

弓状韧带综合征 CT 血管成像检查的影像学特征

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【摘要】 目的 探讨弓状韧带综合征(MALS)CT血管成像(CTA)检查的影像学特征。**方法** 采用回顾性描述性研究方法。收集2019年11月至2020年10月上海交通大学医学院附属瑞金医院收治的56例MALS病人的临床影像资料;男30例,女26例;中位年龄为54岁,年龄范围为19~78岁。病人均行CTA检查。观察指标:(1)CTA检查情况。(2)相关性分析。(3)手术情况。正态分布的计量资料以 $\bar{x} \pm s$ 表示。计数资料以绝对数表示。采用Spearman相关性分析统计腹腔干狭窄程度与腹腔干起始部和肠系膜上动脉起始部距离、腹腔干和肠系膜上动脉最近距离的相关性,检验水准为0.05。**结果** (1)CTA检查情况。①腹腔干狭窄程度:CTA横断面检查结果示56例病人中,腹腔干闭塞2例,重度狭窄10例,中度狭窄9例,轻度狭窄35例。CTA矢状面检查结果示:56例病人中,腹腔干闭塞2例,重度狭窄21例,中度狭窄15例,轻度狭窄18例。②不同狭窄程度检查情况:以CTA矢状面检查结果为标准。2例腹腔干闭塞病人均未见动脉瘤、夹层及血管变异,均可见胰十二指肠前后弓代偿增粗迂曲。21例腹腔干重度狭窄病人中,2例可见动脉瘤,1例可见夹层,7例可见胰十二指肠前后弓代偿增粗迂曲,8例可见胰十二指肠前后弓吻合,8例可见血管变异。15例腹腔干中度狭窄病人中,2例可见动脉瘤,3例可见夹层,2例可见胰十二指肠前后弓代偿增粗迂曲,4例可见胰十二指肠前后弓吻合,7例可见血管变异。18例腹腔干轻度狭窄病人中,1例可见动脉瘤,2例可见夹层,7例可见胰十二指肠前后弓吻合,6例可见血管变异。56例病人均未见肝、脾、胃等脏器缺血。③腹腔干发出位置:56例病人中,43例自第12节胸椎(T12)椎体下缘水平发出,2例自T12椎体中部发出,1例自T12椎体上部发出,7例自第1节腰椎(L1)椎体上部发出,1例自L1椎体中部发出,2例闭塞。(2)相关性分析。CTA矢状面检查结果示:56例病人腹腔干起始部与肠系膜上动脉起始部的距离为 (6.0 ± 4.0) mm,腹腔干轻度、中度、重度狭窄病人的起始部距离分别为 (6.2 ± 2.8) mm、 (8.1 ± 4.4) mm、 (5.3 ± 3.2) mm。56例病人中,23例起始部距离 <5 mm。相关性分析结果显示:腹腔干狭窄程度与腹腔干起始部和肠系膜上动脉起始部的距离无关($r = -0.205, P > 0.05$)。CTA矢状面检查结果示:56例病人腹腔干和肠系膜上动脉的最近距离为 (3.8 ± 2.4) mm,腹腔干轻度、中度、重度狭窄病人的最近距离分别为 (4.2 ± 2.0) mm、 (4.4 ± 3.3) mm、 (3.0 ± 1.9) mm。56例病人中,45例最近距离 <5 mm。相关性分析结果显示:腹腔干狭窄程度与腹腔干和肠系膜上动脉的最近距离无关($r = -0.249, P > 0.05$)。(3)手术情况:56例病人中,2例有临床症状(腹部疼痛),54例无临床症状;4例行手术治疗,52例未治疗。4例行手术治疗病人中,2例病人因腹部疼痛就诊,上腹部CTA检查结果示MALS,腹腔干呈重度狭窄,行腹腔动脉造影检查、腹腔动脉支架置入术。术后CTA检查结果示腹腔干未见明显狭窄。2例病人无明显临床症状,因胰头部肿瘤行胰十二指肠切除术。术前CTA检查结果示腹腔干重度狭窄,术中行动脉搭桥术,缓解术中、术后因胃十二指肠动脉结扎造成的肝脏缺血,避免MALS术后并发症发生。术后CTA检查虚拟三维图像显示搭桥血管通畅。**结论** CTA矢状面检查结果可评估MALS病人腹腔干狭窄程度、与弓状韧带的关系以及发出位置。

