基于表面肌电图评价颈型颈椎病单侧颈痛患者颈椎活动时两侧胸锁乳突肌功能

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摘　要　目的:评价颈型颈椎病单侧颈痛患者颈椎活动时两侧胸锁乳突肌功能。**方法:**选取 40 例颈型颈椎病单侧颈痛患者,采用表面肌电图仪采集其颈椎前屈、后伸、右侧屈、左侧屈、右旋、左旋时两侧胸锁乳突肌的表面肌电信号,利用表面肌电图仪自带软件处理表面肌电信号,并生成表面肌电标准分析报告和表面肌电频率/疲劳度分析报告,提取报告中的平均肌电(averaged electromyography,AEMG)值、积分肌电(integrated electromyography,IEMG)值、平均功率频率(mean power frequency,MPF)值及中值频率(median frequency,MF)值进行统计分析。**结果:**颈型颈椎病单侧颈痛患者颈椎前屈、后伸、右侧屈、左侧屈、右旋、左旋活动时,疼痛侧胸锁乳突肌的 AEMG 值和 IEMG 值均小于非疼痛侧[前屈:(12.915±7.302)μV,(18.750±14.520)μV,$Z=-5.497$,$P=0.000$;(582.315±295.895)μV·s,(883.635±549.678)μV·s,$Z=-5.511$,$P=0.000$;后伸:(15.510±18.862)μV,(19.215±17.137)μV,$Z=-2.971$,$P=0.003$;(684.635±777.440)μV·s,(898.240±923.353)μV·s,$Z=-3.038$,$P=0.002$;右侧屈:(16.710±14.353)μV,(22.955±14.697)μV,$Z=-2.473$,$P=0.013$;(703.115±601.570)μV·s,(994.365±599.673)μV·s,$Z=-2.433$,$P=0.015$;左侧屈:(12.255±5.255)μV,(17.005±13.523)μV,$Z=-2.393$,$P=0.017$;(527.070±266.853)μV·s,(731.240±519.03)μV·s,$Z=-2.406$,$P=0.016$;右旋:(17.195±27.397)μV,(39.715±50.327)μV,$Z=-2.063$,$P=0.039$;(739.535±1 181.48)μV·s,(1 813.390±2 146.325)μV·s,$Z=-2.057$,$P=0.040$;左旋:(15.515±29.353)μV,(40.250±53.145)μV,$Z=-2.016$,$P=0.044$;(725.245±1 262.037)μV·s,(1 729.850±2 385.365)μV·s,$Z=-2.070$,$P=0.038$],疼痛侧胸锁乳突肌的 MPF 值和 MF 值与非疼痛侧相比,差异均无统计学意义[前屈:(63.480±26.205)Hz,(62.115±34.965)Hz,$Z=-1.237$,$P=0.216$;(39.840±30.515)Hz,(38.110±39.990)Hz,$Z=-0.363$,$P=0.717$;后伸:(65.160±25.250)Hz,(67.820±26.727)Hz,$Z=-0.148$,$P=0.882$;(42.030±33.111)Hz,(45.930±20.975)Hz,$Z=-1.593$,$P=0.111$;右侧屈:(64.085±24.470)Hz,(65.525±25.500)Hz,$Z=-0.417$,$P=0.677$;(38.355±29.713)Hz,(42.375±23.113)Hz,$Z=-0.484$,$P=0.628$;左侧屈:(57.905±18.997)Hz,(58.530±19.820)Hz,$Z=-0.390$,$P=0.697$;(34.800±19.598)Hz,(36.255±19.687)Hz,$Z=-0.444$,$P=0.657$;右旋:(67.460±27.015)Hz,(69.410±18.528)Hz,$Z=-0.255$,$P=0.798$;(47.130±20.742)Hz,(48.920±27.063)Hz,$Z=-0.914$,$P=0.361$;左旋:(62.035±25.763)Hz,(66.200±22.447)Hz,$Z=-0.349$,$P=0.727$;(45.330±28.12)Hz,(47.025±21.93)Hz,$Z=-0.444$,$P=0.657$]。**结论:**颈型颈椎病单侧颈痛患者在颈椎活动时,疼痛侧胸锁乳突肌较非疼痛侧肌肉收缩能力减弱,但两侧胸锁乳突肌肌肉疲劳度无差异。

