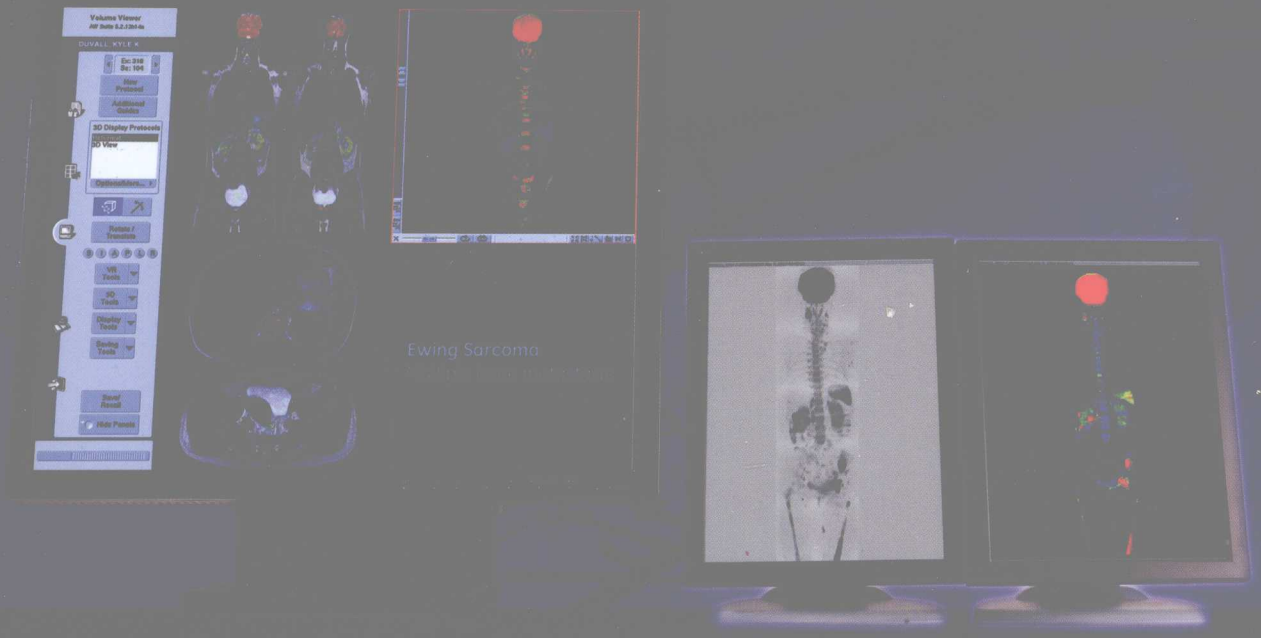
# 全身弥散加权成像肿瘤学临床应用图谱

# Atlas of Whole Body Diffusion Weighted Imaging in Oncological Clinical Application

中英文双语版

主编　金征宇　薛华丹

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## 内 容 简 介

本书以图谱的形式，采用中英文双语的方式介绍了磁共振全身弥散加权成像技术在以肿瘤影像学为主的临床工作中的应用情况。依据临床对全身弥散加权成像技术的需求特点铺开，主要包括肿块良、恶性鉴别，原发恶性病灶的筛查，肿瘤 NM 分期，以及放、化疗随访等内容，提供了数百例有病理结果的典型病例供读者学习参考。全书图文并茂、内容丰富，不仅有全身弥散加权图像的病灶显示，更有包括磁共振常规图像、CT 图像、核医学图像及 PET 图像等其他影像学检查结果作为辅助及对照，有利于读者对全身弥散加权成像技术的深入了解和掌握。

本书不仅适合影像科医师及技术人员参考，对于肿瘤相关专业的临床医师也有很高的实际应用价值。

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# 前 言

# (preface)

磁共振全身弥散成像技术(whole body diffusion weighted imaging, WB-DWI)采用反转恢复回波平面弥散序列(简称 STIR-DWI-EPI),在抑制肌肉、脂肪、肝脏等组织背景信号的基础上,突出病变区域的弥散加权对比,大大提高了病变组织,尤其是恶性肿瘤及其转移灶的检出率。由于采用了全身大范围扫描,并加以 3D 后处理重建,其成像效果和临床意义与正电子发射断层成像(PET)有许多类似之处,因此也被称为 MR"类 PET"技术。