【关键词】 动脉; 诊断,鉴别; 弓状韧带; 腹腔干; 狭窄; CT血管成像; 手术

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Features of median arcuate ligament syndrome in computed tomography angiography

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【Abstract】 Objective To investigate the features of median arcuate ligament syndrome (MALS) in computed tomography angiography (CTA). **Methods** The retrospective and descriptive study was conducted. The clinical and imaging data of 56 patients with MALS who were admitted to Ruijin Hospital, Shanghai JiaoTong University School of Medicine from November 2019 to October 2020 were collected. There were 30 males and 26 females, aged from 19 to 78 years, with a median age of 54 years. All 56 patients underwent CTA. Observation indicators: (1) CTA examination; (2) correlation analysis; (3) surgical situations. Measurement data with normal distribution were represented as $Mean \pm SD$. Count data were described as absolute numbers or percentages. Spearman correlation analysis with test level of 0.05 was used to analyze the correlation between celiac trunk stenosis and the distance between the original location of celiac trunk and original location of superior mesenteric artery and the minimum distance of celiac trunk and superior mesenteric artery. **Results** (1) CTA examination. ① Celiac trunk stenosis: results of cross sectional examination of CTA showed that of 56 patients, there were 2 cases of celiac trunk occlusion, 10 cases of severe stenosis, 9 cases of moderate stenosis and 35 cases of mild stenosis. Results of sagittal examination of CTA showed that of 56 patients, there were 2 cases of celiac trunk occlusion, 21 cases of severe stenosis, 15 cases of moderate stenosis and 18 cases of mild stenosis. ② Examination of patients with different degree of vascular stenosis: according to the results of sagittal examination of CTA, the 2 cases with celiac trunk occlusion were negative for aneurysms, aortic dissection or vascular variations but positive for compensated varix of the anterior and posterior pancreaticoduodenal arches. Of the 21 cases with celiac trunk severe stenosis, 2 cases were positive for aneurysms, 1 case was positive for aortic dissection, 7 cases were positive for compensated varix of the anterior and posterior pancreaticoduodenal arches, 8 cases were positive for collateral circulations of anterior and posterior pancreaticoduodenal archs and 8 cases were positive for vascular variation. Of the 15 cases with celiac trunk moderate stenosis, 2 cases were positive for aneurysms, 3 cases were positive for aortic dissection, 2 cases were positive for compensated varix of the anterior and posterior pancreaticoduodenal arches, 4 cases were positive for collateral circulations of anterior and posterior pancreaticoduodenal archs and 7 cases were positive for vascular variation. Of the 18 cases with celiac trunk mild stenosis, 1 case was positive for aneurysms, 2 cases were positive for aortic dissection, 7 cases were positive for collateral circulations of the anterior and posterior pancreaticoduodenal arches, 6 cases were positive for vascular variation. All 56 patients were negative for ischemia of liver, spleen and stomach. ③ Original location of celiac trunk: of 56 patients, there were 43 cases had celiac trunk originated horizontally from the lower edge of T12 vertebral body, 2 cases had celiac trunk originated from the middle of T12 vertebral body, 1 case had celiac trunk originated from the upper part of T12 vertebral body, 7 cases had celiac trunk originated from the upper part of L1 vertebral body, 1 case had celiac trunk originated from the middle of L1 vertebral body and 2 cases had occluding celiac trunk. (2) Correlation analysis: results of sagittal observation on CTA examination showed the distance between the original location of celiac trunk and original location of superior mesenteric artery of the 56 patients was (6.0 ± 4.0) mm. The distance between the original location of celiac trunk and original location of superior mesenteric artery of patients with celiac trunk mild, moderate or severe stenosis were (6.2 ± 2.8) mm, (8.1 ± 4.4) mm and (5.3 ± 3.2) mm respectively. There were 23 cases of the 56 patients had the distance between the original location of celiac trunk and original location of superior mesenteric artery < 5 mm. Results of correlation analysis showed that the degree of celiac trunk stenosis was not related to the distance between the original location of celiac trunk and original location of superior mesenteric artery ($r = -0.205$, $P > 0.05$). Results of sagittal observation on CTA examination showed the shortest distance between celiac trunk and superior mesenteric artery of the 56 patients was (3.8 ± 2.4) mm. The shortest distance between celiac trunk and superior mesenteric artery of patients with celiac trunk mild, moderate or severe stenosis were (4.2 ± 2.0) mm, (4.4 ± 3.3) mm and (3.0 ± 1.9) mm, respectively. There were 45 cases of the 56 patients had the shortest distance between celiac trunk and superior mesenteric artery < 5 mm. Results of correlation analysis showed that the degree of celiac trunk stenosis was not related to the shortest distance between celiac trunk and superior

