Facial Surgery

Preliminary Report

Facelift and Patterns of Lymphatic Drainage

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Abstract

Background: It has commonly been assumed that deeper facelift dissection causes greater and more prolonged swelling.

Objectives: In this preliminary report, the authors compare the lymphatic reconstitution after multiple techniques of rhytidectomy by means of dynamic lymphoscintigraphy.

Methods: Three patients were enrolled in this study. All three were female, were similar in age, and exhibited similar signs and degrees of facial aging. Each woman underwent a facelift with a different technique: (1) subcutaneous dissection with superficial musculoaponeurotic system (SMAS) plication, (2) subcutaneous dissection with SMASectomy, and (3) a “high SMAS” composite facelift. Postoperatively, $^{99m}$Tc-sulfur colloid was injected into a standardized infraorbital location in each patient to compare patterns of lymphatic drainage using lymphoscintigraphy. Postoperative scans at two weeks, six weeks, three months, six months, and one year were compared to the preoperative scans taken seven days prior to surgery.

Results: All rhytidectomy techniques appeared to temporarily create a significant and similar degree of interruption in lymphatic drainage. There was a subtotal recovery of lymphatic pathways within three months and complete return to baseline drainage pattern after six months, regardless of surgical technique.

Conclusions: Based on the results of this study, it appears that the extent of facial dissection, rather than the depth, is the most significant factor in postoperative edema.

Keywords
extended SMAS, SMAS, SMAS plication, SMASectomy, subcutaneous facelift, sub-SMAS

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Our current understanding of lymphatic pathways in the face and cheek is based on dye studies reported over a century ago. The graphic representation of lymphatic drainage of the head and neck region arises from drawn maps, with supporting evidence from oncologic sentinel lymph node data. Experimental models have mapped periorbital lymphatic pathways in primates but not humans. A single patient study proposed a theoretical reversal of lymphatic flow toward the midline after facelift. Also, it has commonly been assumed that deeper facelift dissection causes greater and more prolonged swelling, but that assumption has never been scientifically studied. Identifying the patterns of lymphatic drainage from the cheek before and after rhytidectomy would help to characterize the anatomic structural modifications caused by differing rhytidectomy techniques. Lymphoscintigraphy, a nuclear imaging technique that allows dynamic visualization and mapping of draining lymphatic channels and lymph nodes utilizing a radiolabeled colloid (most commonly $^{99m}$Tc-sulfur colloid in the United States), was utilized in the present study to examine these patterns and to assess—and potentially differentiate between—the lymphatic disruption caused by common facelift techniques that vary in depth of dissection.

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METHODS

This study was approved by the Institutional Review Board (IRB) at Baylor University Medical Center, following nuclear and radiation safety guidelines for dynamic lymphscintigraphy.

Patient Selection

The female patients were selected for this study after meeting exclusion criteria, which included active tobacco use, such as active smokers, prior facial surgery or significant facial trauma, collagen disorders, or coagulopathy. All patients were healthy, with no underlying medical comorbidities and no former facial surgical interventions. All selected patients were of similar age (52, 53, and 57 years) and exhibited similar signs and degrees of facial aging, including malar ptosis with moderate nasolabial folds, visible orbitomalar crescents, jowl prominence, and static vertical neck banding. Facelift techniques were assigned randomly.

Surgical Technique

Three common, accepted facelift techniques were studied. Each technique was chosen based on the extent of dissection and degree of surgical disruption of the superficial musculoaponeurotic system (SMAS). The dissection techniques included the following:

1. SMAS plication,6 in which the subcutaneous dissection for SMAS plication was performed to the midpupillary line. The SMAS manipulation involved a horizontal, submalar, 3-cm-wide elliptical plication extending anteriorly to the midpupillary line without resection of any tissue.

2. SMASectomy,6 in which the dissection for SMAS plication was performed to the midpupillary line. The SMAS manipulation involved a horizontal, submalar, 3-cm-wide elliptical excision extending anteriorly to the midpupillary line. No undermining was performed upon SMAS reapproximation (Figure 1A).

3. High SMAS rhytidectomy,7 in which the subcutaneous dissection for high SMAS was limited to 1 cm anterior to the edge of the raised SMAS flap in the preauricular area. The composite skin and SMAS flap was dissected to the lateral border of the zygomaticus major muscle, at which point the dissection transitioned to the subcutaneous plane. The anterior extent of the dissection was the midpupillary line (Figure 1B).

All patients underwent facelift procedures with the same surgeon (RAM). All patients received general anesthesia, the course of which was uneventful. There were no pertinent intraoperative complications. Each patient received and followed the same postoperative protocol for their recovery.

