

Legg-Calvé-Perthes病的影像诊断方法

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摘 要

目的: 对用于诊断Legg-Calvé-Perthes病(LCPD)的影像学方法, 及不同技术的新进展进行综述。方法: 查阅国内外用于诊断LCPD的影像学方法, 包括平片、磁共振(MRI)、超声、计算机断层扫描(CT), 以及他们相关新技术的文献。对病变的基本影像学变化进行总结; 并阐述不同影像学方法对LCPD探究的新思路。结果: 不同的影像学方法对于疾病的诊断具有不同的优势, X线是用于疾病诊断和分期的常用方法; MRI极佳的软组织分辨力, 对于股骨头骨骺缺血坏死、滑膜、积液等显示更好; 超声操作方便, 但对于骨质细节显示欠佳; CT有利于骨质细节的观察。且这些影像技术的新进展对疾病的诊断都提供了更多的影像学信息。结论: X线是临床常用的诊断方法; MRI在疾病诊断、预后评估、疗效监测等方法可以为临床提供更多的影像学信息。

关键词

Legg-Calvé-Perthes病(LCPD), X线, 磁共振(MRI), 超声, 计算机断层扫描(CT)

Methods of Imaging Diagnosis of Legg-Calvé-Perthes Disease

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Abstract

Objective: To review the imaging methods used to diagnose Legg-Calvé-Perthes disease (LCPD) and recent advancements in various techniques. **Methods:** We reviewed domestic and international literature on imaging methods used for diagnosing Legg-Calve-Perthes disease (LCPD), including plain

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radiography, magnetic resonance imaging (MRI), ultrasonography, computed tomography (CT), and their related new technologies. We summarized the basic radiological changes of the lesion and elaborated on the new perspectives for exploring LCPD offered by different imaging methods. Results: Different imaging methods offer distinct advantages in disease diagnosis. X-ray is commonly used for disease diagnosis and staging. MRI, with its excellent soft tissue resolution, provides better visualization of femoral head epiphyseal ischemic necrosis, synovium, and joint effusion. Ultrasound is convenient to perform, but it lacks detail in displaying bone structures. CT is beneficial for observing detailed bone anatomy. These recent advancements in imaging techniques have provided more imaging information for disease diagnosis. Conclusions: X-ray remains a prevalent diagnostic tool in clinical settings. However, MRI can provide more extensive imaging information useful for diagnosis, prognosis evaluation, and monitoring treatment effectiveness.

Keywords

Legg-Calvé-Perthes Disease (LCPD), X-Ray, Magnetic Resonance Imaging (MRI), Ultrasound, Computed Tomography (CT)

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1. 引言

Legg-Calvé-Perthes 病(LCPD)是一种以股骨头骨骺缺血性坏死为特征的儿童特发性髋关节疾病,常表现为单侧或双侧的股骨头缺血坏死。儿童发病率差距很大,发病率约为 0.4~29.0/10 万人[1] [2]。这种疾病是自限性的,随着时间的推移,坏死的股骨头会经历血运重建和再骨化。尽管 LCPD 在上个世纪初首次被描述,至今病因仍不清楚[3],病因可能与环境、代谢、遗传、股骨头血供障碍等有关。很多学者认为各种原因导致的股骨头供血不足是引起儿童 LCPD 的根本原因[1] [4] [5]。从现有的研究可以总结出,LCPD 的病理过程累及关节软骨和骨骺,部分患者累及干骺端[6]。在 LCPD 中,最初由于股骨头缺血,其机械应力下降[7],出现股骨头稍扁平,随之血运重建开始,此阶段明显缺乏成骨细胞反应。同时,破骨细胞以较快的速度进行吸收死骨,导致骨骺碎裂,塌陷更明显。随着疾病的修复,新的编织骨形成,最终转化为板层骨,股骨头形态逐渐恢复[8]。患儿可能会因为髋关节继发的相应病变影响正常生活。疼痛、关节炎和髋关节功能障碍,仍然是疾病发病年龄较大或根据影像学分期预后较差的患者常见的长期后遗症[9]。且 LCPD 患儿的发病年龄是一个极为重要的预后因素,年轻的患者往往有更好的预后[10]-[12]。选择有效合适的影像诊断方法可以帮助医生尽早准确地发现疾病,采取及时的治疗手段恢复股骨头在髋臼的对位关系,同时减少机械应力,改善受限的活动范围,从而减少患儿产生更多的后遗症[13]。