在短短几年的临床应用过程中,我们发现,磁共振全身弥散成像技术不仅具备了接近于 PET 的恶性肿瘤敏感性(sensitivity)和特异性(specificity),而且成本较低、检查方便、无电离辐射,极有希望成为广大肿瘤患者的一项重要而有效的常规影像学检查项目。北京协和医院等全国十余家医院,在总结几千例病例经验的基础上,编写了本专著,涉及包括淋巴瘤、白血病、宫颈癌、肺癌、胃癌、肝癌、肾癌、食管癌、乳腺癌等以肿瘤为主的多种疾病。本书的写作思路依临床对全身弥散加权技术的需求特点铺开,主要包括肿块良、恶性鉴别,原发恶性病灶的筛查,肿瘤 NM 分期,以及放、化疗随访等,提供了数百例有病理结果的典型病例供读者学习参考。

肿瘤筛查方面:全身弥散加权成像因其敏感性高,无辐射,可以一次性进行大范围扫描,病变/正常结构信号对比明显,能够有效地协助在全身寻找原发灶部位,是非常适合于临床筛查的一项检查手段。另外,不仅仅是对于恶性肿瘤,全身弥散成像也可用于发现全身长 T2 信号良性病变,而它对于高危人群的筛查价值还在进一步探讨中。

肿块良、恶性鉴别方面:DWI 在发现病变方面的能力毋庸置疑,但对病变的定性诊断能力也就是良、恶性的鉴别能力却有着较为模糊的结果。

评估肿瘤分期方面:目前临床比较常用的肿瘤分期为 TNM 分期法,对不同部位肿瘤分期的方式大多相近,N 分期主要评价淋巴结转移的情况,全身弥散加权成像有着一定的优势,M 分期主要评价远处脏器转移情况;大部分恶性肿瘤在发现远处脏器转移后都会放弃手术切除的治疗方案,因此,明确有无远处转移对于患者来说是非常必要的。由于转移部位分散,临床多采用骨扫描+局部 CT 或 MRI 的方法来进行术前评估,但多种检查手段往往需要更多的检查时间及消耗更多的钱财,且仍有漏诊可能。全身弥散加权成像就可以省去繁琐的检查过程,一次完成全身各部位的检查。当然,对于肺内直径小于 1cm 的转移灶、骨骼系统的成骨性转移灶、脑内没有周围水肿且直径小于 1cm 的转移灶,全身弥散加权成像的发现能力尚不够强大,因此,在 M 分期的临床应用价值较 N 分期相比就较为逊色。

肿瘤化疗疗效的评价及预测方面:有效的抗肿瘤治疗会导致肿瘤细胞溶解、细胞破裂、

细胞间隙增宽，因此，水分子弥散能力增加，放疗或化疗后 ADC 值的升高会很快出现，且多早于形态学的改变，如瘤体缩小等。还有研究发现，接受治疗前 ADC 值较高的肿瘤治疗效果往往不如治疗前 ADC 值较低的肿瘤理想。这意味着 DWI 检查对于肿瘤治疗效果有一定的预测能力，将是一个非常有价值的研究领域。

总之，全身弥散成像技术是一项全新的磁共振成像技术，在肿瘤筛查和良、恶性鉴别诊断及肿瘤的分期、肿瘤治疗的随访中具有很高的临床价值。希望本书的出版能帮助临床影像学医师进一步认识和了解这项崭新而有着极强生命力及发展前景的检查项目，共同促进该技术的进步，更好地为广大患者服务。