mesenteric artery ($r=-0.249$, $P>0.05$). (3) Surgical situations: of 56 patients, 2 cases were positive for clinical symptoms of abdominal pain, 54 cases were negative for clinical symptoms, 4 cases underwent surgical treatment and 52 cases not underwent surgical treatment. Of the 4 cases undergoing surgical treatment, 2 cases with abdominal pain were diagnosed as MALS by upper abdominal CTA. Celiac trunk of the 2 cases were severe stenosis and stents implantation under celiac arteriography were performed. Results of postoperative CTA showed celiac trunk was negative for obvious stenosis. The other 2 cases who were negative for clinical symptoms of MALS were planned to pancreaticoduodenectomy for pancreatic head tumor. Results of preoperative CTA showed severe stenosis of celiac trunk and arterial bypass grafting was performed for the 2 cases during pancreaticoduodenectomy to alleviate liver ischemia caused by gastroduodenal artery ligation which would avoid the incidence of postoperative MALS associated complications. Result of postoperative CTA three-dimensional reconstruction showed the bypass vessel was unobstructed. **Conclusion** Based on sagittal result of CTA examination, the stenosis of celiac trunk, the anatomical relationship between celiac trunk and arcuate ligament and the original location of celiac trunk of MALS patients can be evaluated.

【Key words】 Arteries; Diagnosis, differential; Arcuate ligament; Celiac trunk; Stenosis; Computed tomography angiography; Surgery

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弓状韧带综合征 (median arcuate ligament syndrome, MALS) 又称膈肌中脚压迫综合征、腹腔动脉压迫综合征, 是由主动脉裂孔前方横膈角形成的正中弓状韧带压迫腹腔干导致的疾病, 严重时可引起临床症状和并发症, 部分病人需要手术治疗^[1-4]。腹腔干狭窄及其侧支循环的准确诊断、MALS 并发症的评估, 对肝脏、胰胆管等手术有重要价值^[5-6]。CT 血管成像 (computed tomography angiography, CTA) 是一种特殊的 CT 检查方式, 在血管团注对比剂后, 选取靶血管中对对比剂浓度最佳时刻进行 CT 扫描, 重建血管二维、三维影像, 常用于血管性疾病的诊断^[7]。本研究回顾性分析 2019 年 11 月至 2020 年 10 月我科收治的 56 例 MALS 病人的临床影像资料, 探讨 MALS CTA 检查的影像学特征。

资料与方法

一、一般资料

采用回顾性描述性研究方法。收集 56 例 MALS 病人的临床影像资料; 男 30 例, 女 26 例; 中位年龄为 54 岁, 年龄范围为 19~78 岁。本研究通过我院医学伦理委员会审批, 批号为 (2021) 临伦字第 (135) 号。病人及家属均签署知情同意书。