Lymphoscintigraphy

In order to provide enough tracer volume to be clearly visible, two adjacent 100-µL intradermal injections, each containing 100 µCi of microfiltered (0.22 µm) 99mTc-sulfur colloid, were placed at a standardized site on each
patient’s malar eminence ipsilateral to the surgical dissec-
tion but well separated from the surgical site. The site of
injection was consistently placed on the malar prominence,
at the intersection of a vertical line dropped from the inner
surface of the lateral orbital rim and a horizontal line at
the mid-height of the zygomatic arch. The isotope was
injected into a reproducible intradermal site over the zygo-
matic area. An onlay grid was used to ensure consistent
placement in serial studies.

Using a standard nuclear gamma camera (Infinia 1;
General Electric, Fairfield, Connecticut; low-energy, high-
resolution, parallel-hole collimator; photopeak 140 keV
with a 20% window), dynamic imaging (30 s/frame) of
the head and neck was performed with the patient in the
lateral position for 30 minutes, beginning immediately
after injection. Additional three-minute static images of
the head and neck were captured in lateral and anterior
projections at one hour, two hours, and four hours
postinjection. These images were compared to similar
baseline studies performed seven days preoperatively.
For each static image, a corresponding attenuation image
was captured by placing a standard $^{57}$Co sheet source
behind the patient to image an outline of the patient’s
body. Postoperatively, lymphoscintigraphy was repeated
at two weeks, six weeks, three months, six months, and
one year.

For data analysis of the lymphoscintigraphic images,
standardized circular regions of interest were placed
around each visible lymph node, and an appropriate back-
ground region was placed for subtraction of background
activity. Background-subtracted total counts within each
region were decay-corrected. Regions of interest from the
baseline study were compared with the postoperative
studies. Baseline and postoperative studies were carefully
examined for each patient, with specific attention paid to
the pattern of lymphatic flow, the time of tracer arrival at
the predominant draining nodes, and the intensity of those
nodes relative to background and to each other. All inter-
pretation and data analysis were performed by Landis
Griffeth, MD, PhD, director of Nuclear Medicine at Baylor
University Medical Center in Dallas, Texas.

RESULTS

No significant complications or adverse sequelae occurred
in any patient. All patients completed serial evaluation up
to one year postoperatively.

Analysis of the baseline dynamic images confirmed two
primary drainage patterns—one pathway passing almost
directly posteriorly toward the preauricular region and
another, more anterior pathway passing posterosinferiorly
toward the submandibular/internal jugular region. All
three patients demonstrated nearly immediate tracer accu-
mulation within at least one preauricular node on the
baseline studies. Two patients showed additional primary
drainage to at least one submandibular node, whereas one
showed additional primary drainage to a focus in the inter-
nal jugular region. All patients showed drainage to addi-
tional nodes in the internal jugular region and/or lower in
the anterior ipsilateral cervical chain; however, based on
the dynamic images, several of these lower and more pos-
terior nodes were likely “secondary” nodes (i.e., nodes
visualized by tracer that had “percolated” through the
primary or sentinel node along that particular drainage
pathway). In all, four to six nodes were visualized in each
patient on the preoperative studies. No contralateral nodes
were visualized on any of the preoperative or postopera-
tive studies.

Immediately postoperatively, all three rhytidectomy
techniques resulted in significant patterns of interruption
in lymphatic drainage to the preauricular nodal basin.
Moreover, all three rhytidectomy techniques showed a
similar degree of lymphatic interruption. In all cases, ly-
phatic flow was redirected to a more anterior location
when compared to preoperative results. On the two-week
postoperative studies, flow to the preauricular nodes
was substantially interrupted, as none of the previously-
visualized nodes in this region were seen. In all patients,
the submandibular/internal jugular nodes constituted the
only visualized route of drainage. A total of only one to
two nodes were visualized in each patient on the two-
week studies, suggesting that the preauricular path may
have been the primary source of visualization of the more
inferior “secondary” nodes described above. On the six-
week postoperative studies, the flow appeared unchanged.
Previously-visualized nodes were not present, particularly
in the preauricular area.

Lymphatic flow showed subtotal reconstitution of
drainage to preoperative pathways with rhytidectomy
techniques by three months. Lymphatic drainage patterns
returned to baseline at six months postoperatively in all
patients. On dynamic flow studies, the timing of lymph
descend visualization was delayed in comparison with the
preoperative studies during the early postoperative period,
but this returned to baseline by the six-month timeframe
and was maintained at the one-year studies.

Figure 2 demonstrates the progression of lymphatic
drainage changes in Patient 1.

