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SURGICAL AND NON-SURGICAL APPROACHES IN THE MANAGEMENT OF LIPEDEMA: A SYSTEMATIC REVIEW

ABORDAGENS CIRÚRGICAS E NÃO CIRÚRGICAS NO TRATAMENTO DO LIPEDEMA: UMA REVISÃO SISTEMÁTICA

ABORDAJES QUIRÚRGICOS Y NO QUIRÚRGICOS EN EL TRATAMIENTO DEL LIPEDEMA: UNA REVISIÓN SISTEMÁTICA

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ABSTRACT

Introduction: Lipedema is a chronic, progressive loose–connective-tissue disorder characterized by painful, disproportionate subcutaneous adipose tissue, functional limitations, and impaired quality of life, prompting growing interest in evidence-based management strategies.

Objective: To systematically review contemporary human studies on surgical and non-surgical treatments for lipedema, with emphasis on symptom control, functional outcomes, complications, and quality of life, and to synthesize comparative effectiveness across modalities.

Methods: We planned a PRISMA-compliant search of PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov, and ICTRP for the last five years, expanding to ten years only if fewer than ten eligible studies were found; inclusion criteria prioritized human clinical trials and observational studies, with basic science excluded from synthesis; risk of bias and certainty of evidence (GRADE) were prespecified; data were extracted for populations, interventions, comparators, outcomes, and follow-up.

Results and Discussion: Recent literature suggests that compression therapy, exercise, and pneumatic compression can reduce pain and edema and improve patient-reported outcomes, while liposuction techniques including tumescent, power-assisted, and water-assisted approaches generally show substantial improvements in symptoms and health-

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related quality of life with acceptable complication rates; however, heterogeneity in diagnostic criteria, outcome measures, and follow-up limits certainty of pooled estimates.

Conclusion: Contemporary evidence supports a stepped, individualized approach beginning with optimized conservative care and progressing to lipedema reduction surgery in appropriately selected patients, with shared decision-making and standardized outcome measurement essential for practice and future research.

Keywords: Lipedema. Compression Therapy. Liposuction. Quality of Life.

RESUMO

Introdução: O lipedema é uma doença crônica e progressiva do tecido conjuntivo frouxo, caracterizada por tecido adiposo subcutâneo doloroso e desproporcional, limitações funcionais e comprometimento da qualidade de vida, o que desperta um interesse crescente em estratégias de tratamento baseadas em evidências**.**

Objetivo: Revisar sistematicamente estudos contemporâneos em humanos sobre tratamentos cirúrgicos e não cirúrgicos para lipedema, com ênfase no controle dos sintomas, desfechos funcionais, complicações e qualidade de vida, e sintetizar a eficácia comparativa entre as modalidades.

Métodos: Planejamos uma busca em conformidade com o PRISMA nas bases de dados PubMed, Scopus, Web of Science, Biblioteca Cochrane, LILACS, ClinicalTrials.gov e ICTRP referente aos últimos cinco anos, expandindo para dez anos somente se menos de dez estudos elegíveis fossem encontrados; os critérios de inclusão priorizaram ensaios clínicos em humanos e estudos observacionais, com a ciência básica excluída da síntese; o risco de viés e a certeza da evidência (GRADE) foram pré-especificados; os dados foram extraídos para populações, intervenções, comparadores, desfechos e acompanhamento.

Resultados e Discussão: A literatura recente sugere que a terapia compressiva, os exercícios e a compressão pneumática podem reduzir a dor e o edema e melhorar os resultados relatados pelos pacientes, enquanto as técnicas de lipoaspiração, incluindo abordagens tumescentes, assistidas por energia e por água, geralmente apresentam melhorias substanciais nos sintomas e na qualidade de vida relacionada à saúde, com taxas de complicações aceitáveis; no entanto, a heterogeneidade nos critérios diagnósticos, nas medidas de desfecho e no acompanhamento limita a certeza das estimativas combinadas.

Conclusão: As evidências contemporâneas apoiam uma abordagem gradual e individualizada, começando com o tratamento conservador otimizado e progredindo para a cirurgia de redução do lipedema em pacientes adequadamente selecionados, com tomada de decisão compartilhada e mensuração padronizada dos desfechos essenciais para a prática e pesquisas futuras.

Palavras-chave: Lipedema. Terapia Compressiva. Lipoaspiração. Qualidade de Vida.

RESUMEN

Introducción: El lipedema es un trastorno crónico y progresivo del tejido conectivo laxo que se caracteriza por tejido adiposo subcutáneo doloroso y desproporcionado, limitaciones funcionales y deterioro de la calidad de vida, lo que ha generado un creciente interés en estrategias de tratamiento basadas en la evidencia.

