磁力疏通技术在术后消化道狭窄中的应用

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2020-01-04 收稿, 2020-02-07 修回, 2020-02-10 接受, 2020-02-12 网络版发表

国家自然科学基金(81470896)和陕西省科技资源开放共享平台项目(2016FWPT-01)资助

摘要 磁吻合或磁力疏通技术是一种创新性的吻合技术, 可完成狭窄消化道的重建. 我们采用该技术治疗常规治疗方法无效的消化道狭窄, 现探讨该技术的安全性及有效性. 收集2012年1月~2019年10月西安交通大学第一附属医院及中国人民解放军总医院肝胆外科收治的17例术后消化道狭窄患者: 年龄11~78岁, 男女比例11:6; 胆道狭窄14例, 结直肠吻合口狭窄1例, 食管吻合口狭窄2例; 完全性狭窄14例, 顽固性狭窄3例; 末次手术后0~120月发现狭窄, 在接受2~8次无效的标准治疗后行磁力疏通技术治疗. 疏通装置由子母稀土钕铁硼磁铁构成, 柱状或环状. 通过不同的输送路径, 在狭窄消化道的上下端分别置入子母磁体, 通过磁体间的磁力压迫狭窄组织而达到再通, 再通后在新吻合口放置支架或进行扩张等治疗. 观察指标包括术前狭窄距离、磁吻合再通时间、手术30 d内相关并发症、支架留置时间、吻合口狭窄复发等. 采用门诊及电话随访, 随访时间至2019年12月. 16例患者完成磁力疏通治疗(成功率94.1%), 分别为10例胆道-胆道吻合、3例胆道-肠道吻合、1例食管-食管吻合、1例食管-胃吻合、1例结肠-直肠吻合. 3例患者术后早期子母磁环脱开, 2例自动复位, 1例再次经PTCD(percutaneous transhepatic cholangial drainage)窦道置入一枚子母磁体复位耦合. 3例有手术并发症(急性胆管炎、胆道出血及结肠瘘各1例), 均予保守治疗后好转. 16例术前狭窄段长度 $2\sim 7.1(4\pm 1.9)$ mm, 再通时间 $7\sim 50(15.5\pm 10.6)$ d. 再通后4例置入胆道塑料支架, 5例置入胆道全覆膜金属支架, 4例置入经皮肝胆道引流导管, 2例吻合口球囊扩张+金属支架置入, 1例单纯吻合口球囊扩张. 再通后1~17(6.9 ± 4.0)月, 14例患者拔出支架, 1例仍在支架治疗中. 脱支架后随访3~70(22.5 ± 24.9)月, 13例胆道狭窄者未见狭窄复发, 其中2例出现胆道结石, 内镜治愈; 3例胃肠道狭窄者中有2例复发. 综上所述, 磁力疏通技术治疗复杂术后消化道狭窄微创、安全、有效, 可作为常规方法治疗无效后的补救措施.

关键词 磁吻合, 胆道狭窄, 食管狭窄, 胃肠吻合口狭窄, 结直肠吻合口狭窄, 再通

消化道(如食道、胆道、胃肠道等)手术涉及众多的吻合口重建技术, 术后吻合口狭窄是常见的并发症. 无论哪种吻合口发生狭窄, 其对病人的生活质量均将

产生巨大影响. 特别是肝移植术后吻合口狭窄, 术后若不能及时进行纠正, 会引起移植植物功能障碍. 消化道术后吻合口狭窄的治疗多以内镜或介入治疗为主, 如逆

引用格式: 李宇, 苏茂生, 孙学军, 等. 磁力疏通技术在术后消化道狭窄中的应用. 科学通报, 2020, 65: 1283–1294

Li Y, Su M S, Sun X J, et al. Magnetic recanalization technique for the treatment of alimentary tract stricture: A clinical study (in Chinese). Chin Sci Bull, 2020, 65: 1283–1294, doi: [10.1360/TB-2020-0012](https://doi.org/10.1360/TB-2020-0012)

行性胰胆管造影(endoscopic retrograde cholangiopancreatography, ERCP)、经皮经肝胆道引流(percutaneous transhepatic cholangio drainage, PTCD)、内镜下球囊扩张等,大部分病人均能得到良好的治疗效果^[1-3]。但是部分患者因狭窄复杂,如吻合口完全闭塞或者顽固性狭窄,常规方法治疗非常困难,最终患者只能接受再次手术治疗。

