Original Article

Cukurova Anestezi ve Cerrahi Bilimler Dergisi

Use of Ultrasound-Guided Percutaneous Microwave Ablation in the Treatment of Hepatic Cavernous Hemangioma: A Prospective Single-Center Study

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Abstract

Aim: Hepatic cavernous hemangioma (HCH) is the most common benign liver tumor, but the management of small lesions remains controversial. This prospective study evaluated the efficacy, safety, and short- and long-term clinical outcomes of ultrasound (US)-guided percutaneous microwave (MW) ablation in patients with HCH under 5 cm exhibiting significant growth during follow-up. **Methods:** Between March 2010 and February 2015, a total of 38 patients with hepatic cavernous hemangioma (HCH) measuring less than 5 cm were prospectively enrolled at the Department of General Surgery, I.M. Sechenov First Moscow State Medical University (Moscow, Russia). Diagnosis was confirmed by contrast-enhanced multislice computed tomography (CT), and all patients underwent serial ultrasonography (US) and CT follow-up. During follow-up, 25 patients (65.8%) demonstrated stable lesion size and continued conservative surveillance. Thirteen patients (34.2%) showed a documented 2–2.5-fold increase in lesion diameter within 1.5–3 years and therefore met the predefined criteria for intervention. Recurrence was defined as the appearance of new contrast enhancement within the ablation zone or an increase in lesion size on follow-up imaging after initial complete ablation. These patients underwent US-guided percutaneous microwave ablation under intravenous anesthesia (14G probe; 100–120°C; 10–20 minutes) and constituted the treatment cohort analyzed in this study. Post-procedural follow-up included clinical examinations, liver function tests, and imaging studies. **Results:** The 13 treated patients (mean age 44 years; 9 women, 4 men) had 12 solitary and 1 multiple (four lesions) hemangiomas, predominantly right-lobed. Three patients (23.1%) were asymptomatic and ten (76.9%) had right upper-quadrant pain. A single session sufficed in 11 patients (84.6%); 2 (15.4%) required a second session for recurrence. Transient 2–3-fold ALT/AST elevations normalized by day 5. Six patients developed transient fluid collections that resolved spontaneously within 6 months; no major complications or procedure-related mortality occurred. Over a mean follow-up of 20 months (range 8–32), the ablation zone was replaced by fibrotic tissue in all patients. **Conclusion:** US-guided percutaneous MW ablation appears to be an effective, safe, and organ-preserving minimally invasive option for small hepatic cavernous hemangiomas with documented growth. The predominance of single-session success, absence of major complications or procedure-related mortality, and long-term fibrotic transformation of the ablation zone suggest favorable clinical outcomes within the limitations of a small, non-comparative cohort. This technique may represent a feasible alternative between conservative surveillance and surgical resection.

Keywords: Hemangioma; liver neoplasms; microwave ablation; ultrasonography

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1. Introduction

Hepatic cavernous hemangioma (HCH) is the most common benign tumor of the liver. Although it can occur in any age group, a marked female predominance has been reported, with female-to-male ratios ranging from 1.5:1 to 6:1[1–4]. Autopsy series have estimated its prevalence at between 0.4% and 20%, and the majority of cases remain clinically silent[5,6]. Pregnancy and exogenous estrogen exposure have been shown to promote tumor growth, supporting a role for hormonal factors in the pathogenesis of these lesions.

Most hemangiomas are small and asymptomatic; only approximately 20% reach a diameter greater than 5 cm, and multiple lesions are encountered in 10–29% of cases. Although uncommon, giant hemangiomas weighing up to 18 kg have been reported in the literature[1–4].

HCH is most often detected incidentally during abdominal imaging with US or CT performed for unrelated indications. Clinical manifestations, when present, are usually nonspecific and may include abdominal pain, a sensation of fullness, or right upper-quadrant discomfort. In a small minority of cases, life-threatening complications such as Kasabach–Merritt syndrome or massive intra-abdominal hemorrhage due to tumor rupture may develop[1–5].