关键词　颈椎病;颈痛;胸锁乳突肌;肌电描记术;临床试验

Evaluation of bilateral sternocleidomastoid muscle function in states of C－spine motion in neck－type cervical spondylopathy patients with unilateral neck pain based on surface electromyography

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ABSTRACT　Objective: To evaluate the bilateral sternocleidomastoid(SCM)muscle function in states of C－spine motion in neck－type cervical spondylopathy patients with unilateral neck pain(NP). **Methods:** Forty neck－type cervical spondylopathy patients with unilateral NP were selected out. The action surface electromyographic(ASEMG)signals of bilateral SCM muscles were collected in states of cervical anteflexion, backward extension, right lateroflexion, left lateroflexion, right rotation and left rotation by using surface electromyography (sEMG). The ASEMG signals were processed by using the software of sEMG for obtaining the sEMG standard analysis report and sEMG frequency/fatigue analysis report. The parameters, including averaged electromyography(AEMG), integrated electromyography(IEMG),

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mean power frequency(MPF) and median frequency(MF),were extracted from the reports and were statistically analyzed. **Results**:The AEMG and IEMG of SCM muscle were lower on the painful side compared to non-painful side in neck – type cervical spondylopathy patients with unilateral NP in states of cervical anteflexion, backward extension, right lateroflexion, left lateroflexion, right rotation and left rotation (anteflexion: 12.915 ± 7.302 vs 18.750 ± 14.520 μV, $Z = -5.497$, $P = 0.000$; 582.315 ± 295.895 vs 883.635 ± 549.678 μV · s, $Z = -5.511$, $P = 0.000$; backward extension: 15.510 ± 18.862 vs 19.215 ± 17.137 μV, $Z = -2.971$, $P = 0.003$; 684.635 ± 777.440 vs 898.240 ± 923.353 μV · s, $Z = -3.038$, $P = 0.002$; right lateroflexion: 16.710 ± 14.353 vs 22.955 ± 14.697 μV, $Z = -2.473$, $P = 0.013$; 703.115 ± 601.570 vs 994.365 ± 599.673 μV · s, $Z = -2.433$, $P = 0.015$; left lateroflexion: 12.255 ± 5.255 vs 17.005 ± 13.523 μV, $Z = -2.393$, $P = 0.017$; 527.070 ± 266.853 vs 731.240 ± 519.03 μV · s, $Z = -2.406$, $P = 0.016$; right rotation: 17.195 ± 27.397 vs 39.715 ± 50.327 μV, $Z = -2.063$, $P = 0.039$; 739.535 ± 1 181.48 vs 1 813.390 ± 2 146.325 μV · s, $Z = -2.057$, $P = 0.040$; left rotation: 15.515 ± 29.353 vs 40.250 ± 53.145 μV, $Z = -2.016$, $P = 0.044$; 725.245 ± 1 262.037 vs 1 729.850 ± 2 385.365 μV · s, $Z = -2.070$, $P = 0.038$). There was no statistical difference in MPF and MF of SCM muscle between the painful side and non-painful side (anteflexion: 63.480 ± 26.205 vs 62.115 ± 34.965 Hz, $Z = -1.237$, $P = 0.216$; 39.840 ± 30.515 vs 38.110 ± 39.990 Hz, $Z = -0.363$, $P = 0.717$; backward extension: 65.160 ± 25.250 vs 67.820 ± 26.727 Hz, $Z = -0.148$, $P = 0.882$; 42.030 ± 33.111 vs 45.930 ± 20.975 Hz, $Z = -1.593$, $P = 0.111$; right lateroflexion: 64.085 ± 24.470 vs 65.525 ± 25.500 Hz, $Z = -0.417$, $P = 0.677$; 38.355 ± 29.713 vs 42.375 ± 23.113 Hz, $Z = -0.484$, $P = 0.628$; left lateroflexion: 57.905 ± 18.997 vs 58.530 ± 19.820 Hz, $Z = -0.390$, $P = 0.697$; 34.800 ± 19.598 vs 36.255 ± 19.687 Hz, $Z = -0.444$, $P = 0.657$; right rotation: 67.460 ± 27.015 vs 69.410 ± 18.528 Hz, $Z = -0.255$, $P = 0.798$; 47.130 ± 20.742 vs 48.920 ± 27.063 Hz, $Z = -0.914$, $P = 0.361$; left rotation: 62.035 ± 25.763 vs 66.200 ± 22.447 Hz, $Z = -0.349$, $P = 0.727$; 45.330 ± 28.12 vs 47.025 ± 21.93 Hz, $Z = -0.444$, $P = 0.657$). **Conclusion**: In cervical spondylopathy patients with unilateral NP, the contraction ability of SCM muscle declines on the painful side compared to the non-painful side in states of C – spine motion, whereas there is no difference between bilateral SCM in fatigue severity.

