Journal of Cancer Science & Therapy

Zarzour et al., J Cancer Sci Ther 2019, 11:2
DOI: 10.4172/1948-5956.1000579

Case Report Open Access

Microwave Ablation of Metastatic Lung Lesions Under Guidance of Augmented Reality CT Navigation System (Sirio): A Case Report

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Abstract

Microwave ablation (MWA) of lung lesions under guidance of computed tomography (CT) and SIRIO system (Sistema robotizzato assistito per il puntamento intraoperatorio) is providing accurate and real time visualization system. We present a case of 65 y male patient with multiple metastatic lung lesions from gluteal mesenchymal tumor confirmed histopathologically, MWA of two lesions under general anesthesia using double lumen endotracheal tube to exclude LT lung. Complete ablation of lesions was achieved, post-procedure pneumothorax was treated by (Heimlich valve) insertion, 24 hours follow up revealed complete resolution of pneumothorax. In this case report we found that the total procedure time and the total effective radiation dose of the whole procedure were reduced in compared with a previous case of MW ablation of similar sizes lesions under CT guidance only.

Keywords: SIRIO; Real time visualization; Microwave ablation; Post-ablation pneumothorax treatment

Introduction

MWA is recently widely applied in treatment of lung cancer, lung metastases, kidney cancers, hepatic lesions, etc [1]. Percutaneous thermal ablation of lung lesions under guidance of CT or CT-fluoroscopy is a well-established technique, however, some limitations for this system have been reported, one of the most important limitations is the patient exposure to high radiation dose, also the lack of real time visualization is a big limitation for CT guidance [2]. On the other hand, one of the main advantages of CT fluoroscopy is providing real-time visualization, but with the same limitation of high radiation dose exposure for the patients and operators [3]. Even though, the recently developed C-arm cone beam CT (CBCT) has an advantage of increased spatial resolution due to its real-time fluoroscopic &3D properties, however the main limitation of high radiation dose is still present [3]. Nowadays, Research steps are moving towards using tracking systems providing high spatial navigation in real time visualization with low radiation dose exposure, these systems depend on electromagnetic, optical or hybrid tracking of instruments during surgeries or interventional procedures with real time visualization of previously obtained CT or MRI images [4]. Several electromagnetic [5,6], optical [7,8], or hybrid [9,10] navigation systems have been examined and introduced in different medical fields.

There have been more and more reports on the application of MWA for treating lung metastasis under CT guidance, but according to our knowledge only few papers studied the guidance of CT with tracking navigation system and only on percutaneous lung biopsy [11,12]. However, as far as we know, there are no previous case reports or studies on the application of optical-based navigation system (SIRIO) in combination with CT scanners to perform MWA of lung lesions which provide the property of augmented reality.

Case Presentation

We present a case of 65 y male patient with history of RT gluteal muscle metastatic mesenchymal tumor, the patient presented with three LT sided pulmonary metastatic lesions:1stone was centrally located adherent to the LT ventricle, the other two lesions were peripherally located measuring about (20 × 14 mm) and (34 × 24 mm) (Figure 1). According to our multidisciplinary team approach we decided to treat the first central lesion by radiotherapy to avoid any thermal injury to the heart and the other two lesions by MWA guided by CT optical navigation system (SIRIO), MWA has been proved to be effective in different tumors ablation with more and more previous reports on the application of MWA as a treatment for lung Metastases [13,14]. After obtaining patient informed consent and IRB (institutional review board) and under general anesthesia, the patient was placed in the prone position. Double lumen endotracheal tube was introduced to exclude the LT lung and stop respiratory movements, as any fine movement during needle introduction & ablation process may cause severe complications to surrounding critical structures, adjustment of the SIRIO system settings (MASMEC S.P.A,21-Modugno70026-BARI-ITALY) was done in the following order: in the initial phase, placing of the patient tool at first adjacent to lesion site, the optional use of postural markers allows to detect rib cage movements due to breathing and posture changes. Furthermore, to minimize the tracking error it is necessary to prevent needle bending during needle recording and during surgery, after that the operative phase started with performing MSCT of the chest, then sending the CT image series from the CT to the SIRIO system which are connected together with internal cable network, after that the recording antenna (needle tool) is fixed to the ablation needle and coupled with the sensors in the SIRIO system by infrared connection and the needle tract appears as a dotted line on the CT images which are already stored and displayed on the SIRIO system screen. so that when the needle is moved and introduced, the direction of this tract line changes according to the needle's direction, as demonstrated in the flowchart for intervention steps using SIRIO system (Figure 2). As the lesion was

