open approach with manual exenteration and fanning of the small bowel.
- Twin Cannula Assisted Liposuction (TCAL)'s reciprocating inner cannula and stationary outer sheath provide a protective shroud near bowel vasculature.
- TCAL enables a strictly laparoscopic, closed-cavity procedure, minimizing the risk of adynamic ileus and adhesions associated with bowel exenteration.
- Laparoscopic mesenteric defatting acts synergistically with GLP-1 agonists and provides a permanent anatomical off-ramp, preventing post-drug cessation weight rebound.

Introduction

Subcutaneous Lipoplasty Foundations

Modern metabolic medicine has historically focused on systemic weight reduction and symptom management rather than targeting the precise anatomical driver of metabolic disease. Subcutaneous fat, long the primary target of aesthetic liposurgery, has been evaluated for metabolic benefits. Early clinical investigations, notably the landmark large-volume subcutaneous liposuction trial by Giese et al. [1] and a subsequent 123-patient clinical study conducted by D'Andrea et al. [2], demonstrated that large-volume subcutaneous clearance of adipose tissue yields statistically significant improvements in systemic metabolic parameters, resting energy expenditure, blood pressure, and insulin sensitivity in obese women.

Since manual liposuction is both strenuous for the surgeon and creates significant bruising and swelling in patients, the first innovation in liposuction was to pneumatically reciprocate the aspirating cannula. This Power Assisted Liposuction (PAL) was invented by Cucin [3] and manufactured and marketed by the Ethicon Division of Johnson and Johnson as the ARCII Reciprocating Cannula®. Later electrical single cannula reciprocation devices were developed as well. PAL removed the drudgery of surgery for the surgeon and shortened patient convalescences by lessening bruising and swelling. However, the to-and-fro motion of the reciprocating cannula against the patient's tissues and surgeon's hand created a risk of carpal tunnel syndrome and lateral epicondylitis for the surgeon.

To execute these massive subcutaneous aspirations safely, the clinical introduction of patented Twin Cannula Assisted Liposuction (TCAL) technology, highlighted in Cucin and Pelosi's "A Safer and Faster Alternative to Bariatric Surgery" [4], proved vital. The TCAL system features an inner reciprocating cannula ensheathed within a completely stationary outer cannula, sparing the patient's tissues and the surgeon's upper extremities from the high-fatigue "battering ram" stroking of traditional single-cannula power-assisted liposuction (PAL) devices. The outer cannula acts as a physical shim and protective spacer, leaving the subdermal fascial vascular lattice uninjured while promoting profound skin contraction, shorter convalescence, and minimized blood loss [5]. TCAL devices migrated from pneumatic to electromechanical actuation to facilitate wider adoption.

The clinical successes of large-volume subcutaneous fat clearance and next generation technology naturally led researchers to evaluate the far more active and pathogenic visceral fat compartment.

The Visceral Target and GLP-1 Therapy Limitations

A critical biological distinction exists between passive subcutaneous adipose storage and the highly active visceral fat wrapping around internal organs. Articulated by Dr. Robert L. Cucin, intra-abdominal visceral fat—particularly mesenteric fat—functions as a toxic endocrine gland, or a "noxious cytokine factory" [6], releasing a continuous stream of inflammatory cytokines (resistin, angiotensinogen, IL-6) and free fatty acids directly into the portal vein. This portal efflux directly bathes the liver, generating profound hepatic insulin resistance, dyslipidemia, and systemic atherosclerosis. To address this biological cause, Cucin patented a method and apparatus specifically designed to treat abdominal obesity and metabolic syndrome by targeted intra-abdominal visceral fat removal, originally filed on August 5, 2009 (U.S. Patent No. 8,348,929 B2) [6], followed by conceptual validations published in BAOJ Diabetes [8] and Clinical Research in Diabetes and Endocrinology [9].

The current therapeutic landscape relies heavily on GLP-1 receptor agonist pharmaceuticals. However, GLP-1 therapies suffer from severe systemic limitations: clinical data indicates that over 15% of patients cannot tolerate GLP-1 side effects for more than a single month due to persistent gastrointestinal distress or complications, and over 50% of patients completely discontinue the medication within one year. Upon drug cessation, the majority of patients experience rapid, profound weight rebound, regaining some or all of their lost weight. Crucially, over 30% to 40% of the weight lost during active GLP-1 therapy is composed of lean muscle mass. Upon drug discontinuation, this vital metabolically active muscle is not regained—only the fat returns. This creates a highly detrimental state of sarcopenic adiposity, resulting in a significantly lower resting metabolic rate than pre-treatment [10].