二、纳入标准和排除标准

纳入标准: (1) 行上腹部 CTA 检查。 (2) CTA 检查结果示腹腔干起始部狭窄。 (3) CTA 检查确诊为 MALS。

排除标准: (1) CTA 检查结果示腹腔干动脉粥样硬化斑块、肿瘤侵犯腹腔干、腹腔干大动脉炎导

致的腹腔干起始部狭窄。 (2) 有腹部手术史。

三、影像学检查

(一) 仪器与方法

采用日本东芝公司 CT 仪 (型号: Toshiba Aquilion ONE)、中国联影公司 CT 仪 (型号: uCT760) 或荷兰飞利浦公司 CT 仪 (型号: Philips IQon-Spectral) 行上腹部 CTA 检查; 管电压为 120 kV, 管电流为 150~200 mA, 矩阵为 512×512, 扫描层厚层距为 5 mm, 重建层厚层距为 1 mm。对比剂为碘普罗胺 1.5 mL/kg。

(二) 图像分析

容积数据重建后使用多平面重组、最大密度投影处理技术显示血管。由 2 位放射科医师共同阅片, 经商讨后达成影像意见一致作为判断结果。

四、观察指标

观察指标: (1) CTA 检查情况包括腹腔干狭窄程度、不同狭窄程度检查情况、腹腔干发出位置。 (2) 相关性分析: 腹腔干狭窄程度与腹腔干起始部和肠系膜上动脉起始部距离的相关性; 腹腔干狭窄程度与腹腔干和肠系膜上动脉最近距离的相关性。 (3) 手术情况: 手术类型、手术完成情况。

评价标准: 参考文献 [8] 评价腹腔干狭窄程度, 重度狭窄为血管腔狭窄程度 >75%, 中度狭窄为血管腔狭窄程度为 50%~75%, 轻度狭窄为血管腔狭窄程度 <50%。

五、统计学分析

应用 SPSS 19.0 统计软件进行分析。正态分布的计量资料以 $\bar{x} \pm s$ 表示。计数资料以绝对数表示。采用 Spearman 相关性分析统计腹腔干狭窄程度与腹腔干起始部和肠系膜上动脉起始部距离、腹腔

干和肠系膜上动脉最近距离的相关性,检验水准为0.05。

结 果

一、CTA 检查情况

(一)腹腔干狭窄程度

CTA 横断面检查结果示:56 例病人中,腹腔干闭塞 2 例(图 1A),重度狭窄 10 例(图 1B),中度狭窄 9 例(图 1C),轻度狭窄 35 例(图 1D)。CTA 矢状面检查结果示:56 例病人中,腹腔干闭塞 2 例(图 2A),重度狭窄 21 例(图 2B),中度狭窄 15 例(图 2C),轻度狭窄 18 例(图 2D)。

(二)不同狭窄程度检查情况

以 CTA 矢状面检查结果为标准。2 例腹腔干闭塞病人均未见动脉瘤、夹层及血管变异,均可见胰十二指肠前后弓代偿增粗迂曲。21 例腹腔干重度狭窄病人中,2 例可见动脉瘤,1 例可见夹层,7 例可见胰十二指肠前后弓代偿增粗迂曲,8 例可见胰十二指肠前后弓吻合,8 例可见血管变异。15 例腹腔干中度狭窄病人中,2 例可见动脉瘤,3 例可见夹层,2 例可见胰十二指肠前后弓代偿增粗迂曲,4 例可见胰十二指肠前后弓吻合,7 例可见血管变异。18 例腹腔干轻度狭窄病人中,1 例可见动脉瘤,2 例可见夹层,7 例可见胰十二指肠前后弓吻合,6 例可见血管变异。56 例病人均未见肝、脾、胃等脏器缺血。