There is currently no consensus regarding the optimal management of HCH. Some authors advocate surgical resection only for large or symptomatic lesions, whereas others consider documented progressive enlargement—regardless of lesion size—to be a sufficient indication for operation[2]. A third approach favors conservative observation as long as no complications arise. With recent advances in minimally invasive techniques, less traumatic and organ-preserving treatment options have emerged for selected patients in this group, providing a clinically attractive alternative situated between active surveillance and surgical resection.

The aim of this prospective study was to evaluate the efficacy, safety, and short- and long-term clinical outcomes of US-guided percutaneous MW ablation in patients with hepatic cavernous hemangiomas smaller than 5 cm but exhibiting documented growth on follow-up. By doing so, we sought to clarify the role of this minimally invasive approach—positioned between traditional surgical resection and passive observation—in current clinical practice and to provide data on its therapeutic value in carefully selected patient subgroups.

2. Materials and Methods

This prospective clinical study was conducted between March 2010 and February 2015 at the Department of General Surgery, University Clinical Hospital No. 1, I.M. Sechenov First Moscow State Medical University (Moscow, Russian Federation). The study protocol was reviewed at the January 2010 meeting of the Surgical Clinic of Moscow State Medical University and evaluated by the Institutional Ethics Committee. Under Protocol No. 14, the study was approved without any scientific or ethical objections. The investigation was carried out in accordance with the principles of the Declaration of Helsinki, and written informed consent was obtained from every patient prior to enrollment.

A total of 38 patients with hepatic cavernous hemangioma measuring less than 5 cm were prospectively enrolled and followed with serial ultrasonography and contrast-enhanced CT examinations. During follow-up, 25 patients (65.8%) demonstrated stable lesion size and continued conservative surveillance. Thirteen patients (34.2%) showed a documented 2–2.5-fold increase in lesion diameter within 1.5–3 years and therefore met the predefined criteria for intervention. These 13 patients underwent US-guided percutaneous microwave ablation and constituted the treatment cohort analyzed in this study.

Recurrence was defined as the appearance of new contrast enhancement within the ablation zone or an increase in lesion size on follow-up imaging after initial complete ablation.

During the surveillance period, patients underwent ultrasonographic evaluation every 6 months and contrast-enhanced CT annually. Following microwave ablation, ultrasonography was performed on postoperative day 1, at 1 month, 6 months, and every 6 months thereafter. Contrast-enhanced CT examinations were obtained 6 months after treatment and annually thereafter to assess ablation completeness, detect recurrence, and evaluate the morphological evolution of the ablation zone.

Indications for percutaneous MW ablation were established on the basis of prior experimental data from intraoperative MW ablation in large hemangiomas, in which pathomorphological assessment had demonstrated that the resulting thermal-necrosis zone formed an ellipsoid coagulation area approximately 3.5 × 5.0 cm in size. Patients in whom a 2–2.5-fold increase in hemangioma diameter was documented during 1.5–3 years of follow-up were treated with US-guided percutaneous MW ablation.

All ablation procedures were performed under intravenous anesthesia and real-time US guidance. An intercostal or subcostal access route was selected according to lesion location. The MW probe used had a 14-gauge shaft and an active tip length of 2–2.5 cm. The ablation duration was 10–20 minutes, and the target temperature was set at 100–120°C. After the procedure, all patients received short-course antibiotic prophylaxis together with hepatoprotective and supportive therapy.

Early and late postoperative evaluations were prospectively performed using clinical examination, liver function tests (ALT, AST, total/direct bilirubin, alkaline phosphatase [ALP], and gamma-glutamyl transferase [GGT]), and imaging (US and contrast-enhanced CT). Outcome measures included technical success of the ablation, completeness of necrosis, complication rate, recurrence requiring re-ablation, and long-term morphological evolution of the ablation zone (Table 1).