Keywords　cervical spondylosis; neck pain; sternocleidomastoid; surface electromyography; clinical trial

随着社会经济的发展及人们生活方式的改变,颈椎病成为一种常见的慢性疾病。颈痛是颈椎病的常见临床症状,具有持续时间长、易反复发作等特点,约37%的颈椎病患者颈痛持续时间超过 1 年,22%的颈椎病患者颈痛反复发作[1-2]。多项研究表明,颈痛与颈部肌肉组织形态、激活模式、协调性以及运动控制策略的改变有关[3-4]。目前,临床多采用超声、MRI及表面肌电图等方法对肌肉进行检查评估[5-8]。表面肌电图测定法通过表面肌电图仪引导、记录肌肉活动时的生物电信号,并生成表面肌电图,在一定程度上能够反映肌肉运动单位的活动同步化、肌纤维募集、疲劳度、收缩能力等情况。该方法具有无创、可动态监测、可量化等优点,现已广泛应用于神经肌肉的功能检查中[9]。胸锁乳突肌是人体重要的颈浅屈肌,发挥维持颈椎稳定、参与颈椎活动的作用。为了评价颈型颈椎病单侧颈痛患者颈椎活动时两侧胸锁乳突肌的功能,我们测定了颈型颈椎病单侧颈痛患者颈椎前屈、后伸、右侧屈、左侧屈、右旋、左旋时两侧胸锁乳突肌的表面肌电信号,并对其进行处理和分析,现总结报告如下。

1　临床资料

1.1　一般资料　纳入研究的 40 例患者均为 2020 年 9 月至 2021 年 2 月在天津中医药大学第一附属医院门诊就诊的颈型颈椎病患者。男 15 例,女 25 例。年龄 22 ~ 50 岁,中位数 37 岁。身高 155 ~ 178 cm,中位数 168 cm;体质量 51 ~ 100 kg,中位数 60 kg。病程 10 ~ 60 个月,中位数 36.5 个月。均为单侧颈痛,右侧 24 例、左侧 16 例。颈痛视觉模拟量表评分 3 ~ 7 分,中位数 5 分。试验方案经医院医学伦理委员会审查通过。

1.2　诊断标准　参照《第二届颈椎病专题座谈会纪要》中颈型颈椎病的分型依据[10]制定颈型颈椎病诊断标准:①颈部疼痛且存在压痛点;②X 线片显示颈椎曲度改变或椎体不稳定;③排除肩周炎、落枕、肌筋膜炎等颈部其他疾患。

