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Review Article

Surgery Section

Mechanochemical Ablation: Current Status in the Management of Varicose Veins: A Comprehensive Review

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ABSTRACT

Varicose veins, a common venous disorder, often lead to significant discomfort and a reduced quality of life. Over the years, numerous treatment approaches have been explored to alleviate the associated symptoms. Surgical interventions such as saphenofemoral junction ligation and Great Saphenous Vein (GSV) stripping were transformative in their time, but the emergence of endovenous techniques like Endovenous Laser Therapy (EVLT) and Radiofrequency Ablation (RFA) marked a significant shift. While these endovenous techniques have shown exceptional clinical outcomes and cost-effectiveness, they do come with the drawback of pain due to the application of heat for ablation and the necessity of infiltrating tumescent anaesthesia around the vein. In recent years, non thermal, non tumescent methods have arisen as effective alternatives that reduce patient discomfort. These methods encompass procedures such as Mechanochemical Ablation (MOCA) and endovenous cyanoacrylate glue, which minimise heat generation and eliminate the need for tumescent anaesthesia. This article provides a comprehensive overview of the current status of MOCA. It covers its mechanism of action, clinical outcomes, cost-effectiveness, and safety profiles in managing varicose veins.

Keywords: Great saphenous vein stripping, Non thermal, Tumescent endovenous techniques

INTRODUCTION

Varicose veins are a prevalent issue, affecting nearly one-third of the population. This has resulted in substantial healthcare expenditures, with venous disease accounting for approximately 1-2% of the healthcare budget [1]. This condition encompasses a spectrum of lesions, ranging from telangiectasias and reticular veins to more severe manifestations such as varicose veins, trophic ulcerations, and thrombotic complications. A significant proportion of these cases can be attributed to venous hypertension secondary to reflux in one or more GSVs [2].

The treatment of Chronic Venous Disease (CVD) has been shown to significantly enhance the quality of life for affected individuals. Historically, the management of axial reflux of the GSV and Small Saphenous Vein (SSV) involved surgical ligation and stripping through substantial incisions. While effective, these open procedures are associated with considerable morbidity [3]. In contrast, endovenous ablation techniques have become the standard of care for GSV ablation. They offer advantages such as reduced postoperative pain, a lower incidence of surgical site infections, quicker return to normal activities, and work resumption. However, it is worth noting that these benefits come with the drawback of high equipment costs [4]. Additionally, the use of thermal energy in procedures like EVLT and RFA has been associated with procedural pain, necessitating the use of tumescent anaesthesia. These techniques have also been linked to complications, including thermal burns and skin rashes [5].

A study by Puggioni A et al., conducted between 2001 and 2004, revealed an overall complication rate of 15.4% in limbs treated with EVLT (20.8% in the EVLT group and 7.6% in the RFA group). These complications included superficial thrombophlebitis, excessive pain, haematoma, oedema, and cellulitis. Notably, few of these adverse effects required hospitalisation [6]. To mitigate the complications associated with thermal energy, innovative methods such as sclerotherapy, cyanoacrylate glue, and MOCA have emerged.

Non thermal, non tumescent methods for varicose vein treatment have gained rapid popularity due to their clinical efficacy, combined with a superior safety and tolerability profile. Cyanoacrylate glue treatment, which initiates vein fibrosis through rapid polymerisation, has shown promise but is associated with rare complications [7-9]. MOCA involves mechanical injury to the endothelium combined with infusion of liquid sclerosants without the use of tumescent anaesthesia [10]. This review article aims to provide a comprehensive understanding of MOCA and its role in the management of varicose veins.