Table 1. Study methodology and patient characteristics

Variable	Value
Total number of patients	38
Patients with documented growth on follow-up	13 (34.2%)
Age, mean (range)	44 years (30–58)
Sex distribution	Female: 9 (69.2%); Male: 4 (30.8%)
Number of lesions	Solitary in 12 patients; 4 lesions in 1 patient
Lesion size	<5.0 cm
Lesion location	Right lobe: 9; Left lobe: 3; Bilobar: 1
Diagnostic modality	Contrast-enhanced multislice computed tomography
Access route	Intercostal or subcostal
Imaging guidance	Real-time ultrasonography
Anesthesia	Intravenous
Microwave probe	14-gauge shaft; active tip 2–2.5 cm
Ablation duration	10–20 minutes
Target temperature	100–120°C
Postoperative therapy	Antibiotic prophylaxis, hepatoprotective and supportive therapy

MW, microwave; CT, computed tomography.

2.1.Statistical Analysis

Given the descriptive nature of the study, only descriptive statistics were used. Continuous variables were expressed as mean ± standard deviation or median (range), while categorical variables were presented as frequencies and percentages.

3. Results

Of the 38 patients prospectively enrolled, 25 (65.8%) showed no significant change in lesion size during the observation period. In contrast, 13 patients (34.2%) demonstrated a 2–2.5-fold increase in hemangioma diameter within 1.5–3 years of follow-up and were subsequently treated with percutaneous MW ablation. The mean age of the treated patients was 44 years (range 30–58); 9 (69.2%) were women and 4 (30.8%) were men. Twelve patients had a single lesion, while one patient harbored four hemangiomas ranging from 2.5 to 5.0 cm in diameter. The lesions were located in the right lobe in 9 cases, in the left lobe in 3 cases, and bilobar in 1 case.

Three of the 13 treated patients (23.1%) were asymptomatic, while 10 (76.9%) presented with right upper-quadrant pain. All patients tolerated the MW ablation procedure well. In the early postoperative period, only mild pain and discomfort were reported; no major complications or procedure-related mortality occurred.

A single ablation session was sufficient in 11 patients (84.6%), whereas 2 patients (15.4%) required a second session because of recurrence confirmed on follow-up CT. On the first postoperative day, transient elevations of ALT and AST up to 2–3 times the upper limit of normal were observed; liver function tests had returned to normal values by the fifth postoperative day.

The mean long-term follow-up was 20 months (range 8–32 months). Over time, the ablation zone was progressively replaced by fibrotic tissue in all patients. Six patients developed transient peri-ablational fluid collections in the early postoperative period; these resolved spontaneously within 6 months without any need for intervention (Table 2).

Table 2. Outcomes following ultrasound-guided percutaneous microwave ablation

Parameter	Finding
Procedural tolerance	Well tolerated in all patients
Early postoperative complaints	Mild pain and discomfort
Major complications	None observed
Procedure-related mortality	None
Single-session efficacy	11 patients (84.6%)
Need for second session	2 patients (15.4%)
ALT/AST kinetics	Transient 2–3-fold elevation on day 1; normalized by day 5
Long-term follow-up	8–32 months (mean, 20 months)
Ablation zone evolution	Replaced by fibrotic tissue in all patients
Peri-ablational fluid collections	6 patients; spontaneously resolved within 6 months

ALT, alanine aminotransferase; AST, aspartate aminotransferase; CT, computed tomography; MW, microwave.

4. Discussion

The optimal management of hepatic cavernous hemangioma (HCH) remains a matter of debate, and no consensus has yet been reached among clinicians. The traditional approach favors avoidance of active treatment until lesions become overtly symptomatic, with conservative surveillance regarded as sufficient for asymptomatic patients. By contrast, several authors consider documented progressive enlargement—regardless of lesion size—to be a sufficient indication for intervention, given that large hemangiomas may give rise to pain, thrombocytopenia, and rarely life-threatening complications such as rupture[1–4,7]. In line with this view, our cohort included only patients in whom a 2–2.5-fold increase in lesion diameter had been documented over 1.5–3 years of follow-up, al-

lowing us to evaluate the feasibility of early, minimally invasive intervention specifically in patients exhibiting growth dynamics.

Surgical resection remains the standard treatment option for symptomatic hepatic hemangiomas and for those associated with a high risk of complications. The surgical approach achieves anatomical removal of the lesion and minimizes the risk of recurrence; however, because of its invasive nature and the inherent risk of complications such as bleeding, infection, and bile leakage, it is generally reserved for selected patients[7]. In our series, the need for major surgery was successfully obviated by percutaneous MW ablation: all treated patients benefited from an organ-preserving, minimally invasive approach, thereby avoiding the morbidity associated with open hepatic resection.