1.3　纳入标准　①符合上述诊断标准;②单侧颈痛;③年龄 18 ~ 50 岁;④病程≤5 年;⑤同意参与本研究,签署知情同意书。

1.4　排除标准　①合并严重的心脑血管疾病或肝肾功能障碍者;②合并严重皮肤病或颈部皮肤损伤者;③有精神病史或智力障碍者;④妊娠或哺乳期妇女。

2　方　法

2.1　表面肌电图测定方法　患者端坐位,双眼平视前方,双臂自然下垂,双手自然放置在大腿上,保持全

身放松且上半身直立。暴露两侧胸锁乳突肌处皮肤,使用砂纸磨除局部毛发,以75%的酒精棉球充分擦拭,待酒精挥发、皮肤干燥后,将2组LT-7型电极片(上海励图医疗器材有限公司)分别贴放于患者左右两侧胸锁乳突肌肌腹最隆起处皮肤,电极方向与胸锁乳突肌走向平行,同侧电极片电极中心相距2 cm;地线电极片贴于患者右侧尺骨茎突下方。患者按照示范动作依次进行颈椎前屈、后伸、右侧屈、左侧屈、右旋、左旋6个动作,每个动作重复3次,完成1个动作后休息1 min。以颈椎前屈为例,在节拍器辅助下,患者自中立位缓慢匀速前屈至最大程度,用时约3 s,并于前屈最大程度保持3 s,再缓慢恢复至中立位,用时约3 s,并于中立位保持3 s。采用MyoMove-EOW型表面肌电图仪(上海诺诚医疗器械有限公司)采集颈椎活动时两侧胸锁乳突肌的表面肌电信号,利用表面肌电图仪自带软件处理表面肌电信号,并生成表面肌电标准分析报告和表面肌电频率/疲劳度分析报告,提取报告中的平均肌电(averaged electromyography,AEMG)值、积分肌电(integrated electromyography,IEMG)值、平均功率频率(mean power frequency,MPF)值及中值频率(median frequency,MF)值进行统计分析。测定环境:室温15~25 ℃,湿度45%~55%;系统设置:陷波60 Hz,低通500 Hz,高通5 Hz。

2.2 数据统计方法 采用SPSS23.0统计软件对所得数据进行统计学分析。两侧胸锁乳突肌表面肌电信号的AEMG值、IEMG值、MPF值、MF值的比较均采用秩和检验。检验水准$\alpha=0.05$。

3 结　果

颈型颈椎病单侧颈痛患者颈椎前屈、后伸、右侧屈、左侧屈、右旋、左旋活动时,疼痛侧胸锁乳突肌的AEMG值和IEMG值均小于非疼痛侧,疼痛侧胸锁乳突肌的MPF值和MF值与非疼痛侧相比,差异均无统计学意义(表1)。

4 讨　论

研究发现,慢性颈痛患者颈部肌群表现为颈深屈肌无力和颈浅屈肌过度活跃[11]。胸锁乳突肌是重要的颈浅屈肌之一,多项研究表明其功能改变与颈痛关系密切。Yang等[12]对比分析了机械性颈痛者和无颈痛者在颈椎屈曲过程中胸锁乳突肌收缩至其最大自主收缩的25%时的肌电特征,结果显示与无颈痛者相比,机械性颈痛者胸锁乳突肌的初始和平均放电率明显升高,运动单位短期同步性明显降低,表明在执行所需的运动任务时,机械性颈痛患者胸锁乳突肌运动单位的控制策略相对低效,该研究结果亦支持了机械性颈痛患者神经肌肉控制策略改变的推断。Jull等[13]研究发现,颈椎在向各个方向活动时,颈痛组的胸锁乳突肌和头夹肌的共同激活程度显著高于健康组。此外,黄萍等[14]研究发现,在颈椎前屈、后伸及双手上举过程中,颈痛患者疼痛侧的颈竖脊肌和斜方肌上束的AEMG值和IEMG值均低于非疼痛侧,提示疼痛抑制了局部肌肉活动,导致肌电活动减少、肌肉收缩能力减弱。

