神经超声在腕管综合征诊治中的研究进展

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腕管综合征(Carpal tunnul syndrome,CTS)是最常见和研究最广泛的神经卡压综合征[1]。CTS 通常以手部症状为特征,严重时可累及前臂、上臂,甚至肩部,初始常表现间歇性夜间手指麻木,在病程后期可出现手指感觉丧失伴无力甚至鱼际肌萎缩[2]。成人 CTS 的发病率约为 3%。有研究发现女性 CTS 的发病率约为男性的 3 倍[3-4]。虽然 CTS 的病因多样,可能由于创伤,特别是腕骨骨折或脱位导致,以及继发于风湿免疫性疾病、甲状腺功能减退、肢端肥大症、口服避孕药、糖尿病和怀孕等,但大多数 CTS 是特发性的[5]。

CTS 的诊断主要依靠病史、临床症状和体格检查,必要时还需行电生理(Electrophysiology,EP)检测。近年来神经超声在 CTS 诊疗中被广泛研究和应用。多项研究表明,神经超声诊断 CTS 的敏感性和特异性与 EP 接近[6-11]。超声有许多优点,包括易获得、安全无创、检测时间短和经济实惠等,可用于评估正中神经横截面积的大小、血流量(能量多普勒)和活动性(动态成像)等参数。此外,超声还可提供正中神经和周围结构的解剖变异信息,这些变异可能是引起 CTS 的因素。本研究将对神经超声在 CTS 的临床应用进行综述。

1 神经超声诊断 CTS 的检测参数

CTS 是由正中神经(Median nerve, MN)在腕部通过有限的骨纤维管时受到压迫所致[2]。许多研究已经报道了多种 MN 的神经超声指标,包括 MN 横截面积(Cross-sectional area,CSA)、MN 硬度、MN 血流变化、MN 压扁率,这些参数对 CTS 的诊治均有价值[12]。

1.1 正中神经的横截面积

目前研究最广泛的诊治 CTS 神经超声指标是腕管水平 MN 的 CSA,在 2012 年的一项临床循证指南中 CSA 被认为是诊断 CTS 的 A 级证据[13]。有研究表明,CTS 患者的 CSA 明显较大,是诊断 CTS 最佳的超声指标[14-16]。对 CSA 的研究是多方面的,包括 CSA 诊断 CTS 的临界值,腕管入口水平正中神经横截面积与近端正中神经横截面积差(Δ-CSA)、腕管入口水平正中神经横截面积与前臂正中神经横截面积比值(R-CSA)能否提高 CTS 诊断的准确性,以及 CSA 大小与 CTS 严重程度之间的关系。

目前的研究表明,在腕管入口水平测量 CSA 能更好地诊断 CTS,同时测量入口与出口水平 CSA 并不能提高诊断的准确性,故大部分的 CSA 研究采用腕管入口即豌豆状骨水平测量[6,17-19]。近年来,许多研究对 CSA 诊断 CTS 的临界值进行了研究,以求有 1 个标准的量化数值可诊断 CTS,但目前尚未有 1 个确切的结果。有研究表明,诊断 CTS 的 CSA 临界值范围为 9~14 mm^2,敏感性为45.83%~97.2%,特异性为57.1%~100%[5,18,20-27]。有研究提出,通过测量腕管入口水平与前臂近端正中神经差值(Δ-CSA)及腕管入口水平与前臂近端正中神经横截面积比值(R-CSA)能更好地诊断 CTS,较单纯的测量远端 CSA 更能提高 CTS 诊断的准确率[28-30]。一项研究定义了前臂远端旋前方肌水平的近端测量标志,认为这种测量为计算近端正中神经横截面积提供了 1 个更具可重复性的标志,并更好地补偿了正中神经横截面积的个体间变异性[30]。目前关于 R-CSA 的研究多于 Δ-CSA的研究,且与单纯测量远端 CSA 一样,没有 1 个确切的临界值,各项研究的敏感性和特异性差异较大[30-36]。