DISCUSSION

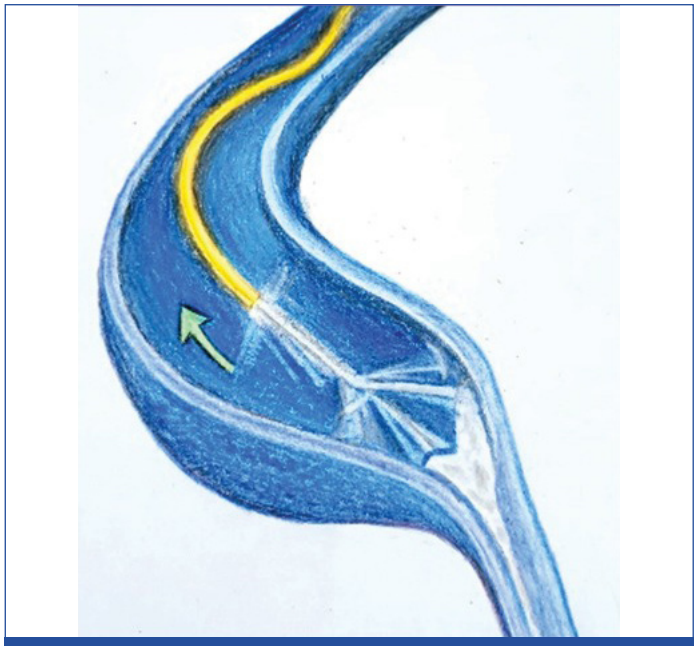
MOCA ingeniously combines mechanical endothelial damage, achieved through a rotating wire or radial cutting hooks, with concurrent catheter-guided infusion of a liquid sclerosant. This dual approach irreversibly disrupts the cellular membranes of the endothelium, triggering vein fibrosis [1,10]. The mechanical and chemical damage to the endothelium not only aids the sclerosant's penetration into the vessel wall but also induces vasoconstriction, as substantiated by ex-vivo and animal models [2,11]. This dual mechanism implies that MOCA may yield lower recanalisation rates compared to methods relying solely on mechanical or chemical ablation [1]. There are two established systems of MOCA: one is the ClariVein system [4], and the other is the Flebogriff system, a more recent system.

a) The ClariVein System

The ClariVein system represents a notable form of MOCA. It utilises a rotating catheter tip spinning at 3500 rpm to mechanically agitate the vessel wall. Simultaneously, it releases a 1.5-2% sodium tetradecyl sulphate solution through the tip of the catheter for chemical sclerosis. This procedure can be performed using local anaesthesia at the insertion site, and through a 4 or 5 Fr sheath. The technique involves percutaneous introduction of the ClariVein sheath and wire into the vessel, followed by controlled withdrawal of the catheter and wire down the vein while ultrasound guidance ensures proper sclerosant administration. Postprocedure care entails a 24-hour compression bandage from the foot to the groin, followed by thigh-high compression stockings at 15 to 20 mm Hg for 48 hours, with daytime use for the subsequent 10 days [Table/Fig-1] [4].

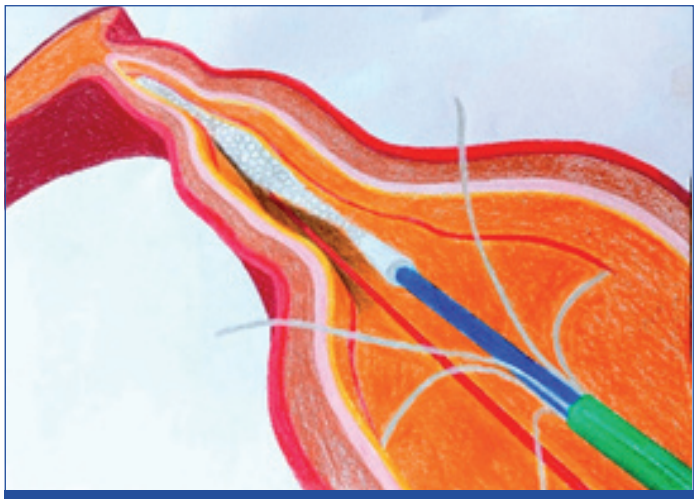
b) The Flebogriff System

The Flebogriff system, a newer MOCA method, comprises five retractable elements with sharp tips that induce mechanical



[Table/Fig-1]: Image showing ClariVein system of Mechanochemical Ablation (MOCA) [4].

endothelial damage. This innovative approach facilitates stronger vessel contraction and deeper penetration of the sclerosant into the vein wall [Table/Fig-2] [1].