编　者

2009 年 1 月

# 目 录

## (contents)

# 第一章

# 绪论(introduction)

在2008年的北美放射年会上,磁共振技术领域的一大亮点和热点就是全身弥散成像技术(whole body diffusion weighted imaging,WB-DWI)。该技术采用一种全新的脉冲序列——反转恢复回波平面弥散序列(STIR-DWI-EPI),在抑制肌肉、脂肪、肝脏等组织背景信号的基础上,突出病变区域的弥散加权对比,大大提高了病变组织,尤其是恶性肿瘤及其转移灶的检出率。由于采用了全身大范围扫描,并加以3D后处理重建,其成像效果和临床意义与正电子发射成像(PET)有许多类似之处,因此也被称为MR"类PET"技术。

一直以来,肿瘤影像学是整个影像学的重点和难点。如何做好肿瘤的筛查(screening)、肿瘤良性和恶性的鉴别(discrimination)、肿瘤的分期(staging)及肿瘤治疗效果的评估(evaluation)是肿瘤影像学要解决的核心问题,同时也是影像技术最为关注的问题。PET成像是目前应用于肿瘤诊断和肿瘤分期的最先进的影像技术。但是,对患者而言,PET成像费用昂贵并伴有电离辐射;对医院而言,成本高昂且受国家宏观控制,因而其临床使用受到了很大限制。MR全身弥散成像技术的出现突破了这个困扰多年的成本-效益(cost-effective)难题:它不仅具备了接近于PET的恶性肿瘤敏感性(sensitivity)和特异性(specificity),而且成本较低、检查方便且无电离辐射,因而极有希望能在临床大范围推广而造福广大肿瘤患者。从笔者所在医院的经验来看,自2006年5月至今,共扫描350余例病患,主要包括淋巴瘤、白血病、宫颈癌、肺癌、胃癌、肝癌、肾癌、食管癌、乳腺癌等恶性肿瘤,检查的目的包括肿块良、恶性鉴别,筛查原发恶性病灶,肿瘤NM分期,以及放、化疗随访等。在进行了统计学评价的淋巴瘤、宫颈癌等疾患组中,以病理作为金标准,WB-DWI的敏感性均接近100%。目前,MR全身弥散技术已得到了多家医院临床科室的广泛认可,该项目在淋巴瘤患者及宫颈癌患者中已逐渐成为必不可少的肿瘤分期和疗效评估的常规检查之一。

全身弥散成像的方法学原理与普通弥散成像是相同的。它通过两个方向相反、大小相同的弥散梯度来探测人体组织细胞间隙水分子扩散运动的强弱,从而间接反映特定组织细胞水平构成的状况。大部分肿瘤组织在细胞学上具有生长密集、核浆比高的特点,这使得其细胞内和细胞外可供水分子自由扩散的空间变小,在弥散成像中弥散受限而呈高信号,通过WB-DWI测量得到的表观弥散系数(ADC值)就低,这就为探测恶性肿瘤提供了方法学上的可能性。具体而言,WB-DWI在肿瘤影像学中具有以下四方面临床价值:

### 1. 肿瘤筛查方面的价值

全身弥散加权成像因其敏感性高、无辐射,是非常适合于临床筛查的一项检查手段。临床首先发现转移灶且原发灶不明的患者,往往需要行头部、颈部、胸腔、腹腔、盆腔等多处的

CT 或 MRI 检查寻找原发灶，但这样的检查组合往往时间效率差、经济效益差、有射线辐射危险，且图像的信息量极大，不能快速有效地发现病变部位，使用全身弥散加权成像检查则可以一次性进行大范围扫描，病变/正常结构信号对比明显，能够有效地协助全身性寻找原发灶部位。另外，不仅仅是对于恶性肿瘤，全身弥散成像也可用于全身长 T2 信号良性病变的发现。我们对 60 例正常患者（年龄在 17~77 岁）进行健康筛查，共发现脑梗死灶 12 例（18 处）、结节性甲状腺肿 6 例、肾囊肿 24 例（30 处）、肝囊肿 9 例（13 处）、子宫肌瘤 15 例（15 处）、附件囊肿 6 例，此外，还有乳腺良性结节、前列腺囊肿、肾上腺意外瘤等，进一步的 CT 及 B 超等检查证实率达 99%，也说明本项检查作为健康筛查手段有着较高的临床性价比。而它对于高危人群的筛查价值还在进一步的探讨中。

