·综　　述·

doi:10.3969/j.issn.1671-8348.2023.04.025

# 电磁导航支气管镜下微波消融术在肺结节治疗中的应用进展*

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[摘要] 随着低剂量计算机断层扫描在肺癌筛查方面的应用,肺结节检出率逐年增高。肺结节是有潜在恶性或从良性到恶性生长过程的可能,使患者面临巨大心理压力。若积极手术干预,可能会切除肺组织,损失肺功能,甚至造成医疗资源的浪费;而消极处理可能导致肿瘤进展,失去早期治疗的机会。对于肺结节的诊治,需要发现后既能快速诊断,又能立即治疗的方法。电磁导航支气管镜下微波消融能解决这一问题。电磁导航支气管镜以电磁定位技术为基础,结合薄层计算机断层扫描虚拟图像路径对肺结节精准定位,通过支气管镜经自然通道以微侵入的方式达到病变部位,获取组织细胞学诊断。微波消融术是肿瘤热疗领域中的新兴技术,在电磁导航支气管镜引导下,将微波天线从自然通道送达肿瘤内,肿瘤组织在短时间内达到 70～160 ℃,诱导肿瘤细胞发生凝固性坏死。该文介绍了电磁导航支气管镜下微波消融在治疗肺结节中的应用进展。

[关键词] 电磁导航系统;电磁导航支气管镜;肺结节;微波消融;综述
[中图法分类号] R655.3　　[文献标识码] A　　[文章编号] 1671-8348(2023)04-0613-05

# Application progress of electromagnetic navigation bronchial mirror microwave ablation in the treatment of lung nodules*

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[**Abstract**] With the application of low-dose computerized tomographic scanning (CT) in the screening of lung cancer, the detection rate of lung nodules has increased year by year. Lung nodules may be an underlying malignancy or have an potential of a benign to malignant growth process. Patients are facing huge psychological pressure. If active surgical intervention may remove lung tissue, lose lung function, and even cause waste of medical resources; negative treatment may lead to tumor progress and lose the chance of early treatment. For the diagnosis and treatment of lung nodules, we need a method that can be able to diagnose quickly and immediately treat it after discovery. Microwave ablation under the electromagnetic navigation bronchial mirror can solve this problem. The electromagnetic navigation bronchial mirror is based on electromagnetic positioning technology, combined with thin layer CT scaning the virtual image path to accurately position the lung nodules, and achieve the lesion site in a minimally invasive way through the natural channel of the bronchial mirror to obtain the diagnosis of tissue cytology. Microwave elimination is an emerging technology in the field of tumor hyperthermia. Under the guidance of electromagnetic navigation bronchoscopy, the microwave antenna is delivered to the tumor from the natural channel. The tumor tissue reaches 70～160 ℃ in a short period of time, which induces coagulative necrosis in tumor cells. This article introduces the application progress of electromagnetic navigation bronchial mirror microwave ablation in the treatment of lung nodules.

[**Key words**] electromagnetic navigation system; electromagnetic navigation bronchial mirror; lung nodule; microwave ablation; review

肺癌是威胁人类健康的恶性肿瘤之一,已成为全球发病率和致死率最高的肿瘤[1]。肺癌早期症状不典型,当患者出现症状时多数已处于中、晚期或因患者心肺功能等原因失去手术治疗的机会。1990 年,有学者首次提出将低剂量计算机断层扫描(LDCT)用于肺癌筛查,该方法避免了胸部 X 线片漏诊高和普通计

* 基金项目:重庆市科卫联合医学科研项目(2021MSXM005)。 作者简介:李林峻(1983－),主治医师,硕士,从事肺癌及心血管疾病研究与治疗。 △ 通信作者,E-mail:qcwucq@163.com。

算机断层扫描(CT)辐射强的缺点[2],起到早发现作用,降低肺癌的致死率[3]。随着 LDCT 筛查肺部肿瘤的普及,大量原发或转移性肺结节被检出,这也给患者带来焦虑心理,其在随访过程中承受了巨大心理压力。近年来,高龄、肺功能差、合并基础疾病的初发肺结节患者增多,其难以承受手术治疗甚至活检,在治疗上存在困境。针对上述情况,需要既能快速、微创诊断又能立即治疗的方法。电磁导航支气管镜下肺结节活检及微波消融较好地解决了这一问题。该方法经人体自然通道精准路径到达病变部位,特别是肺外周病变,进行快速细胞学检查,若结节为恶性可立即行微波消融治疗,达到早期微创诊断及时治疗的目的。本文就电磁导航支气管镜下微波消融在治疗肺结节方面的研究进行综述如下。