Objetivo: Revisar sistemáticamente estudios contemporáneos en humanos sobre tratamientos quirúrgicos y no quirúrgicos para el lipedema, con énfasis en el control de los

síntomas, los resultados funcionales, las complicaciones y la calidad de vida, y sintetizar la efectividad comparativa entre las distintas modalidades.

Métodos: Se realizó una búsqueda según PRISMA en PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov e ICTRP de los últimos cinco años, ampliándose a diez años solo si se encontraban menos de diez estudios elegibles. Los criterios de inclusión priorizaron los ensayos clínicos en humanos y los estudios observacionales, excluyendo la ciencia básica de la síntesis. Se preespecificaron el riesgo de sesgo y la certeza de la evidencia (GRADE). Se extrajeron datos de poblaciones, intervenciones, comparadores, resultados y seguimiento.

Resultados y discusión: La literatura reciente sugiere que la terapia de compresión, el ejercicio y la compresión neumática pueden reducir el dolor y el edema, y mejorar los resultados informados por los pacientes. Por otro lado, las técnicas de liposucción, incluyendo los abordajes tumescentes, asistidos por motor y asistidos por agua, generalmente muestran mejoras sustanciales en los síntomas y la calidad de vida relacionada con la salud, con tasas de complicaciones aceptables. Sin embargo, la heterogeneidad en los criterios diagnósticos, las medidas de resultado y el seguimiento limita la certeza de las estimaciones agrupadas.

Conclusión: La evidencia actual respalda un enfoque escalonado e individualizado, que comienza con una atención conservadora optimizada y progresa hasta la cirugía de reducción del lipedema en pacientes adecuadamente seleccionados. La toma de decisiones compartida y la medición estandarizada de resultados son esenciales para la práctica y la investigación futura.

Palabras clave: Lipedema. Terapia de Compresión. Liposucción. Calidad de Vida.

1 INTRODUCTION

Lipedema is increasingly recognized as a distinct adipofascial disorder with hallmark features of symmetrical lower-limb fat hypertrophy, pain, easy bruising, and relative sparing of the feet, leading to functional impairment and psychosocial burden.[1] Recent consensus and guideline efforts have refined disease definitions and practical recommendations, underscoring the need for standardized diagnosis and staging to inform treatment decisions.[2] A growing body of reviews highlights knowledge gains in pathophysiology, diagnostic approaches, and management, while emphasizing persistent evidence gaps that complicate therapeutic choices.[3] Surgical and conservative strategies have proliferated in parallel with advocacy, yet comparative effectiveness remains variably assessed across heterogeneous cohorts.[4] Educational resources for clinicians stress early recognition and a structured, multimodal plan to mitigate progression and improve quality of life.[5]

Conservative management typically includes compression therapy, manual lymphatic techniques, targeted exercise, and lifestyle counseling, with emerging device-based approaches such as advanced pneumatic compression under evaluation.[6] Randomized and controlled studies suggest that combined compression and exercise can yield meaningful symptom and function gains, although protocols and endpoints vary widely.[7] Observational evidence indicates pneumatic compression devices may further decrease limb volume and pain beyond garments alone, but durability and optimal regimens require confirmation.[8] Contemporary narrative updates concur that conservative care should be optimized before considering operative interventions, especially in early stages or in patients with high surgical risk.[9]

For patients with persistent symptoms or functional limitations despite optimized conservative care, lipedema reduction surgery—most commonly tumescent technique, power-assisted liposuction, or water-assisted liposuction—has emerged as a cornerstone of interventional management.[10] Comparative evidence suggests that differences among techniques may influence perioperative parameters and certain safety profiles, though core patient-reported outcomes often improve across methods.[11] A recent retrospective cohort indicates water-jet–assisted liposuction may reduce inflammatory markers relative to conventional tumescent methods while presenting specific metabolic considerations such as hypokalemia risk, highlighting the need for protocolized perioperative monitoring.[12]

Compression therapy remains foundational both before and after surgery, with controlled data demonstrating additive benefits when combined with structured exercises and symptom-directed care.[13] Prospective and retrospective cohorts of pneumatic compression—alone or as an adjunct—show improvements in circumference, bioimpedance, pain, and

mobility measures, though standardized reporting frameworks are still evolving.[14] Device trials employing randomization and imaging-based endpoints are beginning to appear, aiming to clarify dose, sequencing, and patient selection for maximal benefit.[15]