### 2. 肿块良、恶性鉴别方面的价值

DWI 在发现病变方面的能力毋庸置疑，但对病变的定性诊断能力，也就是良、恶性的鉴别能力却有着较为模糊的结果。在我们的淋巴结动物模型实验研究中，正常对照组的淋巴结 ADC 值为（1.35±0.15）×$10^{-3}$ $mm^2$/s，炎性反应组的淋巴结 ADC 值为（1.14±0.02）×$10^{-3}$ $mm^2$/s，而肿瘤转移组的淋巴结 ADC 值为（0.78±0.07）×$10^{-3}$ $mm^2$/s，三者间存在明显的统计学差异，这说明 DWI 对于病灶的良、恶性有一定的鉴别能力。但我们都知道炎性反应有渗出、增殖、坏死、纤维化等不同阶段的改变，而肿瘤组织也因肿瘤细胞类型的不同有不同的组织形态，如腺癌与鳞癌的细胞间隙就有着较大的差异。上述这些差异会在一定程度上影响组织的 ADC 值。有文献报道，在脊柱、前列腺等部位的肿瘤局部 DWI 测定中，良、恶性病变的 ADC 值有一定的差别，但也有很大程度的重叠。上述结果说明，ADC 值目前只能作为半定量的数据用来参考，而 DWI 对于病灶良、恶性的鉴别能力是有限的。在多组不同脏器的比较中我们还发现，不同中心间得到的同一正常脏器或同种肿瘤的 ADC 值有较明显的差别。这可能与不同研究所采用的序列、设备、后处理软件、$b$ 值、受检者例数及年龄分布不同有一定的关系。当然，ADC 值在运用到临床时还需要做大量的工作，如全身各脏器及组织在不同年龄段内的正常 ADC 值的测定。这项工作也是非常必需的，作为进行良、恶性鉴别诊断的基础。另外，全身弥散加权成像若能在各部位局部弥散加权成像技术研究的基础上，综合并统一全身各部位的数据及扫描参数，相信能够得到更有价值的结果。

### 3. 评估肿瘤分期的价值

目前临床比较常用的肿瘤分期为 TNM 分期法，对不同部位的肿瘤分期的方式大多相近。T 分期主要评价肿瘤的局部浸润情况，目前单纯采用全身弥散加权成像进行肿瘤 T 分期的评估还是非常困难的，主要的限制因素如下：①全身弥散采用的线圈多为大体线圈而非局部线圈，空间分辨率不足；②大部分脏器的 T 分期是病理水平上的，而目前磁共振还不能对脏器的黏膜层、肌层、浆膜层等结构进行区分。N 分期主要评价淋巴结转移的情况，在这一方面全身弥散加权成像有一定的优势。淋巴结多位于脏器间的脂肪组织内，常规 T2WI 序列对于淋巴结的观察能力有限，T1WI 及压脂 T2WI 序列能够较有效地显示脂肪内的淋巴结，但尚需与血管断面鉴别。我们对一组正常人的筛查扫描发现，与高分辨率 CT 结合压脂 T2WI 序列结果比较，50 例患者中弥散加权成像对双侧颈部、双侧腋下、双侧腹股沟及腹膜

后淋巴结的显示能力都可以达到98%左右，可以准确地发现淋巴结大小及形态学特征的改变。经研究发现，对于淋巴瘤的患者，受累淋巴结ADC值的减低有显著的统计学意义。M分期主要评价远处脏器转移情况。大部分恶性肿瘤在发现远处脏器转移后都会放弃手术切除的治疗方案，因此，明确有无远处转移对患者来说是非常必要的。转移最常见的受累脏器包括肺、肝、骨、脑、肾上腺等。由于上述部位较分散，故临床多采用骨扫描＋局部CT或MRI的方法来进行术前评估，但多种检查手段往往需要更多的检查时间及更多的经济消耗，而仍有漏诊可能。全身弥散加权成像就可以省去繁琐的检查过程，一次完成全身各部位的检查，当然，对于肺内直径小于1cm的转移灶、骨骼系统的成骨性转移灶、脑内没有周围水肿且直径小于1cm的转移灶，全身弥散加权成像的发现能力尚不够强大，因此，在M分期的临床应用价值与N分期相比就较为逊色。但是，上述某些问题是有希望通过技术上的改进来解决的，如希望能够随着呼吸门控DWI成像序列技术的成熟而提高肺内较小结节的显示率。