磁力疏通技术(magnetic recanalization technique, MRT)是利用磁体间特殊的“非接触性”磁场力完成空腔脏器无线化吻合的新技术。山内荣五郎等人于1998年开始应用磁吻合(magnetic compression anastomosis, MCA)技术完成消化道重建^[4]。随后又有学者把磁压榨技术用于消化道梗阻的再通,实为MRT的雏形。其原理是通过磁力压迫狭窄组织,使其发生缺血性坏死、脱落,磁体周围上皮细胞增生修复,实现管腔再通^[5]。目前,该技术已有应用于胆道狭窄^[6-8]、肠道吻合口狭窄^[9,10]及食管吻合口狭窄^[11,12]的病例报道。西安交通大

学第一附属医院10余年前即开始对磁外科技术开展基础研究,自2012年开始将磁力疏通技术应用于临床上,取得了不错的效果。

1 资料与方法

1.1 研究对象

2012年1月~2019年10月,共有17例消化道术后吻合口狭窄患者于西安交通大学第一附属医院及中国人民解放军总医院接受磁力疏通技术治疗(表1)。纳入标准:(1)吻合口闭塞,狭窄段距离不超过10 mm;(2)难治性狭窄,经过标准治疗方案仍无效者;(3)ECOG评分0~2分;(4)狭窄性质为良性。年龄11~78岁,男性11例,女性6例;胆道狭窄14例,结直肠吻合口狭窄1例,食管吻合口狭窄2例;完全狭窄14例,顽固性狭窄3例;除1例接受坏死胆汁肠袢切除致胆道梗阻外,余16例在术后1~120月内发现狭窄;在MRT前已接受2~8次标准的内镜治疗

表 1 术前患者基本资料^{a)}

Table 1 General characteristics of the patients

编号	性别	年龄(岁)	既往手术	狭窄诊断时间 (术后月)	狭窄部位	狭窄性质	已接受内镜 治疗(次)
1	男	41	肝移植	1	胆道吻合口狭窄	RS	4
2	男	49	胆囊切除术	12	胆道狭窄	RS	3
3	女	48	肝移植	6	胆道吻合口狭窄	CS	2
4	男	51	肝移植	5	胆道吻合口狭窄	CS	4
5	女	50	肝移植	8	胆道吻合口狭窄	CS	5
6	男	35	肝移植	10	胆道吻合口狭窄	CS	1
7	男	51	肝移植	8	胆道吻合口狭窄	CS	4
8	男	29	右半肝切除,腹壁缺损植皮术	1	胆道狭窄	CS	8
9	男	74	胆道探查	4	胆道狭窄	CS	2
10	女	78	胆道探查	120	胆道狭窄	CS	2
11	男	32	右半肝切除术	1	胆道狭窄	CS	3
12	男	57	胰十二指肠切除术	6	胆肠吻合口狭窄	CS	3
13	女	27	胆肠Roux-en-Y吻合术,坏死胆汁肠袢切除术,剖宫产术	0	胆道梗阻	CS	0
14	男	56	保留十二指肠的胰头切除术,胰腺假性囊肿空肠吻合术,胆道探查术	3	胆道梗阻	CS	2
15	男	60	直肠癌根治术	7	结直肠吻合口狭窄	CS	2
16	女	11	食管部分切除术	2	食管-食管吻合口狭窄	RS	5
17	女	50	近端胃癌根治术	6	食管-胃吻合口狭窄	CS	3

a) CS: complete stricture, 完全狭窄; RS: refractory stricture, 顽固性狭窄

(包括ERCP, PTCD或内镜下球囊扩张), 但均未成功.

1.2 磁力疏通装置

装置包括子磁体(daughter magnet, DM)和母磁体(parent magnet, PM)两部分. 磁体材料为稀土钕铁硼(NdFeB, N45), 表面改性方案为镍铜镍+氮化钛复合镀层. 根据狭窄吻合口的类型使用不同的疏通装置, 如胆道吻合口狭窄多采用柱状磁体(图1(a)), 而胃肠道多采用环状磁体(图1(b)).

1.3 磁力疏通技术操作方法

主要分为三个方面: 通过一定的通路在狭窄上下方分别置入子母磁体; 狭窄再通后取出磁体; 对新吻合口进行后继治疗.