## 1 电磁导航支气管镜

### 1.1 电磁导航支气管镜原理及操作

电磁导航系统是指电磁场发生器可以在其周围空间产生一个磁场,把电磁场定位传感器放入磁场范围内,产生传感电信号,通过电信号计算出传感器在磁场中相应的空间坐标,结合 CT 图像和空间坐标计算出导航位置及路径。电磁导航系统为肺部病变提供了精准定位和最佳路径。

电磁导航支气管镜通过电磁导航的定位和路径,可以实时引导、建立直达肺内病灶的精准诊疗通道,准确到达常规支气管镜无法到达的肺外周病灶,特别是微小结节、磨玻璃结节、微结节,进行结节定位、活检,获取组织细胞学诊断,是一种新兴的内镜检查技术,对于肺部肿瘤的诊断安全有效[4]。

电磁导航支气管镜操作分为 3 个阶段。(1)术前准备阶段:根据患者薄层 CT 扫描的数据形成虚拟的 3D 图像,同时选定数个特定的解剖定位点,如隆突、各段支气管开口,储存图像备用。(2)登记校正阶段:患者平躺于导航定位平板上,置入带有导线的支气管镜,并送达上述选定解剖位点,电脑系统将对各位点的误差进行评估。(3)操作阶段:将支气管镜送达目标肺段开口,根据导航路线将导线送至病灶部位,退出导线后,置入器械(活检钳、活检针或细胞学刷子等),对病灶进行快速细胞学检查[5-6]。

### 1.2 电磁导航支气管镜下诊断及治疗的优势

目前,肺部肿瘤常见的诊断方法包括:手术切除活检、超声支气管镜引导下针吸活检术、内镜超声检查、CT 引导下穿刺、支气管镜检查等。手术切除,特别是小结节切除会面临部分良性病变,造成创伤及肺功能损伤。其他方式检查因定位困难或不准确导致诊断阳性率不高。电磁导航支气管镜技术正好弥补上述缺陷,其采用自然通道微侵入方法,精准到达肺部病变部位,安全有效,提高了诊断效率和准确度[7]。在电磁导航支气管镜的引导下,可结合微波消融(MWA),有效地避开重要结构,提高手术的安全性;同时经气管、支气管到达病变部位,可减少手术并发症。与 CT 引导下经皮 MWA 比较,电磁导航下 MWA 可减少气胸、皮下气肿、支气管皮肤瘘等的发生,避免 CT 辐射,也可反复多次操作,提高治疗效果[8-11]。

## 2 肺癌 MWA

### 2.1 MWA 原理

MWA 是肿瘤热治疗中的新技术,可适用于不同类型肿瘤的热消融治疗。采用 MWA 时,经皮或自然通道将微波天线送达肿瘤内,肿瘤中的极性分子(碳水化合物、蛋白质等)和带电粒子(钾、钠、氯离子等)在微波的电磁场作用下会出现激烈的转动产生摩擦生热效应,使肿瘤组织在短时间内达到 70～160 ℃,肿瘤内的蛋白质变性,从而诱导肿瘤细胞发生凝固性坏死。MWA 是一种安全有效的治疗方法,可以提高患者生活质量及生存率[12]。

### 2.2 MWA 治疗肺癌的优势

DUPUY 等[13]首次报道了经皮射频消融(RFA)治疗肺部恶性肿瘤,肺癌消融治疗得到了进一步探索和研究。近年来,MWA 和冷冻消融受到关注,消融治疗肺部恶性肿瘤被认为是一种较好的局部疗法[14]。与 RFA 比较,MWA 具有如下优势。(1)消融范围更大:对于<3 cm 的肿瘤,RFA 的消融效果较好,拥有 78%～96%的消融效果;对于 3～5 cm 的肿瘤,MWA 有 95%的初始消融效果[15-16],且可以使用 2～3 个探针,更快地达到消融范围,散热更少,止血效果满意[17]。(2)消融时间快:MWA 在可在较短时间内达到更高的肿瘤内温度,产生更大的消融区,缩短治疗时间[18-20],并且能够克服 RFA 在早期非小细胞肺癌治疗中的局限性[21]。(3)实用范围广泛、安全:MWA 在治疗大肿瘤、临近心脏肿瘤(临近心脏 10 mm 或更短距离的肺部肿瘤)、靠近大血管的肿瘤时安全有效[22-24]。(4)疼痛轻。MWA 治疗过程中疼痛较轻微,增加了患者的耐受性,可反复操作,消融效果明显提高[25]。