针对 CSA 是否可以用于区分 CTS 的严重程度,目前的研究结果尚未统一。部分研究认为 CSA 的大小与 EP 检测的严重程度分级相关。这些研究表明 CSA 随 CTS 病情的加重而增大,随 EP 的加重而增大,且认为 CSA 能更好地区分轻中度与重度 CTS[23,30,37-38]。其他研究则显示 CSA 或 R-CSA 并不能区分 CTS 的严重程度,不能作为 EP 严重程度的替代指标[16,36,39]。

1.2 正中神经的硬度

随着超声技术的发展,超声弹性成像被应用于 CTS 的诊断过程中。弹性成像是一组技术,通过给组织施加外部压力来测量组织硬度。由于施加压力,组织尺寸发生变化,这种变形称为应变,而较硬的组织变形较小[40]。超声弹性成像主要分为剪切波成像和应变成像,剪切波成像是用刚度来描述硬度,刚度越大表示组织越硬;应变成像则是用应变来描述,通常通过与正常组织对比的应变比(Strain ratio,SR)来表示组织硬度,应变低则应变比大,组织越硬[41]。一项研究系统回顾了包括 497 例患者和 293 名对照者 MN 弹性评估,结果发现无论使用何种超声弹性成像模式,腕关节 MN 在 CTS 患者中始终比健康对照组硬[42]。

针对 MN 硬度能否解决 CTS 分级这一问题,目前已有的研究表明弹性成像不能区分 CTS 严重程度,但 CSA 结合超声弹性成像或许能替代电诊断试验(Electrodiagnostic Testing,EDT)对 CTS 进行严重程度分级[16,26,43-44]。然而有几项研究表明,在 EP 诊断的轻、中和重度 CTS 以及电生理阴性的 CTS 中 MN 硬度对区分中/重度患者有一定价

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值[16,26,45]。这几项研究使用剪切波弹性成像对 MN 进行弹性(E,单位 Kpa)检测,与轻度/EDT 阴性组比较,中/重度组的 MN 僵硬程度有显著差异,中/重度患者 MN 僵硬度更高[16,26,45]。研究显示 EDT 阴性的患者在 MN 的 CSA 方面也有阴性结果,但在神经僵硬方面没有,EDT 阴性患者的 E 值高于健康患者,EDT 阴性和轻度患者的 E 值相似[26]。

1.3　正中神经的血流变化

MN 是由丰富的神经外膜血管和神经内血管吻合系统提供的,该系统从神经外膜垂直延伸到神经束[46]。病理生理学研究表明,在慢性压迫的早期静脉血回流受阻,导致神经充血和水肿[47]。间质压力增加和神经持续水肿导致轴突运输和神经内血流增加[48]。有研究表明,神经超声可以检测 CTS 患者神经内血流量的增加,可作为诊断 CTS 的一项参考指标。早期 CTS 患者出现微血管密度增加这一病理生理改变,因此在 CTS 早期神经超声可能比其他检测技术更敏感地诊断 CTS[49]。该研究发现,多普勒超声比 CSA 更敏感,他们的研究结果显示血管增生的敏感性为93.4%,特异性为 90%,而 CSA 的敏感性为90.9%,特异性为 94%[49]。

目前应用于检测 CTS 血流的超声技术主要是微血管成像(Superb microvascular imaging, SMI)与彩色多普勒超声(Color doppler ultrasonography, CDUS)和能量多普勒超声(Power doppler ultrasonography, PDUS)。有研究对这 3 种技术进行了比较,结果显示对照组 CDUS, PDUS, SMI 血流显示率无统计学差异,而在患者组 SMI 血流显示率为 90%,高于 CDUS 和 PDUS(分别为 52%和 60%),这表明 SMI 对 CTS 的诊断似乎比 PDUS 更敏感,并且 SMI 结果与神经肌电图(Eleetroneuromyo-graphy, ENMG)的结果有很强的相关性,即 SMI 可能是诊断 CTS 的有用工具[50-51]。