#### 4. 肿瘤化疗疗效的评价及预测

有效的抗肿瘤治疗会导致肿瘤细胞溶解、细胞破裂、细胞间隙增宽，因此水分子弥散能力增加。但是，有些抗肿瘤治疗的方法是通过阻断血流供应的原理实现的，而这种治疗方法将会导致肿瘤组织局部的灌注量减低，在$b$值较低的弥散加权成像序列中也可能会出现ADC值的减低，因为这时血流灌注效应相对较为显著。我们的动物模型结果和其他中心的多组动物实验及临床病例结果均显示，放疗或化疗后ADC值的升高会很快出现，且多早于形态学的改变，如瘤体缩小等。但接受治疗后24小时内的观察发现，此时由于存在发生细胞水肿的可能，出现了ADC值一过性升高。还有研究发现，接受治疗前ADC值较高的肿瘤，治疗效果往往不如治疗前ADC值较低的肿瘤理想。这可能是由于ADC值较高的肿瘤往往更多见坏死，而这类肿瘤多是低氧代谢、酸性、血供较少，对化疗及放疗也就相对不够敏感。这意味着DWI检查对于肿瘤治疗效果有一定的预测能力，将是一个非常有价值的研究领域。

全身弥散成像技术对磁共振硬件系统要求很高。首先是磁场均匀度——EPI序列设有180°复相脉冲的相位重聚，因而要求很高的磁场均匀度，否则自旋质子会在相位方向累积偏差，从而导致图像发生变形、信号失真。其次是梯度线性——EPI序列通过反复高速的梯度震荡来完成相位编码，梯度线性差会造成WB-DWI不同截段间的错位，而无法重建出连贯的全身图像。最后是线圈保真度——容积线圈（如大体线圈、正交头线圈）较之表面线圈或是多个表面线圈串联的相控阵线圈具有更高的信号保真度，从而在WB-DWI的不同截段间表现为更高的信号均匀性。笔者所在医院采用GE公司的HD平台磁共振，在上述三个硬件方面有非常可靠的保证，从而获得了满意的图像质量。

综上所述，全身弥散成像技术是一项全新的磁共振成像技术。初步临床实验表明，与传统PET技术相似，WB-DWI在肿瘤筛查和良、恶性鉴别诊断及肿瘤的分期、肿瘤治疗的随访中具有很高的临床价值。由于其成像机制与PET不同，相信随着研究的深入和技术的完善，WB-DWI还会有更多的临床价值被挖掘、被发现，从而开启肿瘤影像学的新纪元！

A recent national survey in last April showed cancer has become the leading cause of mortality in the urban area of China. So tumor localization, characterization, staging, monitoring response to therapy and recurrence has undoubtedly become a vital task for clinical imaging techniques including

computed tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography (PET). Currently, PET or PET/CT remains the first-choice technology for tumor screening and tumor staging[1-3]. However, it is an invasive and radiating procedure, with high cost and limited accessibility, which prevent it from clinical prevalence. Whole body diffusion weighted imaging (WB-DWI) is a new MR technique provides cellular level structure depiction and functional information. It is based on a fat suppression pulse sequence named short time inversion recovery diffusion weighted echo planar imaging (STIR-DW-EPI), which can greatly suppress the background signal intensity of muscle, fat, liver, and give predominance to lesions including malignancies with restricted diffusion ability[4]. It is especially valuable in the detection of malignancy and its metastasis in whole body range. With three-dimensional maximum intensity projection (3D-MIP) reconstruction and black-white reversion, WB-DWI virtually resembles the well-known technique, PET. Additionally, WB-DWI is a non-invasive, no radiation, well compliance imaging tool which will enable it to become a comprehensive used clinical technique in oncology imaging area.