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Received May 11, 2018; **Accepted** February 04, 2019; **Published** February 07, 2019

Citation: Zarzour OA, Orsi F, Bonomo G, Vigna PD, El-Sharkawy MA, et al. (2019) Microwave Ablation of Metastatic Lung Lesions Under Guidance of Augmented Reality CT Navigation System (Sirio): A Case Report. J Cancer Sci Ther 11: 028-033. doi: 10.4172/1948-5956.1000579

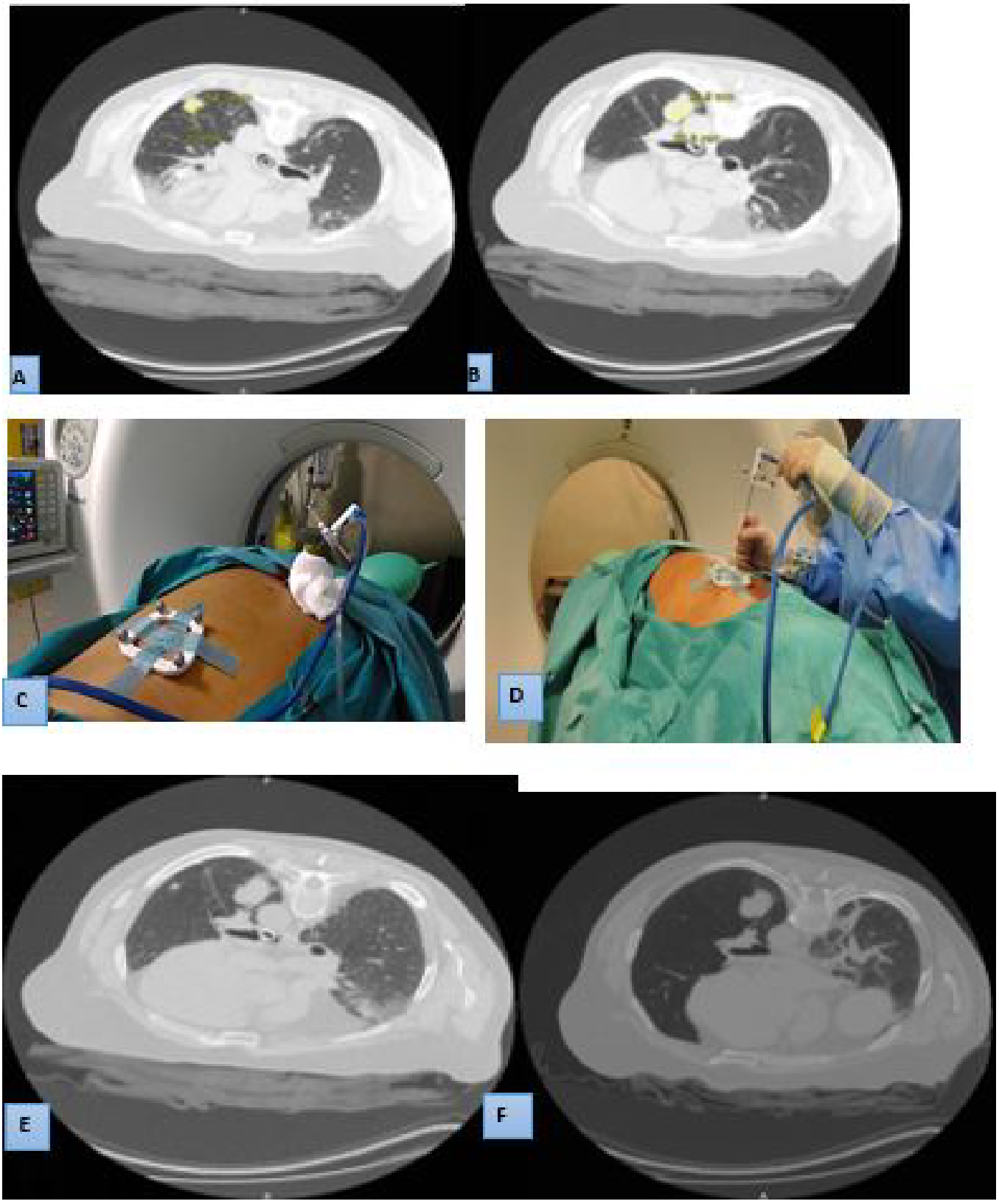

Figure 1: (A and B) Non-contract MSCT chest showing two LT lung metastatic lesions, **(C and D)** showing the patient marker attached to patient skin and needle marker fixed in the ablation antenna, **(E and F)** CT images showing the LT lung before inflation, **(E)** after inflation, **(F)** with the lesion displaced away from aorta.

very close to the aorta, hyperinflation of LT lung was done through the endotracheal tube to displace the lesion away from the aorta avoiding any injury (Figure 1), structures displacement and thermal insulation is very important during ablation to avoid any thermal damage to it.

After accurate adjustment of the entry point and needle approach for each lesion under guidance of SIRIO, the microwave antenna was carefully inserted into the lesions then control CT was done confirming antenna tip position (Figure 3) the energy used during ablation process was of 75 W for 7 min for large lesion and 75 W for 3min for the smaller one. After finishing procedure, a control CT revealed marked LT sided pneumothorax, treatment was done immediately by insertion of (Heilmich valve) catheter and aspiration of the air. Another CT was done showed significant reduction in pneumothorax amount, another follow up contrast CT was performed 24 hours later demonstrated complete resolution of pneumothorax with complete devascularization of the ablated lesions (Figure 4) indicating complete lesion ablation, with complete resolution of complication then the patient had a regular clinical course and was discharged from the hospital the day after treatment. The total procedure time was 18