[Table/Fig-2]: Image showing flebogriff system [1].

Comparison of Efficacy

In a clinical trial conducted in 2012 by Elias S and Raines JK, where 30 GSVs in 29 patients were mechanochemically ablated and followed for safety and efficacy, no major postoperative complications were reported, and the occlusion rate was an impressive 96.7% [12].

In a randomised controlled trial by Mohamed AH et al., where 150 patients were equally randomised between Endovenous Laser Ablation (EVLA) and MOCA, both groups reported low intraprocedural pain scores. Pain levels during axial EVLA were 22 (9-44) compared to 15 (9-29) during MOCA. At the one-year mark, duplex-derived anatomical occlusion rates after EVLA were 91%, while MOCA achieved 77%. Notably, both groups experienced significant improvements in the Venous Clinical Severity Score (VCSS) and the Aberdeen Varicose Vein Questionnaire (AVVQ), with no significant differences between them [13].

A randomised controlled study by Belramman A et al., comparing postprocedural pain using visual analog scales, revealed that MOCA and Cyanoacrylate Adhesive Embolisation (CAE) techniques produced similar periprocedural pain scores [14].

A multicentre prospective randomised controlled trial conducted by Holewijn S et al., involved 213 patients, with 105 in the MOCA group and 104 in the RFA group. The study showed that MOCA resulted in lower median pain scores during the first 14 days compared to RFA. At 30 days, similar complication numbers and Health-Related Quality of Life (HRQoL) scores were observed. While MOCA exhibited a lower anatomic success rate at one and two years compared to RFA, clinical success rates and HRQoL scores were similar [15].

In a prospective observational study involving 68 patients with unilateral GSV incompetence, MOCA-treated patients reported significantly less postoperative pain during the first 14 days compared to RFA-treated patients. This lower pain score was associated with an earlier return to normal activities and work resumption [16].

In a systematic review conducted by Alozai T et al., [17] over the Flebogriff system of MOCA, the three month anatomic success rate was 95.6%, and the 12-month anatomic success rate was 93.2% [Table/Fig-3] [12-17].

Complications Associated with MOCA

MOCA is generally considered a safe procedure with a low-risk of complications. Some patients may experience temporary side-effects such as mild discomfort, bruising, or swelling at the treatment site. Phlebitis, inflammation of the vein, is a potential complication, but it often resolves without significant issues. Haematoma, or localised bleeding, may occur, and in rare cases, allergic reactions to the sclerosing agent are possible.

In the MARADONA trial conducted by Holewijn S et al., in 2018, hyperpigmentation was seen in seven patients in the MOCA group and two patients in the RFA group. There were two serious cardiac adverse events, one in the MOCA group (ventricular fibrillation at one year) and one in the RFA group (unstable angina at two years). One patient developed deep venous thrombosis in the RFA group at the 1-year mark, without clinical sequelae [15].

An early clinical trial by Elias S and Raines JK, involving 30 GSVs in 29 patients, reported no adverse events beyond minor local ecchymosis [12]. A later trial by Whiteley MS et al., treated 85 patients (104 limbs) over one year and noted a technical success rate of 99%. No major complications were observed, with minor complications such as hyperpigmentation, haematoma/bruising, induration, superficial thrombophlebitis, and prolonged pain occurring in less than 14.3% of patients [11].

Lane TR et al., reported a rare complication of MOCA using ClariVein, known as retrograde inversion stripping of the GSV. However, the patient remained asymptomatic and pain-free, with no abnormal neurology or cutaneous numbness during follow-up appointments [Table/Fig-4] [11,12,16-18].