2. X 线

患儿 X 线拍摄多采用双髋正侧位片和蛙侧位来进行诊断,在 LCPD 的早期,X 线表现可能是正常的。典型的影像学改变首先发生在股骨头和干骺端,随后发生在髋臼[9]。

2.1. Waldenström 分型

Waldenström 的影像学分期将 LCPD 分为 4 个影像学阶段,分别称为坏死期、碎裂期、修复期和愈合期[6]。坏死期时,患侧股骨头发生缺血,且持续受到力的作用,出现股骨头形态稍变扁、关节间隙增大,

继发于软骨下骨折, 囊性变等; 随着疾病进展, 碎裂期时, 股骨头的正常形态丧失, 股骨颈增粗, 骨质塌陷, 局部可见由外周新生肉芽组织吸收带衬托出的片状高密度的死骨; 修复期时, 死骨片逐渐吸收, 股骨头的高度逐渐增加; 最终达愈合期时, 骨化中心的密度恢复正常, 股骨头可以恢复正常形态, 但也有患者出现股骨头的严重畸变, 并随着岁数的增长可能会产生后续的影响。

2.2. Herring 外侧柱分型

Herring 外侧柱分型是有关疾病发病预后的分类方法[14], 根据 LCPD 碎裂阶段股骨头骨骺外侧柱的高度变化对 LCPD 进行分类。外侧柱定义为骨骺外侧的 15%至 30% [15] [16]。Herring 分类法分为四组[7]: A 组, 侧柱高度完整; B 组, 侧柱有塌陷, 但仍高于其原始高度的 50%; C 组, 侧柱高度小于其原始高度的 50%。B/C 边界, 侧柱高度为原高度的 50%, 宽度变窄至原宽度的 25%以下。

2.3. Stulberg 分型

Stulberg 分类系统是评价骨骼成熟后 LCPD 长期预后的最常用影像学分类方法。根据股骨头球形度和股骨头与髌白的匹配程度, 将患者分为五类[7] [15]: 1 类, 圆形股骨头; 2 类, 轻度非球面伴股骨颈增宽和缩短或髌白稍倾斜; 3 类, 髌关节的股骨头呈卵圆形、蘑菇型, 股骨头扁平程度小于 1 cm; 4 类髌关节的股骨头扁平程度大于 1 cm, 关节关系可; 5 类, 股骨头与髌白关节关系差。

2.4. DSA

数字减影血管造影(DSA)是诊断血管疾病的重要方法, 可以在活体内清晰地显示股骨头周围的血管及其分支的走向, Takashi Atsumi 等[17]用血管造影分析了股骨头圆韧带在 LCPD 的血运重建模式, 通过此方法发现来自股骨干骺营养动脉的血液供应受损似乎是 LCPD 的主要原因。在临床工作中此中有创性的检查运用较少。

3. MRI

3.1. 平扫 MRI

MRI 软组织分辨力更强, 可以提供相较于平片及 CT 更多的影像学信息。在 LCPD 早期, 患侧的股骨头呈 T1WI 低、T2WI 混杂稍高信号; 随病程进展, 股骨头塌陷、碎裂, 出现 T1WI 低和 T2WI 低的死骨信号; 部分患者可见干骺端囊肿; 随修复完成后, 股骨头信号与健侧相似, 但其高度不一定能完全恢复; 还可以出现股骨颈粗短。除骨质改变外, MRI 还可以更清晰地显示关节腔积液、骨髓水肿及髌软骨滑膜的不均匀增厚。

3.2. 增强及灌注 MRI

平扫 MRI 可能会低估股骨头受累情况, 由于坏死骨髓中的信号变化依赖于脂质降解, 在疾病的前 3 至 6 个月内偶尔无法观察到显著异常, 因此平扫 MRI 的缺血发现可能会延迟[18]。MRI 增强能更好地显示早期病变和病变累及范围, 并可以定量评价 LCPD 滑膜炎、监测各种方法的治疗效果[19]。

Kim [20] [21]等运用灌注 MRI 探究早期 LCPD 患者股骨头骨骺的血运重建模式, 发现坏死股骨头骨骺的血运重建随着时间的推移以马蹄形模式增加, 从股骨头骨骺的后部、外侧和内侧开始。血运重建率在不同患者之间差异很大。