1.3.1 胆道狭窄——胆道-胆道吻合

采用经皮PTCD-经口ERCP方法完成(图2). 经PTCD窦道置入子磁环至狭窄上方. 十二指肠镜下完成胆总管插管, 使用十二指肠乳头切开+球囊扩张技术打

图 1 (网络版彩色)磁体. (a) 用于胆道疏通的柱状磁体, 尾端开孔, 便于系线; (b) 用于胃肠道疏通的磁体, 中心开孔, 便于导丝引导、营养管通过等

Figure 1 (Color online) The magnets. (a) Cylinder magnets used in biliary MRT with a tail at one end for connecting with a silk thread; (b) annular magnets used in gastrointestinal MRT with a small hole in the center, which a guide wire or nutrition tube can pass through

开胆总管下端通道, 置入母磁体至狭窄下方. 在X射线下调整子母磁体的位置, 完成互相吸引达到磁体耦合. PTCD窦道内置入引流管, 暂时外引流胆汁.

1.3.2 胆道狭窄——胆道-十二指肠吻合

采用经引流管或PTCD窦道-经口胃镜途径完成(图3). 子磁体置入方法同1.3.1. 经胃镜活检孔道置牵引线, 连接母磁体, 将其固定于胃镜头侧端, 经口进胃镜

图 2 (网络版彩色)磁压胆道-胆道吻合操作步骤. (a) 经PTCD及ERCP同时行造影确认胆道-胆道吻合口闭塞; (b) 经PTCD窦道置入子磁体至狭窄上方, 并对十二指肠乳头进行球囊扩张; (c) 内镜下置入母磁体至胆总管内(箭: 母磁体; 三角: 十二指肠乳头); (d) X射线透视下同时调整子母磁铁至相互吸引达到耦合; (e) 造影提示闭塞吻合口再通, ERCP下使用取石网篮取出磁体; (f) 置入多支胆道塑料支架

Figure 2 (Color online) Steps of magnetic compression choledochostomy. (a) Complete stricture was confirmed by simultaneous cholangiography from PTCD and ERCP; (b) the daughter magnet was delivered to the proximal end of stricture through PTCD sinus, and the duodenum papilla was dilated by balloon; (c) the parent magnet was delivered through dilated papilla to common bile duct (arrow: parent magnet; triangle: duodenal papilla); (d) the position of two magnets were moved until coupling stably under guidance of X-ray; (e) recanalization was confirmed and magnets were removed by basket through ERCP; (f) multiple plastic stents were deployed across the new stoma

图 3 (网络版彩色)磁压榨胆道-十二指肠吻合操作步骤. (a) T管造影提示胆道下段梗阻, ERCP胆总管插管不成功, 提示胆总管下端完全闭塞; (b) 经T管窦道置入子磁体至胆总管内, 经胃镜将母磁环携带至十二指肠球部; (c) 完成磁压榨胆总管-十二指肠吻合(箭: 母磁体); (d) 经引流管造型提示再通; (e), (f) 新吻合口内置入胆道支架(三角: 胆道支架; 箭: 新吻合口)

Figure 3 (Color online) Steps of magnetic compression choledochoduodenostomy. (a) T tube cholangiography found lower biliary obstruction and bile duct cannulation failed in ERCP, implying a complete stricture; (b) the daughter magnet was inserted through T tube sinus to the common bile duct and the parent magnet was advanced endoscopically to the duodenal bulb; (c) magnetic compression choledochoduodenostomy was achieved (arrow: parent magnet); (d) recanalization was confirmed by cholangiography; (e), (f) single plastic biliary stent was used across the new stoma (triangle: biliary stent; arrow: the new stoma)

至十二指肠球部, 拉紧牵引线使磁体位于镜头头端. X射线透视下移动胃镜, 使两磁体顺利吸引, 完成磁压榨胆道十二指肠吻合. 经原窦道内置入引流管, 暂时外引流胆汁.

1.3.3 结直肠吻合口狭窄

采用经手术造口-经肛途径完成(图4). 通过牵引线将磁环牵拉至镜头侧方, 经造口进结肠镜至结肠闭塞吻合口上方, 将子磁环放置在狭窄近端. 经肛门推入母磁环, X射线引导下完成磁吻合. 保持原有造口引流粪便.