Minimally invasive treatments have increasingly emerged as alternatives to surgery in recent years. Selective embolization of the tumor-feeding vessels is one such option, used to reduce tumor size and alleviate symptoms; however, the literature indicates that this approach is associated with high recurrence rates and a notable risk of complications, particularly biliary injury[3,4,8]. By contrast, in our cohort recurrence was observed in only 2 of the 13 patients (15.4%) treated with percutaneous MW ablation, both of whom were successfully managed by a second ablation session. Complications were limited to transient peri-ablational fluid collections in 6 patients, which resolved spontaneously within 6 months without intervention. In the present cohort, recurrence was observed in only 2 of 13 patients and all cases were successfully managed with repeat ablation. Although these findings are encouraging, direct comparison with embolization is limited by differences in study design, patient selection, and the absence of a comparative control group in the current study.

Thermal ablation techniques—particularly microwave ablation (MWA) and radiofrequency ablation (RFA) performed under ultrasonography or computed tomography guidance—have become increasingly preferred for the treatment of HCH. These techniques rely on heat-induced coagulation necrosis of the target tissue, and their minimally invasive nature substantially reduces the risks associated with surgery[9–13]. In our series, all ablated lesions were eventually replaced by fibrotic tissue on long-term imaging follow-up, and no patient required subsequent surgical resection. In our cohort, all ablated lesions were replaced by fibrotic tissue during long-term imaging follow-up, and no patient required subsequent surgical resection. These findings suggest that percutaneous MW ablation may represent a safe and effective minimally invasive treatment option for selected small HCHs exhibiting progressive growth. However, given the limited sample size and lack of a comparative control group, definitive conclusions regarding long-term efficacy should be drawn with caution.

The principal advantages of MWA include rapid and high thermal-energy delivery, the capacity to achieve uniform heat distribution even in heterogeneous tissues, short procedure times, and accelerated postoperative recovery[9,10,13]. In large hemangiomas, the combination of transarterial embolization with MWA has been reported to be effective in reducing tumor size and lowering the risk of recurrence[14]. Importantly, the therapeutic goals of MWA in benign lesions differ markedly from those in malignant tumors: whereas the primary aim in malignancies is the complete eradication of pathological tissue, in benign lesions disease control is generally considered sufficient. Accordingly, there is no need to widen or push beyond conventional safety margins of ablation in hepatic hemangiomas. Even when the lesion is located in high-risk anatomical regions—such as the diaphragmatic dome, hepatic hilum, or in close proximity to hollow organs—the risk of thermal injury to surrounding structures remains low, provided that the position of the electrode relative to the tumor edge and adjacent risk structures is carefully optimized[15]. Consistent with this, no patient in our cohort developed thermal injury to surrounding tissues

or major procedural complications, supporting the high safety profile of MW ablation when lesion-to-structure distance is meticulously controlled.

Both MWA and RFA have been reported as effective and safe modalities for hepatic hemangiomas. Some studies suggest that MWA may achieve more rapid and homogeneous thermal distribution and potentially higher technical success rates[16]. However, available evidence remains limited, and no definitive superiority between the two techniques has been established. In the present study, MWA demonstrated satisfactory outcomes in small but growing lesions.

This study has several limitations that should be acknowledged. The relatively small sample size, the single-center design, and the absence of a comparative control group restrict the strength of the conclusions that can be drawn. The cohort was not randomized, and the exclusion of hemangiomas larger than 5 cm precludes generalization of our findings to giant lesions. Heterogeneity in lesion number, location, and patient symptomatology should also be considered when interpreting the results. Furthermore, our data reflect long-term outcomes within a mean follow-up of 20 months; longer follow-up may be required to fully characterize late recurrences and the durability of the fibrotic ablation zone. Confirmation of these results in larger, multicenter, and ideally randomized cohorts is therefore warranted.