The systematic review of the Flebogriff system has shown no major complications except for deep vein thrombosis in 0.3% of patients and minor complications like thrombophlebitis and hyperpigmentation in 13-14.5% and 3.3-10.0% of patients, respectively, within three months [16].

Cost-effectiveness

A review article by Epstein D et al., compared the cost-effectiveness of various varicose vein treatments. It considered factors like the cost of staff, kit, consumables, anaesthesia, and more. The analysis revealed that conservative management emerged as the most cost-effective option. Ultrasound-Guided Foam Sclerotherapy (UGFS) was the least expensive treatment over five years but had a higher likelihood of requiring reintervention or retreatment, indicating lower effectiveness. MOCA, EVLA, and High Ligation and Stripping (HL/S) exhibited similar costs and outcomes, suggesting comparable value for money. However, high ligation and surgery required

S. no	Author	Publication year	Type of study	Place of study	System used	Observation
1	Elias S and Raines JK [12]	2012	Clinical trial	New York	Clarivein	Occlusion rate at six months: 96.7%
2	van Eekeren RR et al., [16]	2013	Prospective observational study comparing post procedural pain in MOCA and RFA	Netherlands		MOCA reported significantly less postoperative pain than patients treated with RFA. Pain in VAS. MOCA: 4.8. RFA: 18.6.
3	Mohamed AH et al., [13]	2021	Randomised control trial, single centred	United kingdom	Clarivein	Occlusion rate at one year. MOCA: 77% EVLA: 91%. Pain scores: MOCA: 15 EVLA: 22
4	Holewijn S et al., [15]	2019	Multicentre prospective randomised controlled trial comparing MOCA and RFA	Netherlands		The 1-and 2-year anatomic success rate was lower after MOCA (83.5% and 80%) compared with RFA (94.2% and 88.3%) but with similar clinical success rates.
5	Alozai T et al., [17]	2022	Systematic review	Netherlands	Flebogriff system	three month anatomic success rate: 95.6% nine month anatomic success rate: 93.2%.
6	Belramman A et al., [14]	2022	Multicentre randomised control trial comparing pain outcomes in MOCA and CAE	United kingdom		Pain measured visual analogue scale. MOCA: 24. CAE: 20.

[Table/Fig-3]: Table showing various studies comparing efficacy rates of various interventions [12-17].
MOCA: Mechanochemical ablation; RFA: Radiofrequency ablation; VAS: Visual analogue scale; EVLA: Endovenous laser therapy; CAE: Cyanoacrylate adhesive embolisation

S. no	Author	Publication year	Place of study	Type of study	Complications
1	Elias S and Raines JK [12]	2012	New York	Clinical trial	No complications except for local ecchymosis.
2	van Eekeren RR et al., [16]	2013	Netherlands	Prospective observational study comparing post-procedural pain in MOCA and RFA	MOCA: hyperpigmentation in seven patients, ventricular fibrillation in one patient at one year. RFA: hyperpigmentation in two patients, DVT in one patient, and unstable angina in one patient at two years.
3	Lane TR et al., [18]	2015	United kingdom	Case report	Rare complication of retrograde stripping of GSV.
4	Whiteley MS et al., [11]	2017	Netherlands	Prospective observational study	No major complications were seen minor complications like hyperpigmentation, haematoma/bruising, induration, superficial thrombophlebitis, and prolonged pain occurring in less than 14.3% of patients.
5	Alozai T et al., [17]	2022	Netherlands	Systematic review	Major complications: DVT. Minor complications: thrombophlebitis, hyperpigmentation.

[Table/Fig-4]: Table showing complications in various studies [11,12,16-18].
MOCA: Mechanochemical ablation; RFA: Radiofrequency ablation; DVT: Deep venous thrombosis; GSV: Great saphenous vein

more time in the operating theatre and longer patient recovery, which led to its replacement by endothermal procedures. MOCA, while effective, had a relatively high acquisition cost compared to established methods. CAE had a substantially higher acquisition cost but lacked evidence regarding reinterventions [19].