(三)腹腔干发出位置

56 例病人中,43 例自第 12 节胸椎(T12)椎体下缘水平发出,2 例自 T12 椎体中部发出,1 例自 T12 椎体上部发出,7 例自第 1 节腰椎(L1)椎体上部发出,1 例自 L1 椎体中部发出,2 例闭塞。

二、相关性分析

CTA 矢状面检查结果示:56 例病人腹腔干起始部与肠系膜上动脉起始部的距离为 (6.0 ± 4.0) mm,腹腔干轻度、中度、重度狭窄病人的起始部距离分别为 (6.2 ± 2.8) mm、 (8.1 ± 4.4) mm、 (5.3 ± 3.2) mm。56 例病人中,23 例起始部距离 <5 mm。相关性分析结果显示:腹腔干狭窄程度与腹腔干起始部和肠系膜上动脉起始部的距离无关($r=-0.205, P>0.05$)。CTA 矢状面检查结果示:56 例病人腹腔干和肠系膜上动脉的最近距离为 (3.8 ± 2.4) mm,腹腔干轻度、中度、重度狭窄病人的最近距离分别为 (4.2 ± 2.0) mm、 (4.4 ± 3.3) mm、 (3.0 ± 1.9) mm。56 例病人

中,45 例最近距离 <5 mm。相关性分析结果显示:腹腔干狭窄程度与腹腔干和肠系膜上动脉的最近距离无关($r=-0.249, P>0.05$)。

三、手术情况

56 例病人中,2 例有临床症状(腹部疼痛),54 例无临床症状;4 例行手术治疗,52 例未治疗。4 例行手术治疗病人中,2 例病人因腹部疼痛就诊,上腹部 CTA 检查结果示 MALS,腹腔干呈重度狭窄,行腹腔动脉造影检查、腹腔动脉支架置入术。术后 CTA 检查结果示腹腔干未见明显狭窄。2 例病人无明显临床症状,因胰头部肿瘤行胰十二指肠切除术。术前 CTA 检查结果示腹腔干重度狭窄,术中行动脉搭桥术,缓解术中、术后因胃十二指肠动脉结扎造成的肝脏缺血,避免 MALS 术后并发症发生。术后 CTA 检查虚拟三维图像显示搭桥血管畅通(图 3)。