Whole body diffusion weighted imaging (WB-DWI) has a same physical principle as common DWI, which adopts two diffusion gradients with the same magnitude and opposite direction. It reveals cell structure and their lay-out through the mobility of intracellular and extracellular water. Most tumors possess the feature of high cell density and high nuclear-to-plasma ratio, which limits the diffusive mobility of intracellular and extracellular water. This gives the methodological probability for WB-DWI to detect malignancy, which shows high signal in diffusion weighted image and low signal in apparent diffusion coefficient (ADC) map[5]. WB-DWI has been high valued in the following aspects of oncology radiology:

## Therapeutic evaluation

Currently, imaging tools such as CT, ultrasound and conventional MRI are the most commonly used methods for therapeutic monitoring. Several measurement criteria, such as the World Health Organization (WHO) or Response Evaluation Criteria in Solid Tumors (RECIST) criteria are applied to assess therapeutic efficacy[6]. With WB-DWI, we may easily recognize the changes of size and shape of the multiple malignant lesions in a single tumor patient during the follow-up study based on the whole-body MIP image. And we could also do the measurement of the lesion's three dimension size through the axial DWI image. While, as we all know, after anti-tumor therapy, there are great chemical and cellular level changes happened in the malignancy before the size and shape change. Prognosis for patients receiving anti-tumor treatment can be of great advantage: it provides the opportunity to adjust individual treatment regimes more rapidly, and sparing patients unnecessary morbidity, expense and delay effective treatment. Effective tumor therapy results in dissolving, cracking and dispersing of tumor cells, which increase the mobility of water molecules. The increase of ADC value of the tumor usually happens before its morphological change, which indicates high value of WB-DWI in the evaluation of tumor therapy[7-9]. An interesting finding in recent study showed tumors with lower ADC value are usually more vulnerable than those with higher ADC value

to therapy, this may be explained by the fact that tumors with higher ADC value are mostly necrotic, which are anaerobic, acidic and lack-of-blood-supply, and are insensitive to chemotherapy and/or radiotherapy[10]. This shows WB-DWI may forecast the effectiveness of tumor therapy, another valuable research area.

### Tumor staging

Tumor node metastasis (TNM) staging is widely used in clinic for different types of tumors.

T staging mainly focuses on the local invasion of tumor, which is quite difficult for WB-DWI to evaluate. The main constraint is relative low spatial resolution. Thus prevents it from distinguish microscopic level anatomical layers in most human organs.

N staging focuses on metastasis of lymph nodes, where WB-DWI gains advantage[11]. Lymph nodes usually locate in fat tissue among viscera, which may be shown by T1WI or T2WI with fat suppression, precluded the section of vessels. In our primary study of fifty healthy people, WB-DWI found 98% of the bilateral cervical, subaxillary, inguinal and post-peritoneal lymph nodes as are revealed by hi-resolution CT and T2WI MR with fat suppression. As for head and neck lymph nodes, ADC value of the malignant lymph nodes showed a statistically significant decrease[12].

M staging evaluates the distal visceral metastasis. It is very important to preclude distal metastasis before tumor patients undergo resection. Lung, liver, bone, brain and adrenal gland are main destinations of metastasis, which are quite dispersive and are usually scouted by a complex combination of single photon emission computed tomography (SPECT), local CT and local MR. PET is another choice but the expensive cost hinders it from wide-spread use. As a potential substitution, WB-DWI could also provide large coverage information although this brand-new technique has in-avoidable limitations in detecting small pulmonary metastasis[11], osteo-genetic metastasis[13] and small cerebral metastasis without peripheral edema. Hopefully, these defects could be compensated by the improvement of technique, such as respiration gating, peri-thorax phantom, etc, in the future.