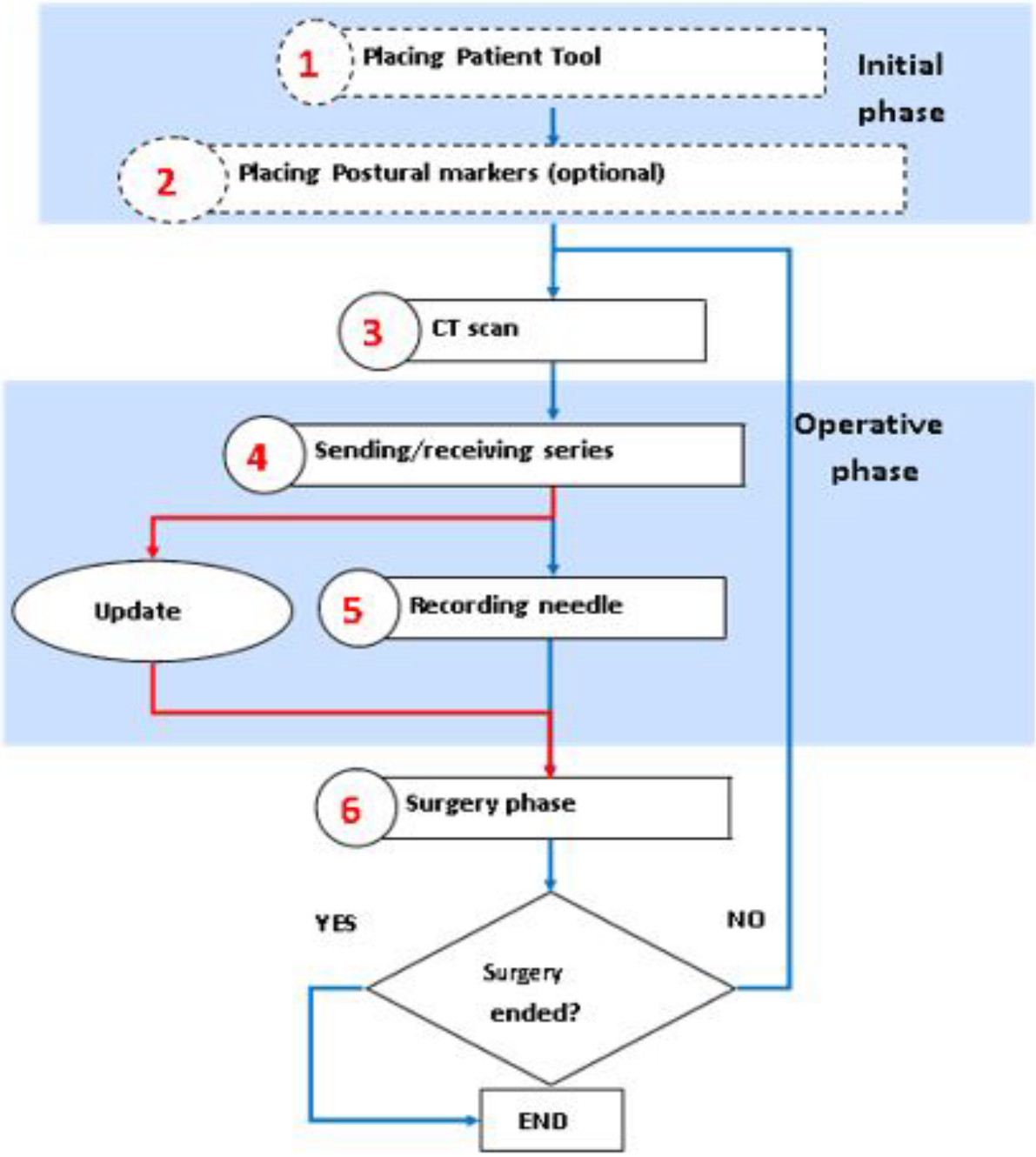

Figure 2: Flow chart illustrating steps of intervention with SIRIO.