表面肌电图是一种能客观反映神经肌肉肌电活动的检查方法,具有操作简便、无创、患者接受度高等优点,在临床广泛应用[15]。测定表面肌电图时,先将表面电极片贴布于目标肌肉处的皮肤,用以采集肌肉活动时的生物电信号;再通过表面肌电图仪将采集的电信号进行放大,显示出电压的时间序列信号。通过一定的分析转换方法可获得时域指标、频域指标、协调性指标等临床评价指标,采用这些指标评价肌肉功能或状态具有良好的实时性和实用性。时域指标包括IEMG、AEMG等。IEMG是在一定时间内肌肉中参与活动的运动单位的放电总量,其数值大小在一定程度上能够反映参与活动的运动单位的数量和每个运动单位的运动能力[16]。肌电信号振幅表明肌肉的收缩能力,振幅越大表明肌肉收缩能力越强,振幅越小表明肌肉收缩能力越弱;AEMG是反映肌电信号振幅变化的特征性指标,AEMG值与振幅大小呈正相关,AEMG值降低提示可能发生肌肉萎缩[17]。本研究结果显示,颈型颈椎病单侧颈痛患者颈椎前屈、后伸、右侧屈、左侧屈、右旋、左旋活动时,疼痛侧胸锁乳突肌的AEMG值和IEMG值均小于非疼痛侧,提示疼痛侧肌肉收缩力减弱,且两侧胸锁乳突肌肌电活动失衡。频域指标包括MPF、MF等。临床常采用MPF来判断肌肉疲劳度,肌肉持续活动时,负荷越大,则肌肉疲劳度越高,会导致肌电频谱左移、MPF值降低[18]。MF是骨骼肌收缩过程中肌纤维放电频率的中间值。MPF值和MF值的大小与肌肉组织中肌纤维的组成比例有关[19]。肌纤维根据其结构与运动性能的不同可以分为慢缩肌纤维和快缩肌纤维:慢缩肌纤维收缩速度慢,收缩力量小,但持续时间长,不易疲劳,兴奋时以低频放电为主;快缩肌纤维收缩速度快,收缩力

表1　颈型颈椎病单侧颈痛患者颈椎活动时两侧胸锁乳突肌表面肌电信号指标

侧别	前屈			
	AEMG1)值/($M \pm Q$,μV)	IEMG2)值/($M \pm Q$,μV·s)	MPF3)值/($M \pm Q$,Hz)	MF4)值/($M \pm Q$,Hz)
疼痛侧	12.915±7.302	582.315±295.895	63.480±26.205	39.840±30.515
非疼痛侧	18.750±14.520	883.635±549.678	62.115±34.965	38.110±39.990
Z值	-5.497	-5.511	-1.237	-0.363
P值	0.000	0.000	0.216	0.717
侧别	后伸			
	AEMG1)值/($M \pm Q$,μV)	IEMG2)值/($M \pm Q$,μV·s)	MPF3)值/($M \pm Q$,Hz)	MF4)值/($M \pm Q$,Hz)
疼痛侧	15.510±18.862	684.635±777.440	65.160±25.250	42.030±33.111
非疼痛侧	19.215±17.137	898.240±923.353	67.820±26.727	45.930±20.975
Z值	-2.971	-3.038	-0.148	-1.593
P值	0.003	0.002	0.882	0.111
侧别	右侧屈			
	AEMG1)值/($M \pm Q$,μV)	IEMG2)值/($M \pm Q$,μV·s)	MPF3)值/($M \pm Q$,Hz)	MF4)值/($M \pm Q$,Hz)
疼痛侧	16.710±14.353	703.115±601.570	64.085±24.470	38.355±29.713
非疼痛侧	22.955±14.697	994.365±599.673	65.525±25.500	42.375±23.113
Z值	-2.473	-2.433	-0.417	-0.484
P值	0.013	0.015	0.677	0.628
侧别	左侧屈			
	AEMG1)值/($M \pm Q$,μV)	IEMG2)值/($M \pm Q$,μV·s)	MPF3)值/($M \pm Q$,Hz)	MF4)值/($M \pm Q$,Hz)
疼痛侧	12.255±5.255	527.070±266.853	57.905±18.997	34.800±19.598
非疼痛侧	17.005±13.523	731.240±519.03	58.530±19.820	36.255±19.687
Z值	-2.393	-2.406	-0.390	-0.444
P值	0.017	0.016	0.697	0.657
侧别	右旋			
	AEMG1)值/($M \pm Q$,μV)	IEMG2)值/($M \pm Q$,μV·s)	MPF3)值/($M \pm Q$,Hz)	MF4)值/($M \pm Q$,Hz)
疼痛侧	17.195±27.397	739.535±1 181.48	67.460±27.015	47.130±20.742
非疼痛侧	39.715±50.327	1 813.390±2 146.325	69.410±18.528	48.920±27.063
Z值	-2.063	-2.057	-0.255	-0.914
P值	0.039	0.040	0.798	0.361
侧别	左旋			
	AEMG1)值/($M \pm Q$,μV)	IEMG2)值/($M \pm Q$,μV·s)	MPF3)值/($M \pm Q$,Hz)	MF4)值/($M \pm Q$,Hz)
疼痛侧	15.515±29.353	725.245±1 262.037	62.035±25.763	45.330±28.12
非疼痛侧	40.250±53.145	1 729.850±2 385.365	66.200±22.447	47.025±21.93
Z值	-2.016	-2.070	-0.349	-0.444
P值	0.044	0.038	0.727	0.657