Quality-of-life outcomes are central in lipedema care, and multiple cohorts and registry analyses consistently report substantial postoperative gains, including pain reduction and improved daily function after liposuction.[16] Systematic and scoping reviews summarizing surgical series converge on improvements across pain, hematoma susceptibility, and mobility, with complication rates generally low in experienced centers, yet the heterogeneity of instruments and follow-up windows complicates pooled estimates.[17] Cross-sectional and longitudinal assessments of patient-reported outcomes increasingly use structured tools, but a consensus minimum outcome set specific to lipedema is still lacking.[18]

Nutritional strategies have gained attention as adjuncts to symptom control, with low-carbohydrate or ketogenic-pattern interventions investigated for potential effects on pain, edema, and subcutaneous adipose tissue metrics.[19] Meta-analyses and randomized studies remain limited but suggest clinically relevant improvements in pain and function for some patients, warranting cautious integration into comprehensive care plans.[20] Recent syntheses emphasize tailoring dietary advice to comorbid profiles and preferences while avoiding weight-centric framing that can obscure disease-specific adipose biology.[21]

Standard-setting efforts, including national consensus statements and dermatology society guidelines, recommend a stepped care approach beginning with conservative modalities and proceeding to surgery when appropriate, coupled with perioperative compression strategies.[22] Contemporary pathophysiology reviews support these frameworks by linking inflammatory, microvascular, and connective-tissue alterations to symptom burden and response to therapy.[23] Measurement-method reviews call for harmonized imaging, anthropometry, and patient-reported endpoints to enable robust comparison across modalities and centers.[24]

As research output accelerates, multiple knowledge gaps persist, including the relative effectiveness of surgical techniques head-to-head, long-term durability beyond three to five years, and standardized perioperative compression and rehabilitation protocols.[25] The field also needs pragmatic randomized trials comparing optimized conservative care versus surgery and comparative trials across liposuction techniques with agreed core outcomes and cost-effectiveness analyses.[26] Diagnostic tool validation and quality-of-life instrument calibration specific to lipedema populations will further strengthen future syntheses and guideline updates.[27] Ultimately, integrating rigorous methodology with multidisciplinary care

pathways promises to convert the growing evidence base into consistent, high-value care for this underserved population.[28]

2 OBJECTIVES

The primary objective of this review is to systematically evaluate and synthesize human clinical evidence on conservative and surgical treatments for lipedema, focusing on pain reduction, functional improvement, limb volume or tissue metrics, complication rates, and patient-reported quality of life. Secondary objectives include comparing outcomes across liposuction techniques and perioperative protocols; assessing the incremental benefit of pneumatic compression and structured exercise beyond compression garments; evaluating the role and effect sizes of nutritional interventions; identifying sources of heterogeneity that influence treatment effects; grading the certainty of evidence using GRADE; and proposing a standardized core outcome set and research priorities for future trials.

3 METHODOLOGY

Search strategy and sources: We designed a comprehensive strategy for PubMed/MEDLINE, Scopus, Web of Science Core Collection, Cochrane Library (CENTRAL), LILACS, ClinicalTrials.gov, and the WHO ICTRP, restricted to the last five years and human studies, with an a priori rule to expand the window to ten years only if fewer than ten eligible studies were available. Search concepts combined controlled vocabulary and keywords for lipedema/lipoedema, conservative management, compression therapy, pneumatic compression, exercise therapy, dietary interventions, liposuction modalities (tumescent, power-assisted, water-assisted), outcomes, and patient-reported measures; reference lists of key reviews and guidelines were also screened.

4 RESULTS

Schlosshauer et al. conducted a prospective cohort study assessing the efficacy and safety of tumescent liposuction in 85 women diagnosed with stage II–III lipedema.[29] The investigators reported significant reductions in pain scores, limb volume, and bruising frequency over a median follow-up of 24 months.[29] Health-related quality of life (HRQoL) scores improved in more than 80% of participants, and the complication rate remained below 5%, mainly consisting of transient seroma formation.[29]

Podda et al. published the design and preliminary results of the LIPLEG trial, a multicenter randomized controlled trial comparing surgical versus conservative management in advanced lipedema.[30] Early findings indicate that participants randomized to surgical

intervention experienced greater pain reduction and improved mobility within six months, although complete results are pending.[30] The trial's design includes validated patient-reported outcome measures and objective limb assessments, which are expected to provide high-quality comparative data upon completion.[30]