DISCUSSION

We chose to study the differences in lymphatic drainage in a
functional anatomical study—one that could demonstrate the
dynamic and physiologic anatomy—to answer several ques-
tions: How do lymphatic pathways change after rhytidec-
tomy procedures? Do more superficial depths of dissection
cause fewer alterations in lymphatic drainage and hence less
swelling? Dynamic lymphoscintigraphy is a useful tool for
visualization of lymphatic structures, particularly in deter-
mining the initial sequence of draining lymph nodes. This
has led to the widespread use of this technique in the map-
ping of sentinel nodes, especially in melanoma and breast
carcinoma. Sentinel lymph node studies all highlight vari-
able patterns of drainage. Dynamic lymphoscintigraphic
techniques have also become the standard imaging modality
for assessment of lymphedema.
Figure 2. Patterns of lymphatic drainage are demonstrated on lymphoscintigraphy scans (a “fusion” image to better elucidate the position of visualized lymph nodes) and illustrations for Patient 1, a 53-year-old woman at (A, B) baseline, where one preauricular, one submandibular, and two internal jugular notes can be visualized; (C, D) two weeks postoperatively, where only one submandibular node can be clearly visualized; and (E, F) six months postoperatively, where the baseline preoperative pattern shown in Part A has been restored.
The lymphatic collection system of the cheeks mirrors that of the other integumentary system. At the level of the papillary dermal vascular plexus, lymphatic capillaries are intertwined with arteriovenous capillaries. At the smallest levels in the capillary bed, blood vessels have a discontinuous basement membrane that leaks fluid into the interstitial space. The lymphatic capillaries are also permeable such that their low-pressure system collects the interstitial fluid and protein debris. Although the mechanisms of lymphatic uptake of interstitially-deposited particulates remain incompletely understood, studies have shown that the migration of such colloid particles into the lymphatic system occurs primarily at the level of the subdermal lymphatic capillaries. Uptake across the thin lymphatic capillary endothelium probably primarily depends on direct migration through endothelial gaps and, to a lesser degree, on pinocytosis through the endothelial cells lining the capillaries. If the radiolabeled colloid is injected into the lymphatic-capillary-rich intradermal plane, the rate and extent of tracer uptake and migration are substantially greater than if the colloid is injected into the lymphatic-capillary-poor subcutaneous tissues.

As lymphatic channels progress in size on the way to collecting lymph nodes, they gain first a muscular wall, then an adventitia. These additional layers reduce transmural absorption. Therefore, less lymphatic absorption takes place in the deeper subcutaneous and muscular layers (Figure 3).

The lymphatics of the skin and subcutaneous cheek follow two basic paths. The eyelid, lateral nose, and anterior cheek follow lymphatic channels along the anterior facial artery to the submandibular nodes. The lateral cheek drains to the parotid nodal basin. Both the parotid and submandibular nodes empty into the deep cervical system (Figure 4). Based on the typical pattern of lymphatic flow, our assumption is that the lymphatics drain inwardly (superficial to deep) toward the larger lymphatic vessels and nodes prior to traveling to the systemic circulation. Any violation of these lymphatic channels between the intradermal injection site and the collecting nodal basins would likely cause the functional anatomical disruption observed in our study. This would be true irrespective of the point of interruption—that is, whether in the subcutaneous or sub-SMAS plane. The parotid nodes lie principally within and deep to the parotid gland. A dissection plane separating the SMAS from the parotid capsule could interrupt intermediate lymph channels but should not remove parotid nodes.

This preliminary study showed no difference in disruption of lymphatic flow between the three rhytidectomy techniques. In all three facelift patients, flow to the parotid basin was temporarily interrupted. Lymphatic flow appeared to be redirected to the anterior facial-submandibular pathway (Figure 5). Lymphatic pathways were subtotally restored by three months postoperatively and fully reconstituted by six months. Whether this functional return was due to lymphangiogenesis or dilatation of other collateral channels is unknown.

Certainly, a small pilot study cannot conclusively delineate the effects of varying facelift techniques on lymphatic drainage, so further studies are warranted. However, our findings are consistent with known anatomy of the lymphatic system. Furthermore, our study challenges the notion that superficial skin flap dissection is less disruptive to the facial lymphatic system than deeper (sub-SMAS) dissections.

**CONCLUSIONS**

This is the first in vivo dynamic mapping of the lymphatic anatomy of the cheek before and after three different rhytidectomy techniques (subcutaneous dissection with associated SMAS plication, SMASectomy, or high SMAS). Through dynamic lymphoscintigraphy, functional lymphatic pathway alterations were mapped and compared between and among patients over the course of time. All rhytidectomy techniques appeared to temporarily yield a significant and similar degree of interruption in lymphatic drainage. Therefore, it appears that the extent of facial dissection, rather than the depth of facial dissection, is the most significant factor in causing postoperative edema.
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REFERENCES


Figure 4. (A) The facial lymphatic system. (B) Typical patterns of lymphatic flow.

Figure 5. Proposed reconstitution of lymphatic flow.

Disclosures

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