冷冻消融在治疗过程中需要冻结-解冻-冻结,治疗时间较长,同时缺乏组织烧灼作用,会出现更高的出血风险,MWA 可弥补了冷冻消融的缺点。目前,越来越多的证据表明,MWA 优于 RFA 和肺冷冻消融[26]。

## 3 肺结节的概念、诊断及治疗

### 3.1 肺结节的概念

肺结节是指不同病因造成肺泡内含气量减少、细胞数目增多、肺泡上皮细胞增生、肺泡间隔增厚等病理变化,在影像学上表现为局灶性边界模糊、清楚直径≤3 cm 圆形或类圆形密度增高影[27]。按密度可分为实性结节和亚实性结节。亚实性结节分为纯磨玻璃结节(GGN)和混合性 GGN[28]。

### 3.2 肺结节的诊断

肺结节在电磁导航支气管镜引导下经自然通道对结节(特别是周围性肺结节)精准定位,通过活检钳、活检针或细胞学刷等取得标本,进行快速现场细胞病理学检查(ROSE)。ROSE 于 1981 年用于介入肺脏病学[29],是一项伴随取材过程的快速细胞学判读技术,分为制片、染色和判读 3 个步骤连续进行。靶部位取材后,将部分标本印涂于玻片,制成细胞学片基,迅速染色并以专用显微镜综合临床病史立即判读。根据细胞成分、形态、分类、计数、构成比、排列、相互关系、背景、细胞核、核仁情况综合判定结节性质[30]。若取材不满意,可实时指导介入操作方法,反复多次操作,形成初步诊断。

### 3.3 单原发或多原发肺结节的治疗与随访

肺结节经电磁导航支气管镜下取材,通过 ROSE 判定,若为恶性肿瘤,立即行 MWA 治疗。术后予以定期随访[31],术后 1 个月复查胸部 CT,3 个月后再复查胸部 CT,以后每 6 个月复查胸部 CT,主要观察局部病灶是否复发、是否逐渐形成瘢痕、肺内是否有新发病灶等。进行短期临床效果评价,术后随访 1 年;中期临床疗效评价,术后随访 3～5 年;长期临床疗效评价,术后随访 6～10 年。消融效果不满意可反复进行消融治疗或手术治疗。对于早期、原发性肺癌,MWA 的效果较为满意[32-34]。经自然通道 MWA 治疗肺部恶性结节,可治疗多个同时性或异时性恶性肺结节,可对肺功起保护作用,提高患者(特别是合并肺部疾病患者)的生活质量[35-36]。MWA 治疗肺结节,不仅能缩短住院时间,降低治疗成本,且并发症发生率低、患者痛苦更少[37-39]。

### 3.4 无法手术或不愿意手术肺结节的治疗

目前,早期肺癌仍采取以手术为主的综合治疗,但约 15%～30%的肺癌患者因为高龄、心功能或肺功能差、患有其他并发症等高危风险,无法行手术治疗,而部分患者也不愿接受常规手术,故需要微创替代治疗方案。MWA 是一项可行的手术替代治疗选择[40-44],扩大了不适合手术患者的治疗范围[45]。研究发现,热消融治疗肺癌成功率与局部肺癌手术治疗效果接近[26],可改善患者的生存率[46]。

### 3.5 复发、转移性肺结节的治疗

由于复发或转移性肺结节的治疗手段有限,可选择 MWA 进行治疗。MWA 能有效控制肿瘤进展,减少肿瘤复发率[47],提高部分复发或转移性肺肿瘤患者的生存率[48]。特别是针对较小的复发灶或转移性肿瘤,MWA 可以缓解肿瘤进展,甚至有治愈的可能[49]。目前,晚期肺癌治疗方式包括放疗、化疗、免疫治疗、靶向治疗等,越来越多的研究表明 MWA 也是晚期肺癌、转移性肺结节的有效治疗方法[50-51]。

## 4 小结与展望

综上所述,在电磁导航支气管镜引导下进行肺结节诊断及 MWA 治疗,是经自然通道、微创、精准定位、快速诊断及治疗的方法,能减少患者心理负担,节约治疗成本,未来在肺结节治疗方面具有独特优势。但是,目前电磁导航支气管镜下 MWA 治疗肺结节安全性和有效性的数据较少,虽然有研究表明 MWA 可弥补 RFA、冷冻消融的缺点,但仍缺乏临床研究,后期需继续探索 MWA 在肺结节治疗方面的临床效果。

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（收稿日期：2022-02-13　修回日期：2023-01-04）