5. Conclusion

The present study suggests that ultrasound-guided percutaneous microwave ablation is a safe, effective, and organ-preserving minimally invasive option for selected patients with small hepatic cavernous hemangiomas showing progressive growth. While results are encouraging, they should be interpreted cautiously due to the limited sample size and lack of a comparative control group. This technique may serve as a bridge between conservative management and surgical resection in carefully selected cases. Further large-scale, controlled studies are required to validate these findings and establish standardized indications.

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Statement of Ethics: The study protocol was reviewed and approved by the Institutional Ethics Committee (Approval No. 14, dated January 15, 2010). All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments. Written informed consent was obtained from every patient prior to enrollment.

Data Availability: The data that support the findings of this study are not publicly available because of patient-privacy considerations but are available from the corresponding author upon reasonable request.

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References

1. Ha Y. Diagnosis and management of benign liver tumors. Korean J Gastroenterol. 2025;85(3):314–318.
2. Skipenko OG, Chardarov NK, Ganiev FA, et al. Hepatic hemangiomas: operation or observation. Khirurgiia (Mosk). 2012;(9):13–20. PMID: 23222975.
3. Deutsch GS, Yeh KA, Bates WB III, Tannehill WB. Embolization for management of hepatic hemangiomas. Am Surg. 2001;67(2):159–164.
4. Huang XQ, Huang ZQ, Duan WD, Zhou NX, Feng YQ. Severe biliary complications after hepatic artery embolization. World J Gastroenterol. 2002;8(1):119–121.
5. Ishak KG, Rabin L. Benign tumors of the liver. Med Clin North Am. 1975;59(4):995–1013. https://doi.org/10.1016/S0025-7125(16)31998-8
6. Marrero JA, Ahn J, Reddy KR, ACG Practice Parameters Committee. ACG clinical guideline: the diagnosis and management of focal liver lesions. Am J Gastroenterol. 2014;109(9):1328–1347.
7. Kacała A, Dorochowicz M, Matus I, et al. Hepatic hemangioma: review of imaging and therapeutic strategies. Medicina (Kaunas). 2024;60(3):449.
8. Srivastava DN, Gandhi D, Seith A, Pande GK, Sahni P. Transcatheter arterial embolization in the treatment of symptomatic cavernous hemangiomas of the liver: a prospective study. Abdom Imaging. 2001;26(5):510–514.
9. Kuang M, Lu MD, Xie XY, Xu HX, Mo LQ, Liu GJ, et al. Liver cancer: increased microwave delivery to ablation zone with cooled-shaft antenna—experimental and clinical studies. Radiology. 2007;242(3):914–924.
10. Liang P, Wang Y, Yu X, Dong B. Malignant liver tumors: treatment with percutaneous microwave ablation—complications among cohort of 1136 patients. Radiology. 2009;251(3):933–940. https://doi.org/10.1148/radiol.2513081740
11. Martin RC, Scoggins CR, McMasters KM. Safety and efficacy of microwave ablation of hepatic tumors: a prospective review of a 5-year experience. Ann Surg Oncol. 2010;17(1):171–178.
12. Livraghi T, Meloni F, Solbiati L, Zanus G, Collaborative Italian Group using AMICA system. Complications of microwave ablation for liver tumors: results of a multicenter study. Cardiovasc Intervent Radiol. 2012;35(4):868–874.
13. Fei L, Hongsong X. Microwave ablation in the treatment of hepatic hemangioma: meta-analysis and meta-regression. Int J Hyperthermia. 2023;40(1):2146214.
14. Sun JP, Zhou K, Pan J, et al. Efficacy and safety of transcatheter arterial chemoembolization combined with microwave ablation for hepatic hemangiomas (>5 cm). World J Gastroenterol. 2025;31(28):109078.
15. Tang XY, Wang Z, Wang T, Cui D, Zhai B. Ultrasound-guided percutaneous microwave ablation for large hepatic hemangioma: efficacy, safety and feasibility. J Dig Dis. 2015;16(9):525–530.
16. Elek A, Günkan A, Ohannesian VA, Chadli N, Oran I. Thermal ablation for giant hepatic hemangiomas: a meta-analysis with subgroup analysis of microwave and radiofrequency ablation techniques. Cardiovasc Intervent Radiol. 2026;49(2):220–228.