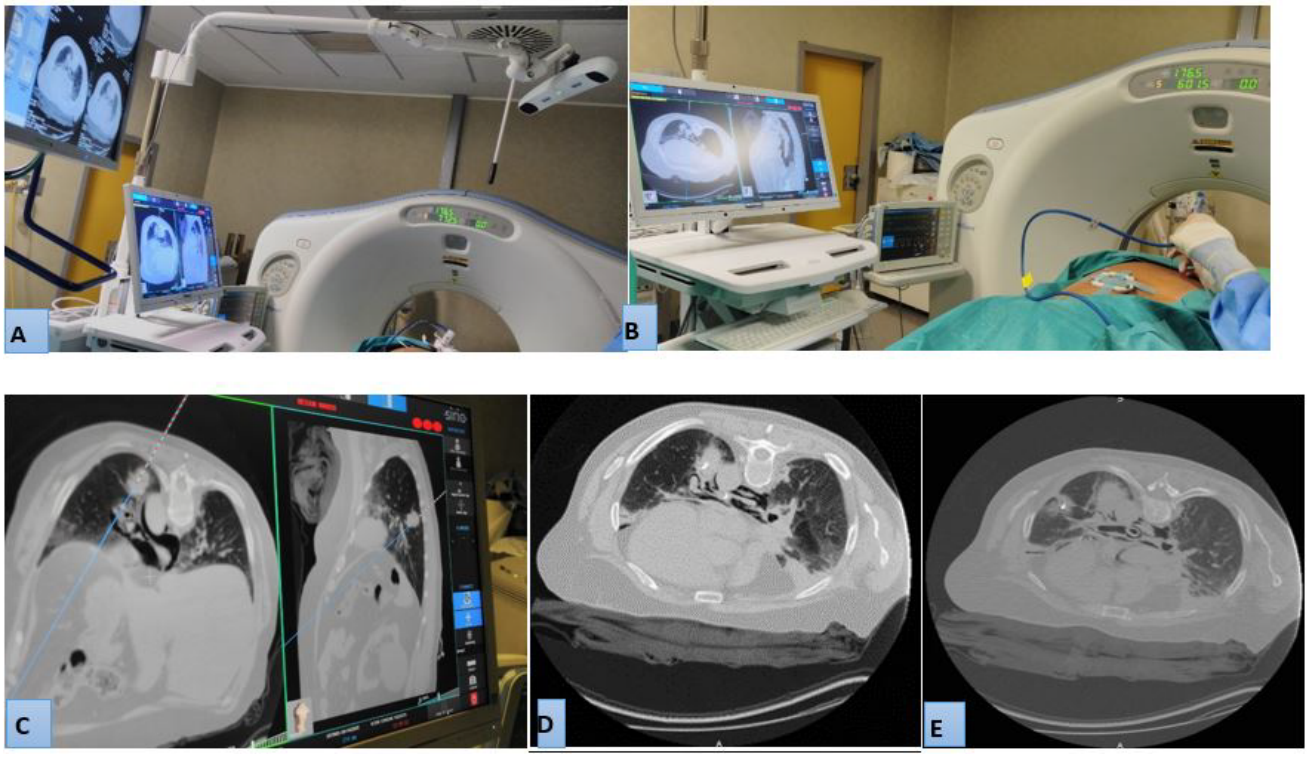

Figure 3: (A) Image of the SIRIO device showing light emitting source and the screen displaying CT images aquired from CT throught ethernet system, **(B)** accurate adjustment of needle position in to the lesion with real time visualization of the needle track on the screen, **(C)** the virtual needle track formed by the navigation system showing needle tip within the lesion, **(D and E)** control CT scans confirming the needle tip position inside the lesion in each time before ablation.

minutes divided as following: 8 minutes for system adjustment, image transfer, needle adjustment & insertion in both lesions and 10 minutes for the ablation process itself in both lesions. While the Effective dose was determined by multiplying the dose length product for each CT scan obtained in different phases during the procedure by a conversion factor (0.015 mSv/mGy-cm) and calculating the sum for each phase of the procedure: initial preoperative phase, operative monitoring phase, and post-ablation survey., Effective dose for the whole procedure was 42 mSv. In comparing with our previous procedure of MW ablation of similar sizes lesions under CT Guidance only, the total procedure time was 27 minutes divided as the following: 17 minutes for planning, targeting, needle's adjustment and insertion, which requires continuous monitoring by CT scans and 10 minutes for the ablation process. While the effective dose of the whole procedure 79 mSv obtained from all CT scans performed in different procedure`s phases.

Discussion and Conclusion

Using SIRIO real-time navigation system as a guidance system significantly reduced the time needed for adjustment of the needle inside the lesion, in terms of reduction of number of required CT scans and therefore, the radiation exposure compared with standard CT guidance [2]. The operator exposure to radiation is zero as it is a real time visualization, so no need to CT fluoroscopy or CBCT for guidance of needle insertion. The significant time reduction is due to ability of introducing the needle for a long distance towards the lesion under real time visualization without performing multiple CT scans to check needle tip position every fine movement of needle [3,15].

