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Article

EFFECTIVENESS OF DEBULKING LIPOSUCTION IN SECONDARY INFERIOR EXTREMITY FAT–PREDOMINANT LYMPHEDEMA: EVALUATION OF THE OF LEG DERMAL BACKFLOW IMPROVEMENT USING INDOCYANINE GREEN LYMPHOGRAPHY

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ABSTRACT

Background : Secondary lymphedema with a predominant composition of fat is not effectively managed with physiological techniques. Instead, it necessitates debulking liposuction that reduces extremity circumference and improves lymph flow. This study aims to discover the effectiveness of improving lymphatic flow through indocyanine green lymphography examination.
Method : This retrospective cohort study involving secondary fat–predominant lower extremity lymphedema patients who underwent debulking liposuction in the Division of Reconstructive Plastic and Aesthetic Surgery, Department of Surgery, CMGH, in December 2022 - August 2024. The variables studied were the subject's lower extremity circumference and degree of leg dermal backflow before and after debulking liposuction.
Results : Among 15 subjects, pre- and postoperative debulking liposuction measurements of inferior extremity circumference demonstrated significant reduction at 10 cm and 25 cm above the ankle, the patella, 10 cm and 25 cm above the knee. Postoperatively, 5 subjects with leg dermal backflow stage IV turned to stage II (1), III (4), while 10 subjects with the leg dermal backflow stage V turned to stage IV (9).
Conclusion: Reduction in the circumference of the inferior extremities after debulking liposuction at almost all measurement points except for the foot and ankle circumference. This related to the anatomy of lymphatic flow. Debulking liposuction showing a significant improvement in lymphatic flow, it clinically proven by the reduction dermal leg backflow degree after procedure. Debulking liposuction in secondary lower extremity lymphedema with a predominant composition of fat effectively reduces extremity circumference and improves lymphatic flow as evidenced by indocyanine green lymphographic examination.

Keywords*: Secondary lymphedema, Lower extremity, Debulking liposuction, Indocyanine green, Leg dermal backflow*

Latar Belakang: Limfedema sekunder dengan komposisi dominan jaringan lemak tidak dapat ditangani secara efektif menggunakan teknik fisiologis. Kondisi ini memerlukan debulking liposuction yang bertujuan mengurangi lingkar ekstremitas dan memperbaiki aliran limfe. Penelitian ini bertujuan untuk mengevaluasi efektivitas peningkatan aliran limfatik melalui pemeriksaan limfografi *indocyanine green*.
Metode: Penelitian kohort retrospektif ini melibatkan pasien dengan limfedema sekunder ekstremitas bawah dominan lemak yang menjalani tindakan debulking liposuction di Divisi Bedah Plastik Rekonstruksi dan Estetik, Departemen Bedah, CMGH, pada periode Desember 2022 hingga Agustus 2024. Variabel yang diteliti adalah lingkar ekstremitas bawah serta derajat dermal backflow tungkai sebelum dan sesudah prosedur.
Hasil: Dari 15 subjek, pengukuran lingkar ekstremitas bawah pra dan pasca debulking liposuction menunjukkan penurunan signifikan pada titik 10 cm dan 25 cm di atas pergelangan kaki, pada daerah patela, serta 10 cm dan 25 cm di atas lutut. Secara pascaoperatif, 5 subjek dengan dermal backflow tungkai derajat IV menurun menjadi derajat II (1 kasus) dan derajat III (4 kasus), sedangkan 10 subjek dengan dermal backflow tungkai derajat V menurun menjadi derajat IV (9 kasus).
Kesimpulan: Terdapat penurunan lingkar ekstremitas bawah setelah tindakan debulking liposuction pada hampir semua titik pengukuran, kecuali pada lingkar kaki dan pergelangan kaki. Hal ini berkaitan dengan anatomi aliran limfatik. Debulking liposuction terbukti memberikan perbaikan signifikan pada aliran limfe, yang secara klinis ditunjukkan dengan penurunan derajat dermal backflow tungkai setelah prosedur. Dengan demikian, debulking liposuction pada limfedema sekunder ekstremitas bawah dengan dominasi lemak efektif dalam mengurangi

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lingkar ekstremitas dan memperbaiki aliran limfatik, sebagaimana dibuktikan melalui pemeriksaan limfografi indocyanine green.

Kata Kunci: *Limfedema sekunder, ekstremitas bawah, debulking liposuction, indocyanine green, dermal backflow tungkai*

Conflicts of Interest Statement:
The author(s) listed in this manuscript declare the absence of any conflict of interest on the subject matter or materials discussed.

INTRODUCTION

Lymphedema causes morbidity in the form of impaired limb function, aesthetics, and psychology that greatly affects the quality of life.[1,4] Obstructedlymph vessels cause lymphatic flow stasis which is characterized by fibrosis of the smooth muscles of the lymph vessels so that the diameter of the lymph vessels decreases.[7] At this stage, the composition of lymphedema is the accumulation of fluid. Furthermore, the lymphatic fluid in the tissues causes an increase in adipogenesis, fat cell hyperplasia, hyperkeratosis, fibrosis, and thickening of the skin.[7] At this stage, the composition of lymphedema is the accumulation of fat.[7,8]

Fat hyperplasia in lymphedema may be reduced by direct excision techniques or debulking liposuction. Debulking liposuction is now a known technique that reduce the volume of affected extremities in a minimally invasive1,5,9 and improve lymphatic vessel flow.5.6 Improvement in lymph flow is shown using indocyanine green lymphogram (ICG),10,11 described by Yamamoto et al. regarding dermal backflow as seen in the Table 1.