### Tumor screening

WB-DWI is most suitable for tumor screening because of its non-invasive nature and high sensitivity[11]. For patients with detected metastasis, it is low cost-effective and high radiation-dangerous to search the primary tumor from multiple loci using CT or MRI. Moreover, it is also difficult to find the precise lesion out from the abundant imaging information. WB-DWI differs in that, it provides a supreme contrast between lesion and normal tissue in the whole body range, which makes it an ideal technique for tumor screening. Besides, WB-DWI may also find benign lesion along with its concomitant STIR image (b=0), such as brain infarction, renal cyst, hepatic cyst, sinusitis and uterus leimyoma.

## Tumor discrimination

DWI has the potential ability to discriminate malignancy from benign one. Many localized DWI studies had shown statistical difference between two pathological types[14-20], which indicates the ability of DWI for tumor discrimination. However, as we all know, there are different stages of inflammatory reaction as effusion, proliferation, necrosis and fibrosis. Also there are different tumor histological types such as adenocarcinoma and epithelioma. It is understandable that there is overlap of ADC value between benign and malignant leisions. By literature comparison, we found that the ADC value of the same organ or the same tumor is quite different between different institutes or studies[21-23]. Possible reason is the different pulse sequence, system, post-processing, b value or enrollment criteria they adopt. Consequently, it is prerequisite to determine the normal ADC value of different organs of different age before we can tell the abnormal ones. And also, unification of scanning parameters of WB-DWI is definitely necessary for multi-center study.

As a conclusion, WB-DWI is a brand-new MRI technique which shows high clinical value as traditional PET in the screening, discrimination, staging, and therapeutic evaluation of tumors. Because its cellular mechanism differs from PET, it has even greater potential in tumor imaging, which may starts a new era of oncology diagnosis.

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# 第二章

# 全身弥散加权成像基本原理 (fundamental technique of WB-DWI)

在医学影像领域，没有一项技术可以像磁共振一样在30多年的成长过程中，接连不断地用一项又一项的创新发明、发现，刺激着从业人员的神经，颠覆着人们以往对其能力的认识。在今天，全球约20 000台的磁共振不仅在为认知科学提供fMRI这一独特的研究方法，更为神经、血管、胸腹、泌尿、关节等部位的疾病提供影像诊断帮助，而且逐渐在肿瘤分期、疗效评估、活检、介入治疗、分子影像等领域发挥着自己独特的功能成像优势。如此庞大的应用领域，肯定远远超过了35年前Paul Lauterbur花费数小时才靠磁共振获得的两支试管中的水的图像时人们对它的最夸张的想象。

磁共振成像手段的发展，除了获益于计算机领域的技术进步、加工工艺的不断完善、线圈理论的逐渐成熟等硬件原因外，成像序列和后处理方法的创新，特别是其紧密结合临床实际需求的研究方向，更是磁共振技术成长的有力基石。成像序列的发展，包括了快速成像技术、并行采集技术、伪影抑制技术等对原有序列的优化完善，也包括各种全新对比度的功能拓展。在对图像对比度的功能发掘过程中，经过30余年的发展，人们对传统对比度的利用，包括T1/T2/T2*/质子密度(PD)，已经相对比较完善。针对这些对比度的序列变化，更多地集中于加快其成像速度、提高成像质量及突出病变对比。而对一些特殊对比度的应用领域的发掘，却才刚刚起步。如稳态进动技术(FIESTA/true FISP/balance FFP)在心血管领域的大显身手，除了传统用于冠状动脉[1]成像技术外，其在心肌灌注[2,3]方面的应用也值得关注，如相位对比技术(phase contrast)从最初的速度测量，逐渐发展到血管成像、水脂分离[4]、弹性成像[5]等应用领域。最近几年还基于相位技术发展出了磁敏感成像(SWI)[6]，甚至铁浓度测量[7]等新的方向。而人们对弥散对比度的发掘，特别是其在临床应用上的优势更是在一点点地被科研工作者展现出来。

