Percutaneous Thermal Segmentectomy

IO Learning spoke with Dr Pierleone Lucatelli, an interventional radiologist at the Policlinico Umberto I in Rome, Italy, regarding his recently published proof-of-concept study on percutaneous thermal segmentectomy. This multicenter, retrospective experience examined the combination of balloon-occluded microwave ablation followed by balloon-occluded transarterial chemoembolization in patients with liver malignancies >3 cm.

Pierleone Lucatelli, MD, PhD, EBIR, FCIRSE

Tell us about your study objective and results.

The aim of this study was to report our multicenter, retrospective experience on a combination of balloon-occluded MWA (b-MWA) followed by balloon-occluded TACE (b-TACE) in patients with liver malignancies >3 cm, focusing on appearance and volume of necrotic area, safety profile, and oncological results. This proof-of-concept analysis included the first 23 patients with different etiologies of liver malignancy (either primary or secondary liver cancer).

The major limitation of ablative treatment is a large tumor dimension. The international CIRSE (Cardiovascular and Interventional Radiological Society of Europe) guidelines suggest ablative treatment for lesions that are <3 cm. However, if one considers the vendor instructions that are included with the various ablation machines, one recognizes that an appropriate, safe ablative margin is not possible if the target lesion range is between 3-5 cm or even larger, because the vendor instructions indicate that an ablative margin >5 mm in each direction is necessary to perform a safe treatment.

The first experience with this combination therapy was proposed by Roberto Iezzi at the Cattolica University in Rome, and investigated the safety profile and the tolerability of MWA under temporary balloon vascular occlusion of the segmental artery feeding the tumor followed by b-TACE. Dr Iezzi was then joined by our team (from the Sapienza University of Rome in Rome, Italy), Renato Argirò (from the University Hospital of Rome Tor Vergata in Rome, Italy), and Laura Crocetti (from the University of Pisa in Pisa, Italy) to merge our experiences.

Over the last 4 years, our research group has focused its attention on the b-TACE procedure, investigating the advantages of performing a transarterial embolization procedure under temporary occlusion. The major featured benefit is the distribution of flow toward the targeted tumor, which has been demonstrated in both Asian and European literature to promote novel typology of embolization—that is, pressure-gradient driven embolization. It has been demonstrated to ameliorate the response rate of TACE treatment, but this is still not enough; a 60% complete response rate in a patient with a tumor between 3-5 cm is clearly an unmet need for patients seeking a curative treatment.

In our study, by achieving temporary occlusion of the feeding vessel while concomitantly adding MWA, we were able to increase the volume of the necrotic area by 100% with a single antenna positioning and to significantly reduce the amount of drug and embolic needed to finish the procedure. After retrospectively analyzing the morphology and the dimensions of the obtained necrotic area, we were struck by how the morphology of the necrotic area was not only 100% greater than suggested by the manufacturer-provided information, but also different in shape. Rather than being rounded in shape (as suggested by the machine's specifications), the necrotic area was irregular and triangular shaped. We analyzed the necrotic area in detail, including the segmental vascular anatomy that we occluded temporarily, and advanced imaging showed a

clear coherence and tracing of the occluded vascular segment, and obtained the morphological shape of the necrotic area.

This combination procedure may act as a "game changer" in the field of liver oncology, because this technique has no fancy devices and has no major learning curve. The positioning of a single microwave antenna and positioning of a balloon temporary occlusion microcatheter is part of our everyday clinical practice. The technique is not complex and uses no guiding software or specialized equipment. Nonetheless, we were able to ameliorate the complete tumor response, which is known to be the strongest predictive factor for overall survival, up to 90% in a sustained fashion, despite treating lesions of up to 5 cm in median diameter.

Were you surprised by any of these results?

We were really surprised, as were our counterparts in oncology and gastroenterology, because all of the treatments were very well tolerated. There were no differences between the combined novel treatment versus a standard ablative procedure other than some mild pain in the subcapsular region, which was easily pharmacologically managed. No prolonged in-hospital stays were seen. The mean diameter of necrotic area obtained was about 6 cm, ranging from 5-7 cm, which had never been achieved with a single antenna prior to using this combined technique. We observed no grade 3 or grade 4 adverse events related to the procedure and the patients had no major complaints after the combination procedure.