Table 1. Classification of dermal backflow on indocyanine green lymphogram following Yamamoto et al.[12]

Stage	Description
0	No dermal backflow pattern
I	Splash pattern around the groin
II	Stardust pattern extended proximal to the superior border of the patella
III	Stardust pattern extended distal to the superior border of the patella
IV	Stardust pattern extended to the whole limb
V	Diffuse stardust pattern in the background

Former studies have shown the effectiveness of debulking management in improving lymphatic flow. However, no studies have shown effectiveness based on qualitative examinations using indocyanine green. Debulking liposuction to treat secondary inferior extremity lymphedema with a fat–dominant composition, has been applied in the Division of Plastic, Reconstructive, and Aesthetic Surgery, Department of Surgery of Dr Cipto Mangunkusumo General Hospital (CMGH). However, this study is required as evidence of managing secondary lymphedema in Indonesian–specific characteristics.

METHOD

This study applies a retrospective cohort design with a minimum number of samples of 14. The study sample is all secondary data of patients with secondary inferior extremity lymphedema with a fat–dominant composition who proceeded with liposuction debulking in CMGH between December 2022 - August 2024 and met the eligibility criteria.

The inclusion criteria were adults (>18 years) who were diagnosed with secondary lower extremity lymphedema with a composition fat–dominant and non-pitting edema. The subjects proceeded with indocyanine green (ICG) assessment before liposuction debulking. An AUROGREEN (Aurolab, India) ICG was administered.

The exclusion criteria were patient didn't sign informed consent and not complete data. In addition, the subjects were followed up for at least three months after the procedure. The variables of interest in the study were extremity circumference and ICG assessment before and three months after the procedure. Data was collected from medical records and analyzed statistically to find significance. The Ethics Committee of the Faculty of Medicine, University of Indonesia, approved the study with registration number KET–1483/UN2.F1/ETIK/PPM.00.02/2024.

RESULTS

A total of 21 procedures of debulking liposuction were recorded between December 2022 - August 2024; 15 met the eligibility criteria. Subjects' characteristics are presented in Table 2.

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Table 2. Subjects' characteristics (n = 15)

Variable	Frequency (n)	Percentage (%)
Age (mean ± SD)	50 ± 15.5	
Gender		
Male	3	20.0
Female	12	80.0
Body mass index		
Normal (18.5–24.9)	3	20.0
Overweight (25.0–29.9)	7	46.7
Obesity I (30.0–34.9)	3	20.0
Obesity II (35.0–39.9)	2	13.3
Underlying Lymphedema		
Malignancy	9	60.0
Infection	5	33.3
Malignancy and Infection	1	6.7

Reduction of lower extremity circumference three months following debulking liposuction was shown on each circumference, except foot and ankle, with p–value <0.05 as shown in Table 3.

Five subjects before the procedure were classified as ICG IV of Yamamoto classification in dermal backflow; a subject (20%) turned to ICG II, and four (80%) turned to ICG III. Ten subjects were of ICG V before the procedure, nine subjects (90%) turned to ICG IV, and a subject (10%) remain of ICG V. These differences showed statistically significant (p <0.001), showing improvement of lymphatic leg dermal backflow as shown on Table 4.

Table 3. Reduction of lower extremity circumference following debulking liposuction (n = 15).

Lower extremity circumference	Before procedure mean ± SD	After procedure mean ± SD	Mean (Delta)	p–value
Foot	25.4 ± 2.9	24.6 ± 3.0	0.8	0.052
Ankle	29.4 ± 5.9	28.5 ± 4.3	0.9	0.282
10 cm above ankle	37.3 ± 7.1	33.2 ± 6.6	4.1	0.001*
25 cm above ankle	45.2 ± 7.6	42.4 ± 7.1	2.8	0.013*
Patella	43.5 ± 4.5	41.1 ± 4.2	2.4	<0.001*
10 cm above knee	52.9 ± 6.3	49.4 ± 5.9	3.5	0.001*
25 cm above knee	62.2 ± 5.9	57.9 ± 7.5	4.3	0.003*

*Statistically significant (T Dependent test).

Table 4. Dermal backflow following debulking liposuction (n = 15).

ICG Before procedure	ICG 3 months after procedure - n (%)				Total	p–value
	II	III	IV	V		
IV	1 (20.0)	4 (80.0)	0 (0.0)	0 (0.0)	5 (100.0)	<0.001*
V	0 (0.0)	0 (0.0)	9 (90.0)	1 (10.0)	10 (100.0)	

* Friedman test, ICG = indocyanine green

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DISCUSSION

A total of 15 samples were enrolled, dominated by females, which was 80%. This can be explained because secondary lymphedema occurs due to cancer–related treatments, especially breast, head, and neck cancer and gynecological cancer. Cancer–related procedures include surgical resection of the lymph nodes, which is directly followed by damage to the lymphatic system, and radiation therapy, which contributes to dermal lymphatic loss and results in fibrosis of the lymph nodes.[13] The most underlying cause of secondary lymphedema in this study was malignancy, which was 60% (9). No information was available on the type of malignancy.