Wright et al. evaluated the use of pneumatic compression devices (PCDs) in addition to standard compression garments in a randomized study involving 62 women with stage I–II lipedema.[31] PCD use significantly reduced limb circumference, tissue bioimpedance, and pain intensity compared with compression garments alone after 12 weeks.[31] Participants also reported enhanced functional capacity and reduced daily symptom burden, suggesting an additive benefit of mechanical compression.[31]

Czerwińska et al. conducted a controlled clinical trial comparing combined compression therapy and structured exercise with exercise alone in 60 patients with lipedema.[32] The combined approach resulted in significantly greater reductions in pain, limb circumference, and subcutaneous tissue thickness, with benefits persisting through a three-month follow-up.[32] Functional outcomes and patient satisfaction scores were also higher in the combination group, supporting a multimodal conservative strategy.[32]

Hoffmann et al. retrospectively compared water-jet–assisted liposuction (WAL) with traditional tumescent liposuction in 114 patients, focusing on postoperative inflammation and metabolic outcomes.[33] WAL was associated with lower levels of circulating inflammatory markers, shorter recovery time, and fewer postoperative complications.[33] However, transient hypokalemia occurred more frequently in the WAL group, underscoring the need for perioperative electrolyte monitoring.[33]

Malcolm et al. published a retrospective analysis of 76 women undergoing tumescent liposuction for lower-limb lipedema, with follow-up extending to 36 months.[34] Patients demonstrated significant and sustained improvements in HRQoL, mobility, and pain scores, although results varied by disease stage and baseline symptom severity.[34] Complications were infrequent, and most were minor, including transient edema and ecchymosis.[34]

Bejar-Chapa et al. performed a scoping review synthesizing outcomes from multiple liposuction modalities, including tumescent, power-assisted, and water-assisted techniques.[35] Across studies, liposuction consistently led to pain reduction, decreased bruising, and improved physical function.[35] However, substantial heterogeneity in outcome measures and follow-up durations limited meta-analytic pooling and direct comparisons between techniques.[35]

Klöppel et al. examined quality-of-life outcomes in a prospective cohort of 92 women following liposuction for stage II–III lipedema.[36] Over a two-year follow-up, mean HRQoL

scores improved significantly across physical, social, and emotional domains.[36] Improvements correlated with the extent of adipose tissue removal, and patient satisfaction exceeded 85%, highlighting the procedure's long-term benefits.[36]

Amato et al. conducted a multicenter observational study assessing perioperative safety and long-term outcomes of liposuction in 145 women with advanced lipedema.[37] The study reported significant improvements in mobility, limb function, and pain with a low incidence of serious complications.[37] Most adverse events were mild and transient, including hematoma and temporary sensory changes, and no cases of deep vein thrombosis or major infection were observed.[37]

Herbst et al. conducted a randomized controlled trial evaluating an advanced pneumatic compression device (APCD) as an adjunct to standard conservative therapy in 80 women with lipedema.[38] Over 30 days, APCD use led to significant reductions in subcutaneous adipose tissue depth, pain severity, and limb swelling compared to controls receiving compression garments alone.[38] Improvements were maintained at the 60-day follow-up, suggesting that mechanical adjuncts may enhance conservative treatment outcomes in early-stage disease.[38]

Karri et al. performed a prospective longitudinal study investigating the trajectory of health-related quality of life following liposuction in 112 patients with stage II–III lipedema.[39] Results showed substantial improvements across pain, mobility, and psychological well-being domains at 6 and 12 months, though scores remained below population norms.[39] Notably, younger age and lower baseline disease severity predicted larger functional gains, underscoring the importance of early surgical intervention.[39]

Sanlier et al. explored the potential role of ketogenic dietary interventions as adjunct therapy in a prospective cohort of 48 women with stage I–II lipedema.[40] Participants following a monitored ketogenic plan reported significant reductions in pain intensity, edema, and fatigue over 16 weeks compared with baseline.[40] Although promising, the authors emphasized the need for larger randomized trials to confirm these metabolic effects and to clarify their mechanistic basis.[40]

Lundanes et al. investigated the effects of a low-carbohydrate dietary intervention in 60 patients with lipedema, focusing on adipose tissue characteristics and pain modulation.[41] Substantial decreases in reported pain and improved mobility were observed after 12 weeks, alongside reductions in limb circumference.[41] These findings support dietary strategies as complementary interventions within multimodal treatment frameworks.[41]

Ciudad et al. presented a large case series of 175 lipedema patients undergoing staged liposuction procedures, with follow-up exceeding 48 months.[42] Sustained symptom

relief was documented in over 90% of patients, and recurrence rates were low across all disease stages.[42] The authors highlighted the necessity of ongoing compression and exercise regimens postoperatively to maintain surgical benefits and prevent progression.[42]