1)平均肌电;2)积分肌电;3)平均功率频率;4)中值频率。

量大,但持续时间短,易疲劳,兴奋时以高频放电为主[20]。以静力性工作为主的骨骼肌中慢缩肌纤维占比较高,以动力性工作为主的骨骼肌中慢缩肌纤维占比较低[21]。本研究结果显示,颈型颈椎病单侧颈痛患者颈椎前屈、后伸、右侧屈、左侧屈、右旋、左旋活动时,疼痛侧胸锁乳突肌的MPF值和MF值与非疼痛侧相比,差异均无统计学意义,提示颈型颈椎病单侧颈痛患者颈椎活动时两侧胸锁乳突肌的肌肉疲劳度无差异。分析其原因可能是:①由于肌肉MPF值的变化特点与其快缩肌纤维所占比例呈正相关,与慢缩肌纤维所占比例呈负相关,胸锁乳突肌以维持头部姿势为主,慢缩肌纤维占比较高,兴奋时以低频放电为主;②本研究中颈椎活动时,胸锁乳突肌进行等张收缩运动,且运动强度小、时间短,不易造成肌肉疲劳。

研究表明,慢性颈痛患者的胸锁乳突肌和头夹肌都保持高度活跃,并且慢性颈痛患者颈浅屈肌与颈深屈肌的功能改变与潜在的神经肌肉功能障碍相关[22]。此外,还有研究表明,颈浅(深)屈肌激活方式及协同作用的改变可能是应对颈部疼痛的代偿策略,但若颈痛时间较长,可能会造成肌肉属性改变及运动

控制功能障碍[23]。慢性颈痛应从恢复颈深屈肌的功能、降低颈浅屈肌的过度活跃、改善颈椎的稳定性等方面进行治疗[24]。Lascurain - Aguirrebeña 等[25]研究发现,颈痛患者通过进行颈部屈肌功能训练,能够增强颈深屈肌耐力,并降低胸锁乳突肌、前斜角肌等浅表肌肉的肌电活动,从而改善颈痛。因此,对于早期颈痛患者,可通过加强颈肩部的肌群锻炼来达到缓解颈痛的目的。

本研究结果表明,颈型颈椎病单侧颈痛患者在颈椎活动时,疼痛侧胸锁乳突肌较非疼痛侧肌肉收缩能力减弱,但两侧胸锁乳突肌肌肉疲劳度无差异。

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