Another advantage of SIRIO is the ability to track any fine movements due to respiratory movements or CT bed horizontal movement occur during the procedure so it will adequately compensate these movements by the marker placed on the patient and the other one fixed to the needle which detect any position change [2]. The main goal of tracking systems is to avoid damage to vulnerable structures adjacent to the target lesion [6]. SIRIO proved to be an effective, feasible guidance tool as the patient marker and needle marker are made of light plastic material which gives more flexibility in operator's manipulation of the needle as it is not attached to heavy, bulky instruments [11]. One of the most common limitations of optic guidance systems is the necessity of (free line of sight) between the source of light (emitting diodes) and the receiving markers [6], but on the other hand, optic guidance has a major advantage over electromagnetic guidance systems which is very sensitive and easily affected by susceptibility effect of metal objects [5], the future of the optical navigation system (SIRIO) is to be used in other thermal ablation procedures in other anatomical locations rather than lung lesions. In conclusion: In our case report we found that the total procedure time and the total effective radiation dose of the whole procedure were reduced significantly in compared with a previous case of MW ablation of similar sizes pulmonary lesions under CT guidance only (as detailed above). Also, under this guidance tool we found it is much easier to navigate the needle precisely towards the lesions reducing the risk of damage to surrounding vital structures in compared with guidance under CT only, however this case was complicated with pneumothorax which is the most common complication following ablation of pulmonary lesions with incidence of 11 to 52% and may be accompanied by subcutaneous emphysema [16,17]. Risk factors for pneumothorax included male gender, no history of pulmonary surgery, high number of tumors ablated, treated tumors in the lower lungs, increased length of the aerated lung traversed