有研究表明,结合多个超声参数,即 MN 腕部 CSA-前臂 CSA 差异和神经内血管增生等,神经超声提供了一种更有用或许能替代 ENMG 的诊断方法,其联合诊断 CTS 的敏感性为98.1%,特异性为21.7%[31]。CSA, MN 硬度和 CDUS 联合应用可使诊断准确率提高到 96%,特异性和敏感性分别为 100%和 93%[43]。

1.4　其他有关参数

有研究显示,MN 活动度、压扁率也与 CTS 发病相关。一项研究运用动态超声成像技术研究 CTS 患者的 MN 在腕管不同区域的纵向活动度,与健康对照组比较,CTS 患者与主动手指屈曲相关的纵向神经运动减少。CTS 患者腕管 MN 纵向活动度(0.0037±0.0011) mm/度明显小于对照组(0.0082±0.0026) mm/度($P<0.05$),尤其是近端(0.0064 mm/度 vs 0.132 mm/度)和中端(0.0033 mm/度 vs 0.0074 mm/度)[52]。由于 MN 受压,MN 变薄变平;也有研究提出 MN 扁平率可能有助于诊断 CTS[31,53]。

2　神经超声在 CTS 治疗中的临床应用

CTS 在轻中度时推荐保守治疗,其中一些保守治疗包括口服药物如非甾体抗炎药(Nonsteroidal antiinflammatory drugs, NSAIDs)、静息腕部夹板、物理疗法、局部注射皮质类固醇和局部注射富血小板血浆(Platelet-rich plasma, PRP)等[54]。近年来,多项研究就腕管内局部注射皮质类固醇激素治疗前后 MN 超声参数是否发生变化,这些参数变化能否评估 CTS 治疗疗效等进行深入探讨[21,55-58]。CTS 注射类固醇后超声显示 MN 肿胀减轻、屈肌支持带弯曲减少和 MN 活动度增加,所有这些改变均与临床症状显著相关[58]。结合功能问卷和电生理检查,研究还显示在类固醇注射后症状显著改善的患者其 CSA 也显著减少[56-57,59]。然而,一项在类固醇注射前后测量 CSA 的研究显示,与 MN 运动潜伏期、感觉传导速度、正中/尺神经运动潜伏期差和感觉潜伏期差在注射后均有显著性变化比较,CSA 并没有明显变化。该研究认为,CTS 入口处正中神经 CSA 等高分辨率超声参数对皮质类固醇注射治疗的 CTS 患者无监测价值[55]。

目前腕管皮质类固醇注射方法包括解剖标志直接注射和超声引导注射[58]。许多研究对这两种注射方法进行比较,以期注射安全性和有效性最大化。有研究结合波士顿腕管问卷(Boston carpal tunnel questionnaire, BQ)、疼痛模拟量表(Visual analogue scale, VAS)、电生理指标以及 CSA,对超声引导下与直接注射法分别进行评估,发现超声引导下注射可能比直接注射更有效[54,57,60-62]。超声引导下分别在 MN 下方和 MN 上方注射皮质类固醇,有研究发现两种方法在减轻症状、MN 横截面积和电诊断结果方面均有效;一项研究表明在 MN 上方注射更能显著减少 CSA[54],而另一项研究则表明两种方法的疗效无明显差异[63]。

3　小　结

神经超声相对电生理检测有许多优点,包括非侵入性、安全无创、易获得、患者耐受性好和经济实惠等。目前诊断 CTS 的超声参数较多,但尚未有能成为一独立且可替代神经电生理检测的指标,包括研究最多的 CSA。不同的研究表明,神经超声检测联合其它检查可提高 CTS 诊断与疗效评估的准确性。但目前的研究并不能证实多种神经超声检测指标的联合应用能够完全替代神经电生理检测。这与以下多种因素有关,包括超声的扫描参数如深度、焦区、频率、色彩增益和脉冲重复频率必须最优化;且这项技术高度依赖操作者,需要评估检测数据的可靠性。神经超声能够帮助诊断 CTS,但需更多的研究来提高诊断和疗效评估的准确性。

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