讨 论

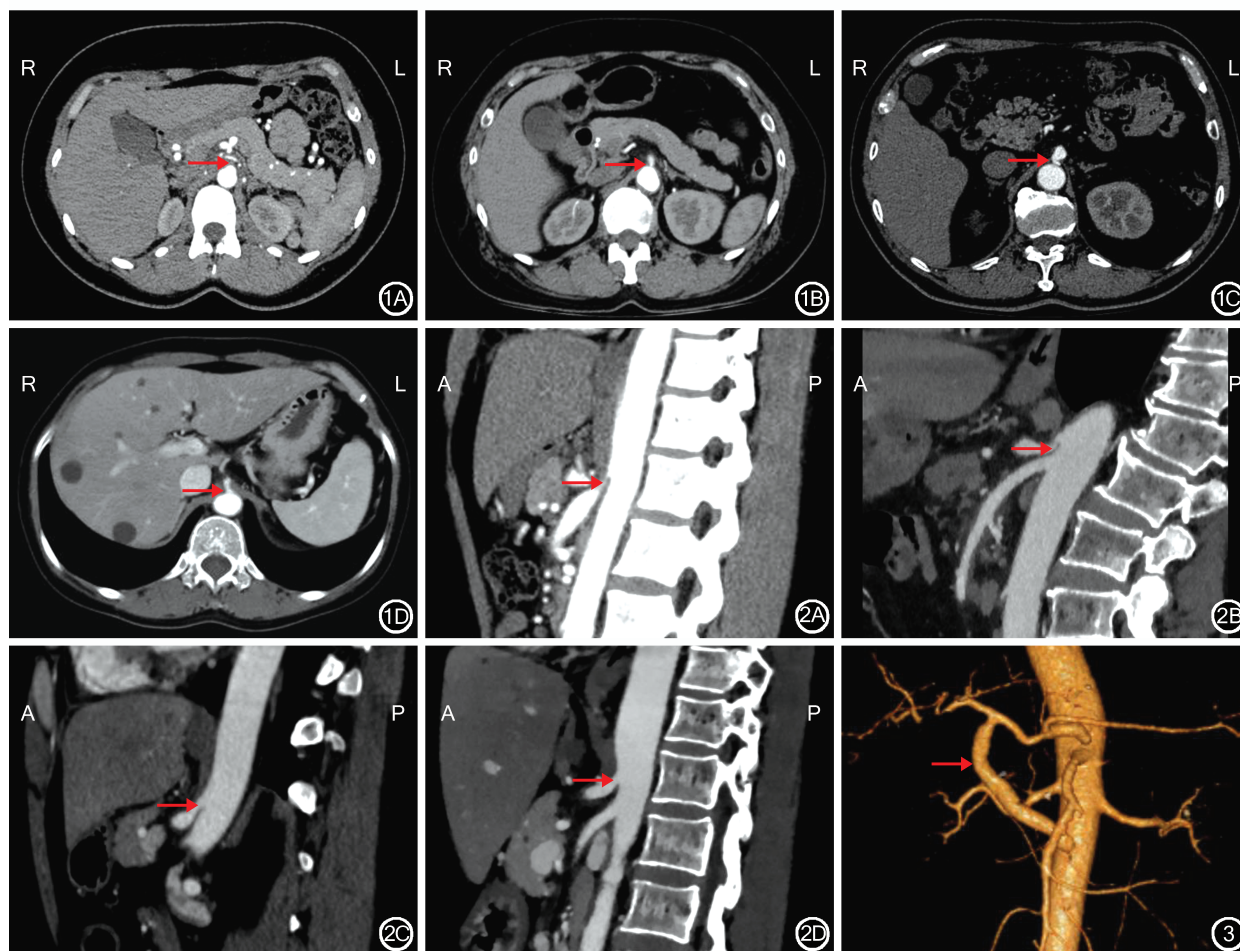
MALS 病人多无明显症状,少数可发生腹部不适等非特异性症状,极少数可导致腹腔动脉压迫综合征^[9-11]。MALS 是腹腔动脉狭窄或闭塞的常见原因之一^[12]。其他导致腹腔动脉狭窄原因有动脉粥样硬化、大动脉炎综合征、肿瘤压迫侵犯等^[13]。MALS 主要并发症为动脉瘤,以胰十二指肠动脉瘤多见,而腹腔动脉瘤罕见^[14-15]。

一、腹腔干狭窄程度

CTA 横断面检查有时不能发现 MALS 压迫表现,导致无法准确评估腹腔干的狭窄程度^[16]。本研究 56 例病人中,横断面检查结果示腹腔干重度狭窄 10 例,矢状面检查结果示重度狭窄 21 例。本研究表明:56 例 MALS 病人中,54 例无临床症状,但 CTA 检查结果示 38 例腹腔干中、重度狭窄或闭塞;并且,在腹腔干轻度、中度、重度狭窄病人中均可见胰十二指肠动脉前后弓吻合,部分病人还可见胰十二指肠动脉吻合弓增粗。已有的研究结果显示:MALS 的侧支交通分为胰十二指肠动脉弓型、胰背动脉型和肝内型,以第 1 种最常见^[17]。这提示多数 MALS 病人无临床症状和较少发生 MALS 相关术后并发症可能是因为侧支交通代偿供血,这可以减轻因腹腔干狭窄引起的腹痛或腹腔干供血脏器的缺血,通常是通过胃十二指肠动脉-胰十二指肠动脉弓吻合-肠系膜上动脉补偿供血。