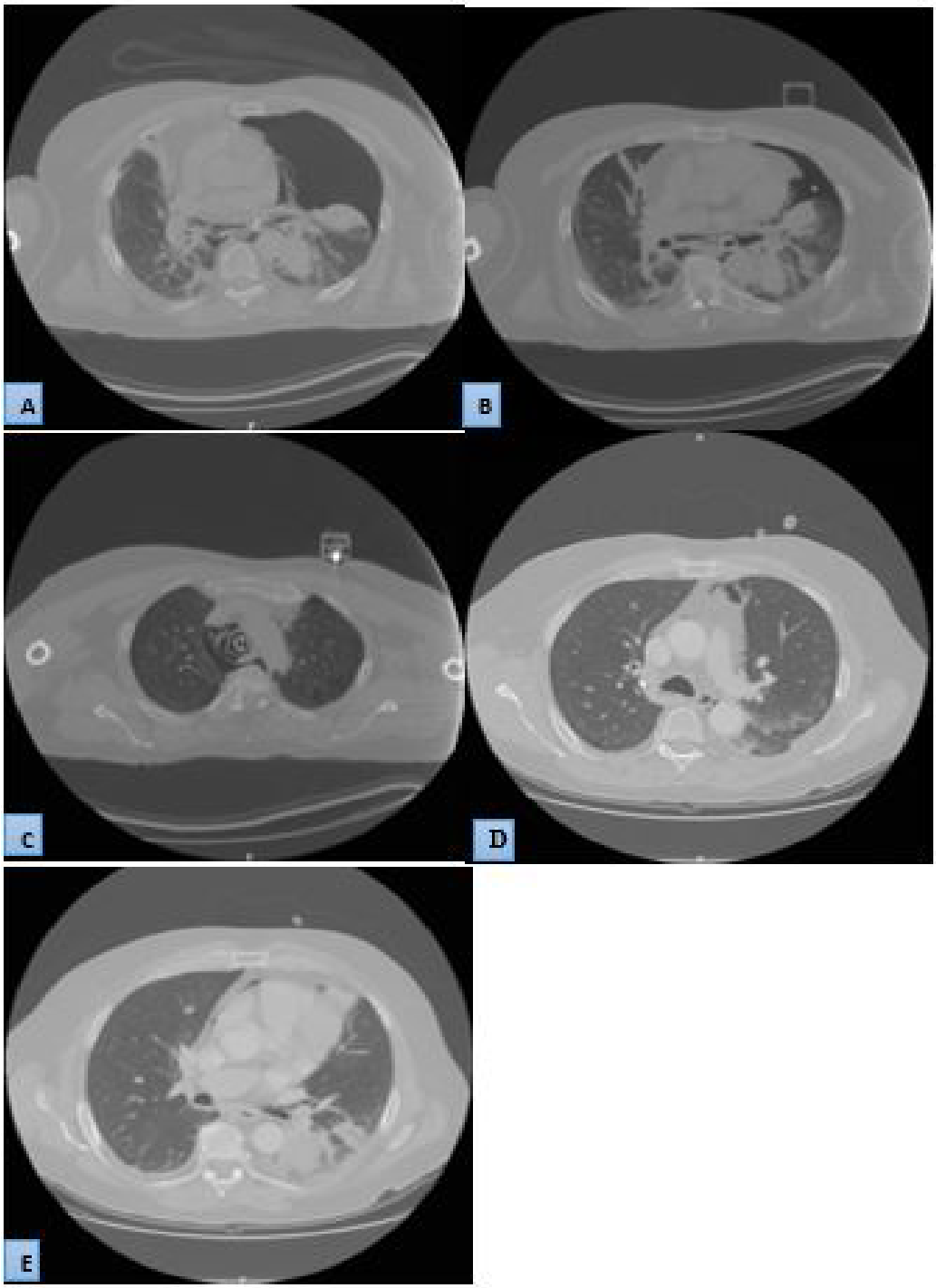

Figure 4: CT scan showing **(A)** marked LT sided pneumothorax, **(B and C)** significant reduction of pneumothorax immediately after Heilmich valve insertion, **(D and E)** 24 hours later: Contrast CT showing complete devascularization of the treated lesions with complete pneumothorax resolution.

by the electrode, pulmonary emphysema, advanced age, small tumors, and traversal of the major fissure by the electrode [18]. As regarding the ablation technique, itself, Microwave ablation allows delivery of high energy in a short time which can achieve a larger ablation zone in a short time, in compared with radiofrequency ablation [19,20]. Protective measurement of inflation of the lung in this case to displace the lesion away from the aorta was successfully reported to displace the surrounding vital structures (aorta) away from the ablation zone, avoiding any risks of thermal damage.

One of the main limitations of this report was the short follow up period due to limited duration of my fellowship, further prospective studies with long-term follow-up are recommended.

Conflict of Interest

The authors don't declare any conflict of interest.

Ethical Approval Statement

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Statement

Informed consent was obtained from all individual participants included in the study.

Acknowledgment

This study was supported in part by grants from Egyptian Ministry of Higher Education and scientific research, Cultural Affairs and the Missions Sector, Egypt.