CONCLUSION(S)

The studies comparing MOCA with traditional methods have shown promising results, including reduced postoperative pain and comparable improvements in patient-reported outcomes. While MOCA presents a compelling alternative, it is essential to consider factors such as cost-effectiveness, complications, and long-term efficacy. Ultimately, the choice of treatment should be tailored to the individual patient's needs and preferences, considering factors like cost, pain tolerance, and clinical outcomes. Continued research and clinical evaluation will further refine our understanding of MOCA's role in the management of varicose veins, offering patients a more comfortable and effective treatment option.

REFERENCES

[1] Joyce DP, Walsh SR, Yap CJQ, Chong TT, Tang TY. Compression therapy following ClariVein® ablation therapy: A randomised controlled trial of Compression therapy following MechanO-Chemical Ablation (COMMOCA). Trials. 2019;20(1):678. Doi: 10.1186/s13063-019-3787-4. PMID: 31806052; PMCID: PMC6894465.

[2] Terlecki P, Boryga M, Kołodziej P, Gołacki K, Stropek Z, Janczak D, et al Mechanical characteristics of the flebogrif system-The new system of mechano-chemical endovenous ablation. Materials (Basel). 2022;15(7):2599. Doi: 10.3390/ma15072599. PMID: 35407933; PMCID: PMC9000315.

[3] Siribumrungwong B, Srikuea K, Orrapin S, Benyakorn T, Rerkasem K, Thakkinstian A. Endovenous ablation and surgery in great saphenous vein reflux: A systematic review and network meta-analysis of randomised controlled trials protocol. BMJ Open. 2019;9(1):e024813. Doi: 10.1136/bmjopen-2018-024813. PMID: 30705242; PMCID: PMC6359740.

[4] Shmelev K, Gupta R. Choosing the best treatment approach for axial vein reflux: Thermal versus nonthermal approaches. Semin Intervent Radiol. 2021;38(2):209-14. Doi: 10.1055/s-0041-1729155. Epub 2021 Jun 3. PMID: 34108808; PMCID: PMC8175110.

[5] Nugroho J, Wardhana A, Ghea C. Mechanical Occlusion Chemically Assisted Ablation (MOCA) for saphenous vein insufficiency: A meta-analysis of a randomized trial. Int J Vasc Med. 2020;2020:8758905. Doi: 10.1155/2020/8758905. PMID: 32411472; PMCID: PMC7204279.

[6] Puggioni A, Kalra M, Carmo M, Mozes G, Gloviczki P. Endovenous laser therapy and radiofrequency ablation of the great saphenous vein: Analysis of early efficacy and complications. J Vasc Surg. 2005;42(3):488-93. Doi: 10.1016/j.jvs.2005.05.014. PMID: 16171593.

[7] Rasmussen LH, Lawaetz M, Bjoern L, Vennits B, Blemings A, Eklof B. Randomized clinical trial comparing endovenous laser ablation, radiofrequency ablation, foam sclerotherapy and surgical stripping for great saphenous varicose veins. Br J Surg. 2011;98(8):1079-87. Doi: 10.1002/bjs.7555. PMID: 21725957.

[8] Gillet JL, Guedes JM, Guex JJ, Hamel-Desnos C, Schadeck M, Lauseker M, et al. Side-effects and complications of foam sclerotherapy of the great and small saphenous veins: A controlled multicentre prospective study including 1,025 patients. Phlebology. 2009;24(3):131-38. Doi: 10.1258/phleb.2008.008063. PMID: 19470865.

[9] Langridge BJ, Onida S, Weir J, Moore H, Lane TR, Davies AH. Cyanoacrylate glue embolisation for varicose veins- A novel complication. Phlebology. 2020;35(7):520-23. Doi: 10.1177/0268355520901662. Epub 2020 Jan 28. PMID: 31992129; PMCID: PMC7488820.