1.3.4 食管吻合口狭窄

非完全性狭窄采用经口胃镜-经口胃镜途径完成(图5). 胃镜下将导丝通过狭窄吻合口, 将扩张球囊和母磁环串连(球囊在前、母磁环在后). X射线引导下对狭窄吻合口进行扩张后, 使用推送器将充分注气的扩张球囊和母磁环一并推入胃腔内. 然后撤回扩张球囊, 将母磁环留置在胃腔内. 等待两周待吻合口回缩后, 再次

在胃镜下将子磁环放置在狭窄上方, 同时通过牵引线将母磁环自胃腔回拉至狭窄处, 完成子母磁体互吸, 完成磁吻合. 沿导丝向胃腔内置入空肠营养管备术后肠内营养支持. 完全狭窄者采用手术胃壁开口-经口胃镜完成(图6). 子磁环置入方法与非完全狭窄者相同. 手术打开胃前壁, 通过器械将母磁环置入狭窄下方, X射线引导下完成子母磁环耦合. 经胃壁开口向远端肠管内置入空肠营养管备术后肠内营养支持.

1.4 术后检查及治疗

术后第1, 3天复查腹部X射线观察磁体位置是否有变动. 若磁体间错位或距离增加, 提示磁吻合失败, 再次手术时可增加子和/或母磁体直径或数量以增加磁力; 若磁体已稳定耦合, 此后每周复查腹部X射线一次或根据临床观察复查. 胆道狭窄者需观察胆汁引流量及大便颜色改变, 若胆汁引流量减少或大便颜色转黄, 提示胆道再通, 此时可行PTCD造影证实; 胃肠道狭窄

图 4 (网络版彩色)磁压榨结直肠吻合操作步骤. (a) 结肠镜下可见吻合口完全梗阻; (b) 结肠镜经小肠造口将子磁环携带至狭窄上方; (c) 经肛推入母磁环, 完成子母磁环互吸耦合; (d) 磁体自动脱落, 经肛造影确认再通; (e) 再通后的吻合口; (f) 经球囊扩张后的吻合口

Figure 4 (Color online) Steps of magnetic compression colo-proctostomy. (a) A complete obstruction was viewed endoscopically; (b) the daughter magnet was advanced to the proximal end of stricture by colonoscopy; (c) the parent magnet was inserted through the anus, and magnets were coupled; (d) the magnets fell off by themselves, and recanalization was confirmed by radiography from anus; (e) the appearance of the new stoma; (f) the appearance of the new stoma after balloon dilation

者需观察进食或排便情况, 并间断牵拉留置于体外的牵引线, 若磁体位置松动, 提示再通可能, 复查腹部X射线或造影来证实。

胆道狭窄再通后, 经ERCP或经皮胆道镜取出磁体, 在新吻合口内放置胆道支架, 支撑时间6个月以上; 胃肠道狭窄者经胃镜或经肛取出磁体, 对新吻合口予定期内镜下球囊扩张术, 必要时放置金属支架。

1.5 观察指标与随访

观察指标包括患者基本参数、既往手术史、狭窄距离、再通时间、手术相关并发症及后继治疗。采用电话及门诊随访, 了解患者进食、体温及排便情况, 并定期复查肝功、B超, 若怀疑狭窄复发, 查MRCP及胃肠镜。随访时间截至2019年12月。

2 结果

2.1 手术相关指标

16例疏通成功(成功率94.1%), 1例失败(病例11)。

失败原因: 胆道缺损距离相对较长(11 mm, 图7(a)), 置入磁体小, 子母磁体之间磁力不足以牵拉狭窄两端胆道形成稳定耦合(图7(b)), 该病人转开腹手术治疗。16例成功者术前狭窄段长度 $2\sim 7.1(4\pm 1.9)$ mm(表2), 完成的磁力疏通技术分别为10例胆道-胆道吻合、3例胆道-肠道吻合、1例食管-食管吻合、1例食管-胃吻合、1例结肠-直肠吻合。16例子母磁体在手术结束时均能形成稳定耦合, 但3例胆道狭窄患者在术后早期复查腹部X射线时发现磁体间距离增加, 2例自动复位耦合, 未见特殊处理, 另1例经PTCD窦道再置入1枚4 mm磁体再次完成耦合。