References

1. Simon CJ, Dupuy DE, Mayo-Smith WW (2005) Microwave ablation: Principles and applications. Radiographics 25: S69-S83.
2. Grasso RF, Cazzato RL, Luppi G, D'Agostino F, Schena E, et al. (2013) Percutaneous lung biopsies: Performance of an optical CT-based navigation system with a low-dose protocol. Eur Radiol 23: 3071-3076.
3. Jin KN, Park CM, Goo JM, Lee HJ, Lee Y, et al. (2010) Initial experience of percutaneous transthoracic needle biopsy of lung nodules using C-arm cone-beam CT systems. Eur Radiol 20: 2108-2115.
4. Yaniv Z, Cheng P, Wilson E, Popa T, Lindisch D, et al. (2010) Needle-based interventions with the image-guided surgery toolkit (IGSTK): From phantoms to clinical trials. IEEE Trans Biomed Eng 57: 922-933.
5. Wood BJ, Zhang H, Durrani A, Glossop N, Ranjan S, et al. (2005) Navigation with electromagnetic tracking for interventional radiology procedures: A feasibility study. J Vasc Interv Radiol 16: 493-505.
6. Bruners P, Penzkofer T, Nagel M, Elfring R, Gronloh N, et al. (2009) Electromagnetic tracking for CT-guided spine interventions: Phantom, *ex-vivo* and *in-vivo* results Eur Radiol 19: 990-994.
7. Meier-Meitinger M, Nagel M, Kalender W, Bautz WA, Baum U (2008) Computer-assisted navigation system for interventional CT-guided procedures: Results of phantom and clinical studies. Rofo 180: 310-317.
8. Aghayev E, Ebert LC, Christe A, Jackowski C, Rudolph T, et al. (2008) CT data-based navigation for post-mortem biopsy: A feasibility study. J Forensic Leg Med 15: 382-387.
9. Khan MF, Dogan S, Maataoui A, Gurung J, Schiemann M, et al. (2005) Accuracy of biopsy needle navigation using the Medarpa system-computed tomography reality superimposed on the site of intervention. Eur Radiol 5: 2366-2374.
10. Khan MF, Dogan S, Maataoui A, Wesarg S, Gurung J, et al. (2006) Navigation-based needle puncture of a cadaver using a hybrid tracking navigational system. Invest Radiol 41: 713-720.
11. Wallace MJ, Gupta S, Hicks ME (2009) Out-of-plane computed tomography: Guided biopsy using a magnetic-field-based navigation system. Cardiovasc Intervent Radiol 29: 108-113.
12. Grand DJ, Atalay MA, Cronan JJ, Mayo-Smith WW, Dupuy DE (2011) CT-guided percutaneous lung biopsy: Comparison of conventional CT fluoroscopy to CT fluoroscopy with electromagnetic navigation system in 60 consecutive patients. Eur J Radiol 79: e133-e136.
13. Wolf FJ, Grand DJ, Machan JT, Dipetrillo TA, Mayo-Smith WW, et al. (2008) Microwave ablation of lung malignancies: Effectiveness, CT findings, and safety in 50 patients. Radiology 247: 871-879.
14. Yang X, Ye X, Zheng A, Huang G, Ni X, et al. (2014) Percutaneous microwave ablation of stage I medically inoperable non-small cell lung cancer: Clinical evaluation of 47 cases. J Surg Oncol 110: 758-763.
15. Klein JS, Salomon G, Stewart EA (1996) Transthoracic needle biopsy with a coaxially placed 20-gauge automated cutting needle: Results in 122 patients. Radiology 198: 715-720.
16. Hiraki T, Tajiri N, Mimura H, Yasui K, Gobara H, et al. (2006) Pneumothorax, pleural effusion, and chest tube placement after radiofrequency ablation of lung tumors: Incidence and risk factors. Radiology 241: 275-283.
17. Yamagami T, Kato T, Hirota T, Yoshimatsu R, Matsumoto T, et al. (2006) Pneumothorax as a complication of percutaneous radiofrequency ablation for lung neoplasms. J Vasc Interv Radiol 17: 1625-1629.
18. Okuma T, Matsuoka T, Yamamoto A, Oyama Y, Toyoshima M, et al. (2008) Frequency and risk factors of various complications after computed tomography-guided radiofrequency ablation of lung tumors. Cardiovasc Intervent Radiol 31: 122-130.
19. Wright AS, Sampson LA, Warner TF, Mahvi DM, Lee FT (2005) Radiofrequency *vs.* microwave ablation in a hepatic porcine model. Radiology 236: 132-139.
20. Huo YR, Eslick GD (2015) Microwave ablation compared to radiofrequency ablation for hepatic lesions: A meta-analysis. J Vasc Interv Radiol 26: 1139-1146.