The other crucial point that I want to underline is that we have been treating different kinds of tumors, such as colorectal cancer carcinoma, tongue cancer metastases, and cholangiocarcinoma that recurred after surgery, and this combination treatment may potentially serve as an alternative to surgery. One must remember that surgeons do not really quantify what they are removing; rather, their goal is to leave a healthy safety margin. We are obtaining an appropriate safety margin with this technique despite the lesion diameter. This is true regardless of the type of tumor and regardless of the ablation machine we employed, which includes devices manufactured by Terumo, Medtronic, RFA Medical HS, and others. In other words, the benefit is not coming from the device, but from the technique itself. We are also seeing these results regardless of the duration of the microwave employment. We always increase the dimension of the necrotic area by applying the microwave energy only after gaining temporary occlusion of the segmental artery feeding the treatment site.

Do you have any thoughts on the presumed mechanism of action behind this technique?

We believe that the advantage of determining ablation under temporary occlusion is mainly due to a potential modification of the water content within the occluded segment, because the spread of the microwave does not stop at the target lesion, but rather spreads toward the boundaries of the vascular occluded segment. It suggests that this temporary vascular occlusion may lead to a different water content within the occluded segment, facilitating its spread far beyond the tumor limits. Therefore, we strongly believe that the success of this technique is not device related. The results suggest that our findings were completely independent of the different ablation machines employed and that the technique itself determines the advantage.

Do you have any future studies planned?

The 3 universities are now running a randomized, controlled trial in order to fully understand our results

STUDY HIGHLIGHTS

- The purpose of this study was to report an Italian, multicenter, retrospective experience on the combination of balloon-occluded microwave ablation (b-MWA) followed by balloon-occluded transarterial chemoembolization (b-TACE) in patients with liver malignancies >3 cm, focusing on appearance and volume of necrotic area, safety profile, and oncological results.
- Twenty-three patients with liver primary malignancies (18 with hepatocellular carcinoma, 2 with intrahepatic cholangiocarcinoma) and metastasis (1 colorectal cancer metastasis, 1 sarcoma metastasis, and 1 breast metastasis) were treated. Maximum mean lesion diameter was 4.4 ± 1 cm. A single-step b-MWA technique was performed after balloon-microcatheter inflation, followed by b-TACE with epirubicin or irinotecan. Necrotic area shape and discrepancy with the expected volume of necrosis suggested by manufacturer ablation charts were assessed at postprocedural computed tomography.
- This single-step procedure led to larger necrotic areas than proposed by manufacturer ablation charts. Tumors were nonspherical in shape and corresponded to the vascular segment occluded during ablation. Promising oncological results were achieved in patients with >3 cm tumors.

and to support our theory that this technique achieves a purely thermal segmentectomy. This theory is supported by the higher rate of complete response despite the target lesion diameter >5 cm. We plan to compare 3 groups. The first will be our standard combined treatment of b-TACE with b-MWA, the second group will include TACE with MWA without vessel occlusion, and the third group will be treated with b-MWA alone (without subsequent b-TACE). We are including this third group because we have already treated several patients and suspect that the embolization used after the ablative procedure is useless. If the results bear out this theory and are statistically significant (or at least similar in terms of response rate), the trial will support the theory that the addition of b-MWA is the mechanism that causes the ablative action to spread through the underlying vascular tracing segment.

Any final thoughts?

This is an easy technique, but the operator must be familiar with standard b-TACE procedures, including appropriate microcatheters and patient selection. In Italy, this combined treatment is offered for a lesion that is visible on the ultrasound, so it can be punctured easily. A critical part of an ablative procedure is correct needle positioning, and it can be challenging to place the needle antenna concentrically within a 3-5 cm lesion. Nonetheless, this technique has been used in several patients with large target lesions, and despite the eccentric position of the needle, we achieved appropriate margin and lesion coverage.

Reference

1. Lucatelli P, Argirò R, Crocetti L, et al. Percutaneous thermal segmentectomy: proof of concept. *Cardiovasc Intervent Radiol.* 2022;45(5):665-676. doi:10.1007/s00270-022-03117-y

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