[10] Boersma D, van Eekeren RR, Kelder HJ, Werson DA, Holewijn S, Schreve MA, et al. Mechanochemical endovenous ablation versus radiofrequency ablation in the treatment of primary small saphenous vein insufficiency (MESSI trial): Study protocol for a randomized controlled trial. Trials. 2014;15:421. Doi: 10.1186/1745-6215-15-421. PMID: 25354769; PMCID: PMC4228073.

[11] Whiteley MS, Dos Santos SJ, Lee CT, Li JM. Mechanochemical ablation causes endothelial and medial damage to the vein wall resulting in deeper penetration of sclerosant compared with sclerotherapy alone in extrafascial great saphenous vein using an ex vivo model. J Vasc Surg Venous Lymphat Disord. 2017;5(3):370-77. Doi: 10.1016/j.jvsv.2016.12.009. Epub 2017 Mar 6. PMID: 28411705.

[12] Elias S, Raines JK. Mechanochemical tumescentless endovenous ablation: Final results of the initial clinical trial. Phlebology. 2012;27(2):67-72. Doi: 10.1258/phleb.2011.010100. Epub 2011 Jul 29. PMID: 21803800; PMCID: PMC3277920.

[13] Mohamed AH, Leung C, Wallace T, Smith G, Carradice D, Chetter I. A randomized controlled trial of endovenous laser ablation versus mechanochemical ablation with clarivein in the management of superficial venous incompetence (LAMA Trial). Ann Surg. 2021;273(6):e188-95. Doi: 10.1097/SLA.0000000000003749. PMID: 31977509.
[14] Belramman A, Bootun R, Tang TY, Lane TRA, Davies AH. Pain outcomes following mechanochemical ablation vs cyanoacrylate adhesive for the treatment of primary truncal saphenous vein incompetence: The MOCCA randomized clinical trial. JAMA Surg. 2022;157(5):395-404. Doi: 10.1001/jamasurg.2022.0298. PMID: 35385061; PMCID: PMC8988024.
[15] Holewijn S, van Eekeren RRJP, Vahl A, de Vries JPPM, Reijnen MMPJ; MARADONA study group. Two-year results of a multicenter randomized controlled trial comparing Mechanochemical endovenous Ablation to RADiOfrequeNcy Ablation in the treatment of primary great saphenous vein incompetence (MARADONA trial). J Vasc Surg Venous Lymphat Disord. 2019;7(3):364-74. Doi: 10.1016/j.jvsv.2018.12.014. PMID: 31000063.
[16] van Eekeren RR, Boersma D, Konijn V, de Vries JP, Reijnen MM. Postoperative pain and early quality of life after radiofrequency ablation and mechanochemical endovenous ablation of incompetent great saphenous veins. J Vasc Surg. 2013;57(2):445-50. Doi: 10.1016/j.jvs.2012.07.049. Epub 2012 Nov 8. PMID: 23141679.
[17] Alozai T, Huizing E, Schreve M, Mooij MC, van Vlijmen CJ, Wisselink W, et al. A systematic review and meta-analysis of mechanochemical endovenous ablation using Flebogrif for varicose veins. J Vasc Surg Venous Lymphat Disord. 2022;10(1):248-57.e2. Doi: 10.1016/j.jvsv.2021.05.010. Epub 2021 Jun 6. PMID: 34091106.
[18] Lane TR, Moore HM, Franklin IJ, Davies AH. Retrograde inversion stripping as a complication of the ClariVein mechanochemical venous ablation procedure. Ann R Coll Surg Engl. 2015;97(2):e18-20. Doi: 10.1308/003588414X14055925060398. PMID: 25723675; PMCID: PMC4473421.
[19] Epstein D, Onida S, Bootun R, Ortega-Ortega M, Davies AH. Cost-effectiveness of current and emerging treatments of varicose veins. Value Health. 2018;21(8):911-20. Doi: 10.1016/j.jval.2018.01.012. Epub 2018 Mar 15. PMID: 30098668.

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