Laparoscopic mesenteric lipectomy provides a definitive, permanent anatomical solution. By physically extracting visceral fat cells, which do not regenerate, it prevents weight rebound. Rather than acting as an either/or alternative, mesenteric de-fatting acts synergistically with GLP-1 therapies: GLP-1 pre-treatment can be utilized to achieve rapid initial weight loss, and laparoscopic visceral fat extraction provides the permanent, physical "off-ramp" to prevent subsequent rebound and protect patient muscle mass.

Pre-clinical Foundations: NOTES Feline Pilot Study

The pre-clinical feasibility of intra-abdominal fat clearance was established by the landmark 2011 pilot study conducted by Lu

Xia, MD, PhD, et al. (Ruijin Hospital, Renji Hospital, Shanghai Jiaotong University School of Medicine) [11]. Utilizing a sham-controlled model in higher mammals, the investigators executed a natural orifice transluminal endoscopic surgery (NOTES) approach to perform omentectomy in felines. The study proved that endoscopic omentectomy was highly safe and feasible, altering weight trajectories and yielding a net weight loss in treated felines compared to a weight gain in sham-surgery controls (-387 ± 437 gm vs. 233 ± 351 gm). While proving safety, this early work was confined to the omental depot, as traditional manual endoscopic instruments lacked the safety margins required to dissect the highly vascular and delicate mesenteric envelope.

The Liquefaction Era and the Small Bowel Exenteration Limitation

Subsequent translational research targeted the mesenteric depot where the vast majority of pathogenic VAT resides. Utilizing Tissue Liquefaction Technology (TLT, HydraSolve®), which employs high-pressure, warmed saline streams (850 psi, 46 °C) for targeted cell separation, investigators successfully cleared 50% to 75% of mesenteric fat in primate baboon models [12] and achieved profound clinical glycemic stabilization in a human pilot trial [13]. While therapeutically revolutionary, these early attempts using liquefaction technology were bound by a major physical limitation: they mandated a semi-open, invasive procedure. The high pressure and heated fluid dynamics of the water-jet system required making a 6-to-8 cm supraumbilical incision to physically externalize, handle, and manually exenterate the entire small bowel and mesentery, fanning them out sequentially, externally in 20 cm increments under direct view to perform the lipectomy. External bowel handling, highly pressurized hot saline, and drying inherently introduce major surgical risks and complications, including transient postoperative gastrointestinal dysfunction, prolonged adynamic ileus, incisional hernias, and extensive intraperitoneal adhesions, limiting MVL's widespread adoption.

Coaxial TCAL

The Pinnacle of Laparoscopic Metabolic Interventions

The Twin Cannula Assisted Liposuction (TCAL) system represents the ultimate mechanical pinnacle of minimally invasive bariatric surgery, entirely overcoming the limitations of manual bowel handling and exenteration. TCAL's patented coaxial, “tube-within-a-tube” engineering comprises a reciprocating inner cannula and a completely stationary outer sheath. The outer sheath is designed with a capsule-shaped longitudinal slot that is slightly wider and longer than the inner cannula's active section. The inner cannula range of reciprocation exposes one or more aligned aspiration apertures within the slot, executing rapid back-and-forth reciprocation without transmitting kinetic energy or friction to surrounding tissues (Figure 1). This unique configuration acts as a physical shield and shroud. Under direct endoscopic/laparoscopic visualization, the surgeon can position the tip against mesenteric fat deposits within the closed peritoneal cavity. The stationary outer cannula ensures that the delicate bowel walls, adjacent arteries, veins, and nerves are physically shielded from the reciprocating cannula. The suction draws visceral fat into the protective slot, where the inner cannula shears and aspirates VAT cells. This mechanical separation eliminates any need to externalize or exenterate the bowel. By performing the entire mesenteric visceral lipectomy strictly laparoscopically, it minimizes bowel handling and eliminates the need for exenteration and risk of drying. This dramatically reduces the likelihood of adynamic ileus, incisional hernias, and postoperative adhesions, enabling mesenteric fat removal to be performed as a safe, rapid, and permanent outpatient procedure.

Figure 1: Simplified schematic illustrating the coaxial tips of the Twin Cannula-Assisted Liposuction (TCAL) system. A slotted, stationary outer cannula serves as a protective spacer, ensheathing a rapidly reciprocating inner canula with three aligned suction apertures which are in turn registered with and exposed by the slot in the outer cannula to permit strictly laparoscopic and localized visceral fat removal without bowel exenteration.