二、弓状韧带与腹腔动脉的关系

CTA 检查可直接显示弓状韧带与腹腔干的解



注:红色箭头为腹腔干

图1 弓状韧带综合征病人CT血管成像横断面检查结果 1A:腹腔干闭塞;1B:腹腔干重度狭窄;1C:腹腔干中度狭窄;1D:腹腔干轻度狭窄 **图2** 弓状韧带综合征病人CT血管成像矢状面检查结果 2A:腹腔干闭塞;2B:腹腔干重度狭窄;2C:腹腔干中度狭窄;2D:腹腔干轻度狭窄 **图3** 弓状韧带综合征病人术后CT血管成像检查虚拟三维图像显示搭桥血管通畅

Figure 1 Cross sectional observation of computed tomography angiography on patient with median arcuate ligament syndrome 1A: Celiac trunk occlusion; 1B: Celiac trunk severe stenosis; 1C: Celiac trunk moderate stenosis; 1D: Celiac trunk mild stenosis **Figure 2** Sagittal observation of computed tomography angiography on patient with median arcuate ligament syndrome 2A: Celiac trunk occlusion; 2B: Celiac trunk severe stenosis; 2C: Celiac trunk moderate stenosis; 2D: Celiac trunk mild stenosis **Figure 3** Result of postoperative computed tomography angiography three-dimensional reconstruction of patient with median arcuate ligament syndrome showed the bypass vessel was unobstructed

剖位置关系,通过多平面重建,可显示腹腔干牵拉压迫程度,进而评估其狭窄程度、有无并发症等^[18-19]。从腹腔干在腹主动脉发出位置来看,已有的研究结果显示:85%的腹腔干开口于第11节胸椎椎体上1/3和T12椎体上1/3之间,而正中弓状韧带常位于L1椎体水平,因此,腹腔干在腹主动脉上发出位置过高或膈肌脚附着点过低可导致腹腔动脉受压,通常前者为最常见原因^[1,20]。本研究结果显示:56例MALS病人中,43例腹腔干发出位置位于T12椎体下缘,与李晚君等^[12]的研究结果相近,推测膈肌脚附着点过低是腹腔干狭窄的主要因素。本研究结果显示:MALS病人腹腔干与肠系膜上动

脉起始位置接近,腹腔干狭窄程度与腹腔干起始部和肠系膜上动脉起始部的距离和最近距离均无关。这提示两者不能作为评估MALS严重程度的指标,亦不能成为是否需要手术的依据。

本研究结果显示:2例腹腔干闭塞病人均未见动脉瘤、夹层、血管变异;18例腹腔干轻度狭窄病人中,1例动脉瘤,2例夹层,6例血管变异。这说明动脉瘤和(或)夹层、血管变异的出现仅提示存在MALS可能性,对于评估腹腔干的狭窄程度作用有限。

三、MALS的治疗和诊断重点

单纯的MALS压迫腹腔干无临床意义,腹腔干狭窄在无症状人群中的发生率约为7.3%^[21]。只有

当 MALS 压迫腹腔干致狭窄并引起临床症状或手术并发症时,才需要进行临床干预^[22-23]。对于需行腹腔干手术的 MALS 病人,术前 CTA 检查有助于准确评估腹腔干狭窄程度、腹腔干供血脏器血供情况,可以预防术后脏器缺血。而术前 CTA 诊断的重点应为 MALS 的直接征象,即腹腔干自腹主动脉发出的位置,矢状面可见弓状韧带压迫腹腔干起始段以及腹腔干的狭窄程度。其他 CTA 征象,如动脉瘤及夹层的发生、血管变异情况、侧支交通代偿情况,仅作为辅助指标。

综上,CTA 矢状面检查结果可评估 MALS 病人腹腔干狭窄程度、与弓状韧带的关系以及发出位置;对有临床症状的 MALS 病人行腹腔干手术时应在搭桥手术前做好充分准备,以有效避免发生脏器缺血。

利益冲突 所有作者均声明不存在利益冲突。

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