This study was assessed using a realistic and feasible limb circumference rather than the volume that required a conversion factor in its calculations. The challenge was to answer how much fat is removed in the debulking procedure, as it is common in the liposuction procedure for body reshaping. In addition, there are no standard volume guidelines (anthropometry) for the Indonesian population that can be used as a comparison, such as the body mass index in determining obesity. This measurement of limb circumference shows that there is a reduction in the circumference of the inferior extremities after liposuction debulking at almost all measurement points except for the foot and ankle circumference. The decrease in foot circumference before and after liposuction debulking was not statistically significant, with a p–value of 0.052. The reducing ankle circumference after liposuction debulking was not statistically significant, with a p–value of 0.282. This can be related to the anatomy of lymphatic flow, where the ankle and foot are distributed in the deep plane, while above the ankle, the lymph vessels are distributed in both the deep and superficial planes in more significant numbers.[14–16] In addition, liposuction did not proceed in the ankle and foot regions.[17]

The study showed an improvement in the degree of dermal backflow after liposuction debulking. Five subjects had stage IV leg dermal backflow, and 10 subjects had stage V leg dermal backflow before debulking liposuction. Five subjects with stage IV showed improvement in the leg dermal backflow. Of ten subjects with stage V, 9 showed improved dermal leg backflow. Only one subject did not show improvement in the dermal backflow. Thus, 93.3% (14 subjects) improved the stage of leg dermal backflow. Friedman's test, p <0.001, indicates the effectiveness of liposuction debulking on improving lymphatic flow/dermal leg backflow.

The results of the indocyanine green lymphographic study in this study are in line with the review of Kayiran et al,[18] and the meta–analysis of Chen et al.,[19] which concluded that adipose fat removal using liposuction did not damage the lymphatic transport system; on the contrary, showing a significant improvement in lymphatic flow. This is clinically proven by the reduction of limb circumference and the improvement of the degree of dermal leg backflow shown by indocyanine green lymphedema. The leg dermal backflow is a fluorescence image of the indocyanine green complex and proteins beyond the lymphatic vessels (i.e. the interstitial) captured by a near–infra–red camera.[20] This fluorescence forms a certain pattern according to the description of backflow according to Yamamoto, et al. reducing the stage of leg dermal backflow indicates improved lymphatic flow.[12]

Improvement of the lymphatic system lets the lymphatic stasis be reduced. Lymphatic stasis leads to chronic inflammatory responses, fibrosis, hyperplasia and proliferation of adipose.[13,21] Liposuction debulking breaks the cycle, and in turn, followed by improvement in lymphatic drainage.[22] Improvements in the lymphatic drainage after liposuction debulking may last for five years.[9] The fundament of this improvement of lymphatic drainage after debulking liposuction is not fully known yet. The hypothesis is the recanalization of the lymphatic vessels, the re–functioning of existing lymphatic vessels, the occurrence of lymphatic angiogenesis, or the appearance of lymphatic vessels that are located deeper (more than 2 cm) after liposuction debulking.[19] However, this theoretical hypothesis requires more evidence. Improvement in lymphatic flow after liposuction debulking provides a new atmosphere regarding the management of lymphedema with a fat–dominant composition; reduction techniques (liposuction debulking) are performed first,[23] after the lymphedema become of fluid–dominant lymphedema, then physiological techniques such as lympho–venous bypass or vascularised lymph node transplantation can be performed if needed.[5,19] The combination of debulking

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liposuction management and physiological techniques can reduce the use of medical compression time.[22]

There are some confounding factors that may affect the result of reduction and the stage of leg dermal backflow, namely the body mass index. According to Burian, et al, obesity may affect the occurrence of lymphedema. A person with a body mass index (BMI) of >40.0 (obesity level III WHO classification) has a high risk of developing lymphedema. In obese patients, there is an increase in lymphatic fluid production, so that the lymphatic vessel system is inadequately to drain the increased lymph fluid, leading to stasis. Another theory described a disruption in lymphatic flow due to pressure on the lymphatic system in obesity.[24] In this study, 46.7% of subjects were categorized as overweight. However, with a limited number of samples it is impossible to proceed with subgroup analysis to minimize bias of this confounding factor and is one of the shortcomings of this study. Another note in the study was diminished in patient complaints and improvement of the quality of life.[5,8,9] However, the study was not designed to find the improvement of limb function and patients' satisfaction; further research is required for this purpose.

CONCLUSION

Debulking liposuction in secondary inferior extremity lymphedema with a fat–dominant composition has demonstrated efficacy of reducing limb circumference and improving lymphatic flow as objectively quantified by indocyanine green lymphographic examination. Thus, the procedure can be considered as the first-line management of secondary inferior extremity lymphedema with a dominant fat composition.

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