Clinical Efficacy

Glycemic Correction and Liver-Targeted Reversal

Metabolic monitoring of human subjects who underwent mesenteric lipectomy proved the rapid [13], substantial metabolic correction of type 2 diabetes markers (Figure 2). Subjects exhibited an immediate drop in Fasting Plasma Glucose from 211 ± 12 mg/dL at baseline to 140 ± 4 mg/dL at 6 months ($p < 0.01$), maintaining stable levels at 145 ± 5 mg/dL at Month 12. This drop was mirrored by glycated hemoglobin (HbA1c), which fell from 8.9% ± 0.6% to 7.7% ± 0.3% (6 months, $p < 0.01$) and stabilized at 7.9% ± 0.4% at 12 months. Continuous Glucose Monitoring (CGM) Time-in-Range (TIR) surged 3.4-fold from 22% ± 3% to 74% ± 6% ($p < 0.001$) at 6 months, with clinical insulin secretion (Disposition Index) increasing over 3.0-fold ($p < 0.05$). Stable isotope tracer clamp studies localized this metabolic correction to the liver, showing a substantial decline in hepatic fat content from 23.9% ± 3.7% to 19.1% ± 3.4% (12 months, $p < 0.004$) and a profound increase in hepatic Endogenous Glucose Production (EGP) suppression from 29% ± 4% to 43% ± 4% ($p < 0.05$).

Fat Aspiration Technology Comparison

The following table (Table 1) compares the mechanical, safety, and clinical parameters of Power Assisted Liposuction (PAL), Tissue Liquifaction Technology (TLT), and coaxial Twin Cannula-Assisted Lipoaspiration (TCAL).

Table 1: Fat Aspiration Technology Comparison: Power-Assisted Liposuction (PAL); Tissue Liquefaction Technology (TLT); Twin Cannula-Assisted Liposuction (TCAL).

Technical Metric	Power Assisted Liposuction (PAL)	Tissue Liquefaction (TLT)	Laparoscopic TCAL (EVL®)
Mode of Action	Single reciprocating cannula	High-pressure heated saline to liquify fat for aspiration	Electromagnetic reciprocation of an aspirating inner cannula within a slotted stationary outer cannula
Adjacent Tissue Protection	None (high risk of organ damage)	Saline stream (selective but broad angle)	Patented stationary outer protective cannula sheath shields moving inner cannula
Surgical Approach	Open or subcutaneous only	Semi-open with small bowel exenteration	Strictly laparoscopic
Bowel Handling & Exposure	Not applicable	Manual fanning & external exenteration	Completely intra-abdominal, laparoscopic
Postoperative Adhesion / Ileus Risk	Not applicable	Elevated due to handling, exenteration and drying	Minimized

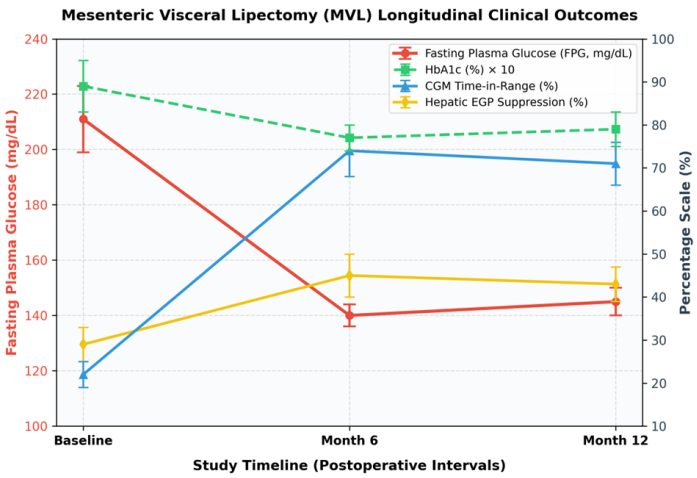

Figure 2: Clinical efficacy of Mesenteric Visceral Lipectomy (MVL) over a 12-month postoperative period.: Fasting Plasma Glucose (FPG)*** is plotted on the left y-axis (mg/dL). Percentage-based parameters, including Glycated Hemoglobin (HbA1c × 10), CGM Time-in-Range (TIR)*, and Hepatic endogenous glucose production (EGP)** suppression, are plotted on the right y-axis (%). Data are expressed as mean ± SEM. Statistical significance thresholds: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ vs. baseline values [13].

Conclusion

Laparoscopic direct mesenteric visceral fat source removal represents the next major frontier in bariatric and metabolic surgery. By bypassing anatomically destructive GI restrictions and rearrangements, it targets the root cytokine source driver of insulin resistance and type 2 diabetes directly. Although historical tissue liquefaction required bowel exenteration and midline incisions, the development of coaxial Twin Cannula-Assisted Liposuction (TCAL) removes this surgical barrier. With its stationary protective outer shield, TCAL enables closed peritoneal laparoscopic mesenteric de-fatting, eliminating extensive bowel handling and its associated risks of adynamic ileus and adhesions. This milestone technology enables EVL® to provide a potentially safe, highly effective, and anatomically preserving bariatric intervention to achieve a long-term metabolic cure. Studies are indicated to document its safety and efficacy and investigate whether it lives up to its full potential.

Conflict of Interests

Robert L. Cucin, M.D. is the founder and C.E.O. of BioSculpture Technology, Inc., the medical device developer and manufacturer of TCAL and EVL® instruments.

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