磁共振弥散成像的最早活体图像是由Denis LeBihan在1986年获得[8]。而其后，1990年，Michael Moseley发现了它在早期脑缺血诊断上的应用价值[9]，促使它被广泛应用于临床领域。在这之后，1996年出现的弥散张力成像[10]更是异军突起，发展成为神经科学的特殊分析方法。随着磁共振硬件的不断成熟，单纯弥散图像质量的不断提高，从事临床科研的学者也逐渐回归弥散技术本身，发现其在肿瘤定性诊断上的能力。特别是2008年最近几个月的一些文章，更不约而同地从几个特殊角度发掘了弥散技术的潜力。2008年4月的*Investigate Radiology*[11]和2008年7月的*Radiology*[12]都分别刊登了利用小*b*值的弥散，可以比常规T2序列更敏感地突出对肝脏病灶的显示。Shiro等[13](2008年8月，*AJR*)更创新性地提出了利用肺结节与脊髓神经弥散对比度上的信号强度差异，可以获得高达80%的肺结节良、恶性的

判断。Cur 等[14]（2008 年 9 月，*Radiology*）详细阐述了利用精确测量 ADC 值的弥散技术，可以对肝转移病灶介入治疗有更早、更准确的评估。

这些文章所描述的研究分别强调了弥散技术在肿瘤发现、鉴别和疗效评估这几个对肿瘤临床研究的关键步骤中的作用，而作为能更充分强调肿瘤病变整体的全身弥散成像技术，无疑对完整客观评价肿瘤病人的情况会起到更突出的作用。

In the past 30 years of medical imaging history, not a technology likes Magnetic Resonance Imaging that has subverted the people's awareness of its capacity, with a string of innovations and discoveries. Now a day, around 20 000 MR scanners are providing unique support in the field of cognition, neurology, cardiology, gastroenterology, urology and musculoskeletal system. Also this machine is tightly involved in the oncology field, like tumor staging, biopsy, interventional therapy, efficacy assessment and even molecular imaging. Back to 1973, at the time two tubes of water were firstly imaged by Paul Lauterbur's MR scanner for several hours, no one could expect such a tremendous application can be explored only within a few decades.

The development of MRI, not only benefited from the hardware, like the advance of computer industry, the constant improvement of material processing technique and maturity of radiofrequency coil theory, it was also strongly supported by the clinical oriented software development, like pulse sequence and post-processing method. In the pulse sequence advances, rapid imaging, parallel imaging and artifact suppression are within one of the focused areas which concentrated on the improvement of original imaging contrast. After 30 years of development, people have established a systematical understanding of traditional contrast, including T1, T2, $T2^*$ or Proton Density. The sequences that related with this contrast are developing towards higher speed, higher quality and higher illness contrast. Another target of pulse sequence is dealing with the newly emerged contrasts, which application may not been fully recognized yet. Like the steady stated gradient echo sequence (so called FIESTA, true FISP or balance FFP) already demonstrated its specialty in the cardiac vascular imaging like coronary artery imaging[1], myocardiac perfusion[2] and delayed enhancement[3]. Like the phase contrast imaging, started from the velocity measurement and gradually evolved into the vessel imaging, water/fat separation[4] and elastography[5]. In recent year, susceptibility weighted imaging[6] and iron concentration[7] are newly uncovered abilities of phase imaging. Diffusion weighted imaging, like the previous two contrasts, is another new image contrast and is gradually demonstrated its promising ability in radiology society.

The very first in vivo diffusion image was acquired by Denis LeBihan in 1986[8]. Four years later, Michael Moseley et al discovered its ability in early detection of regional cerebral ischemia[9]. Later on, in 1996, diffusion tensor[10] was raise up and soon became one of the hottest tools in Neuro-radiology. As the MR hardware turning maturity, the focus of diffusion is returned on its clinical advantages, especially in the oncology field. In recent publication, several articles focused on different aspects of diffusion image itself and revealed some of its potential. Zech CJ et al[11] and van den Bos IC et al[12] described their founding that black-blood diffusion weighted EPI can have a better sensitivity than normal T2 weighted imaging in liver scan, either in 1.5T or in 3.0T. Shiro et al[13] even raised a new idea that diffusion weighted signal intensity can be used to discriminate malignant