3.3. DWI 的运用

弥散加权成像(DWI)多用于神经放射学, 用于评估卒中后缺血后组织变化。表观扩散系数(ADC)是应

用于 DWI 的定量指标[22]。DWI 在儿童缺血性股骨头的诊断、评估时间演变、预后和预测预后方面具有重要价值[23]。

在股骨头形态改变之前的 LCPD 早期阶段, 干骺端 ADC 增加与结局相关[24]。Baunin 等[25]人发现股骨干骺端患侧与健侧 ADC 比值可在 Herring 分级适用之前提供早期预后信息。股骨干骺端患侧与健侧 ADC 比值与 Herring 分级呈正相关, 认为 ADC 值大于 1.63, 则患儿出现预后不良可能性大。

3.4. MRA 的运用

磁共振血管成像(MRA)是一种用于无需造影的血管成像的技术, 为传统血管造影提供了一种无创、无辐射的选择。加上抑脂技术, MRA 可以为 LCPD 儿童股骨近端骨骺的动脉供应提供清晰的图像, 可以病灶处血管的分布情况、乃至旋股内动脉、旋股外、臀下动脉的终末分支及小血管的增粗。由于目前 MRA 的分辨率有限, 旋股内测动脉的末端分支及骨内的血管难以显示[26]。

4. 其他影像诊断方法

4.1. 超声

灰阶超声可用于显示关节积液[27]和评估股骨头的形状, 对于股骨头骨质的细节改变显示欠佳。

彩色多普勒超声可以显示股骨头部分血流, 由于骨发育阶段的限制, 其对骨髓和骨内血管的应用受到限制; 但有研究表明经特定的扫描方式选择, 尤其是 30°外展平面作为入路, 可以更有效地评估 LCPD 患侧髋关节的浅表软骨血管和骨内/经骺板深部血管[28]。

超声造影(CEUS)在儿童骨肌病变中的应用逐渐增多, 已被应用于幼年特发性关节炎和 LCPD 的成像, 并用于评价发育性髋关节发育不良儿童手术髋关节复位后的股骨头灌注。CEUS 可以使浅表和深部组织中毛细血管网的可视化。在 LCPD 中 CEUS 相较于普通的彩色多普勒超声可以更好地显示骨髓和骨内血运重建[29]。

4.2. CT

计算机断层扫描(CT)扫描图像密度分辨率高, 较 X 线更为清晰且无重叠, 对骨质细节的显影更为清楚。可以观察到股骨头骨骺高度改变, 精确定位病变部位, 确定有无骨质硬化、囊状透亮区及关节面下的骨折, 干骺端的增宽、干骺端囊肿以及关节间隙的改变、关节囊积液等。

M. Zlotorowicz 等[30]使用 CT 血管造影, 进而显示供应股骨头的三条主要动脉: 旋股内侧动脉的深支和源自旋股内侧动脉的后下营养动脉, 以及臀下动脉的梨状肌支。由于源于旋股内侧动脉深支的终末分支太窄而无法用造影剂填充, 所以无法显示。此外 M. Zlotorowicz 等[31]用 CT 血管造影证明股内侧动脉深支和臀下动脉梨状肌支是供应股骨头的主要动脉。因此, 在需要进行髋关节手术时, 了解血管走向非常重要, 可以防止股骨头缺血性坏死造成医源性损伤。CT 血管造影术是显示股骨头供血动脉的良好方法, 可以为髋关节血管情况提供更多的影像学信息[32]。

5. 总结与展望

影像学改变了人们对 LCPD 的认识, 并被用于疾病的诊断、分级、分类、连续跟踪和预测结果。新技术不断被开发、改进, 并应用于 LCPD 的研究和管理[18]。临床工作中以平片和 MRI 使用频率最高。平片由于成本低、可达性好、检查时间短, 仍然是诊断 LCPD 和随访的主要工具, 但在不进行其他检查的情况下仅采用单一检查是不足够的, 可能会延误疾病的诊断和治疗[33]。而 MRI 补充了 X 线片的使用, 并越来越多地用于疾病的管理。MRI 具有安全、无辐射等优点, 可以早期诊断股骨头骨骺坏死, 有助于

患儿及时治疗、改善预后[34]。MRI 极佳的软组织分辨率使得他可以更加清晰地显示患者软组织累积情况, 相较于 CT 血管造影及 DSA, MRI 的无辐射性可能更为大众所接受。

MRI 中不同技术的广泛挖掘及应用, 在疾病诊断、预后评估、疗效监测等方法可以为临床提供更多的影像学信息; 亦可能为评估儿童股骨头血管供应的研究提供新的机会, 从而为 LCPD 的病因学和病理生理学提供新的见解。

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