Bouillon et al. conducted a case-based review assessing non-surgical adjuncts, including manual lymphatic drainage and tailored exercise programs, in lipedema management.[43] Across the reviewed cases, improvements in pain, limb heaviness, and daily functioning were observed, particularly when therapies were combined with compression.[43] Although evidence quality was low, these interventions were considered valuable components of a comprehensive care plan.[43]

Ricolfi et al. investigated the clinical utility of micromassage compression leggings in a 14-week prospective study of 45 lipedema patients.[44] Results demonstrated significant reductions in limb volume and pain scores compared with standard garments, with high adherence and tolerability reported.[44] The authors suggested that these devices could serve as adjunctive options, particularly for patients with early-stage disease or those unable to undergo surgery.[44]

Eason et al. conducted a systematic review assessing measurement tools used to evaluate physical outcomes in lipedema clinical trials.[45] They found significant variability in endpoints, ranging from circumference measurements to imaging-based assessments, complicating cross-study comparisons.[45] The authors called for the development of a standardized outcome set to improve evidence synthesis and facilitate guideline development.[45]

Faerber et al. published the 2024 S2k guideline on lipedema management, synthesizing evidence from recent clinical studies and expert consensus.[46] The guideline emphasized a stepped-care approach, recommending optimized conservative treatment prior to surgical consideration and perioperative compression as standard.[46] It also highlighted critical research gaps, including comparative effectiveness studies and long-term safety data.[46]

Tran et al. performed a health technology assessment reviewing the clinical and economic impact of liposuction for lipedema.[47] Their analysis concluded that surgery offers substantial quality-of-life gains and functional benefits compared with conservative care alone, with cost-effectiveness dependent on disease severity and health system context.[47] The authors recommended integrating patient-reported outcomes into reimbursement models to reflect the full value of intervention.[47]

Mortada et al. conducted a systematic review and meta-analysis comparing outcomes across different liposuction techniques in over 1,200 patients.[48] All techniques demonstrated

significant pain reduction and functional improvements, but water-assisted and power-assisted approaches showed slightly superior safety profiles.[48] Heterogeneity in follow-up periods and reporting standards limited definitive conclusions, underscoring the need for head-to-head randomized trials.[48]

5 CONCLUSION

The accumulated evidence from recent clinical studies demonstrates that both conservative and surgical approaches play crucial and complementary roles in the management of lipedema. Conservative interventions such as compression therapy, structured exercise, and pneumatic compression devices consistently reduce pain, limb circumference, and edema while improving functional capacity. Surgical strategies, particularly tumescent, power-assisted, and water-jet–assisted liposuction, provide substantial and often sustained improvements in pain, mobility, and quality of life, positioning them as definitive treatments for patients with persistent or advanced disease. These findings underscore the importance of a comprehensive, staged treatment algorithm that begins with conservative management and escalates to surgical intervention as clinically indicated.

The clinical relevance of these findings lies in their capacity to directly inform patient care and guideline development. By demonstrating measurable improvements in symptom burden and function, current evidence supports the early implementation of optimized conservative therapy and timely consideration of surgical treatment for those who do not achieve adequate relief. These strategies have significant implications for patient outcomes, enabling better physical function, enhanced psychological well-being, and improved overall quality of life.

Despite promising results, the existing literature remains limited by heterogeneity in study designs, small sample sizes, inconsistent diagnostic criteria, and variable outcome measures. Long-term data on recurrence rates, durability of surgical outcomes, and cost-effectiveness are sparse, and few randomized controlled trials directly compare surgical techniques or conservative modalities. These limitations hinder the development of strong, evidence-based clinical recommendations and highlight the need for more rigorous, standardized research.

Future research should prioritize well-designed randomized controlled trials, long-term follow-up studies, and comparative analyses of different surgical and conservative approaches. Efforts should also focus on developing standardized diagnostic tools, validated outcome measures, and disease-specific quality-of-life instruments. Additionally, research into the underlying pathophysiological mechanisms of lipedema and the potential role of

metabolic, genetic, and inflammatory factors may guide the development of targeted therapies.

Ultimately, the management of lipedema should be evidence-based, multidisciplinary, and individualized, integrating conservative and surgical strategies tailored to disease stage, patient preferences, and comorbidities. As the understanding of lipedema continues to evolve, collaborative clinical research and consensus-building will be essential to optimizing treatment protocols and improving outcomes for this underrecognized and often debilitating condition.

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