总体再通时间 $7\sim 50(15.5\pm 10.6)$ d(表2)。13例胆道梗阻患者再通时间 (14.9 ± 11.2) d, 其中9例通过内镜下取石网篮取出磁体, 3例经PTCD窦道取出, 1例自动脱落随大便排出。胃肠道狭窄者中, 2例通过内镜取出磁体, 另1例经肛门排出。

胆道狭窄者经造影证实再通后均立即接受ERCP/PTCD+胆道支架置入治疗, 其中4例塑料支架、5例全覆膜金属支架、4例为PTCD导管, 再通后接受ERCP或

图 5 (网络版彩色)磁压榨食管-食管吻合治疗难治性食管狭窄操作步骤。(a) 胃镜下可见食管吻合口明显狭窄;(b) 沿导丝将扩张球囊及母磁环串联,球囊完全扩张吻合口,推送器将扩张球囊及母磁环一同推送至胃腔内;(c) 撤回扩张球囊,将母磁环留置在胃腔内,同时在胃腔内放置营养管(箭),将牵引母磁环的丝线于体外固定;(d) 待吻合口回缩后,胃镜下将子磁体放置在吻合口上方,回拉母磁体完成耦合,同时经磁环中孔放置营养管(箭);(e) 造影提示再通;(f) 再通后未经扩张的吻合口

Figure 5 (Color online) Steps of magnetic compression esophago-esophagostomy for refractory stricture. (a) An obvious esophageal stricture was viewed endoscopically. (b) The dilation balloon and the parent magnet was inserted over a guide wire in sequence. After the stricture was dilated fully, the parent magnet was pushed to the stomach along with the balloon by a pusher. (c) After withdrawing the balloon, a nutrition tube (arrow) was inserted to the stomach, and the thread tied with parent magnet was fixed outside the body. (d) When the stricture retracted, the daughter magnet was advanced to the proximal side of stricture endoscopically. While pulling back the parent magnet, approximation achieved (arrow: a nutrition tube); after that, a nutrition tube was inserted to the stomach again. (e) Recanalization was confirmed by radiography. (f) The appearance of the new stoma without dilation

PTCD治疗的次数为1~2次。胃肠道狭窄者再通后立即予柱状球囊扩张,两例已完成后继治疗:病例15术后共接受6次扩张、1次直肠金属支架治疗(1个月后支架自动脱落);病例17术后共接受3次扩张、1次食道金属支架治疗(3个月后取出支架)。病例16术后只接受1次扩张,还未完成后继治疗。

2.2 术后并发症

术后17例患者中有3例出现并发症,分别为急性胆管炎、胆道出血及结肠瘘各1例。急性胆管炎及胆道出血者均为轻度,予保守治疗后好转。结肠瘘予营养支持+腹腔通畅引流治疗,2个月后自愈。

2.3 随访结果

胆道狭窄者,12例已脱支架,支架放置时间2~17(7.7±3.7)月,另1例仍在支架治疗期内;12例随访6~70

(25.5±25.6)月,未见狭窄复发。其中2例(病例1和13)分别在脱支架后68和37月时出现急性胆管炎相关症状,均予ERCP治愈,胆管炎原因为胆管结石,但未见吻合口狭窄复发。胃肠道狭窄者,2例已完成后继内镜治疗,随访3~5月再次出现吻合口狭窄相关表现。因吻合口已复通,按吻合口狭窄进行内镜治疗。另1例仍在后继治疗中。

3 讨论

3.1 术前评估

狭窄两端充足的磁力是再通的保障,磁力主要取决于磁体材料、磁体大小、磁体间距离。胆道、胃肠道管腔及内镜操作钳道的大小限制置入体内磁体的直径,因此狭窄段距离不宜过长,术前准确评估狭窄非常重要。磁共振胰胆管成像(magnetic resonance cholangio-

图 6 (网络版彩色)磁压榨食管-胃吻合操作步骤. (a) 胃镜下可见吻合口完全闭塞; (b) 胃镜将子磁体送至狭窄上, 母磁体通过开腹胃壁开口送至吻合口下方胃腔, X射线引导下完成互吸耦合; (c) 消化道造影确认再通(箭: 再通吻合口, ★: 脱入胃腔之磁体); (d) 再通之新吻合口; (e) 吻合口内置入全覆膜食管支架; (f) 支架取出后之吻合口

Figure 6 (Color online) Steps of magnetic compression esophago-gastrostomy. (a) A complete stricture was viewed by gastroscopy. (b) The daughter magnet was delivered by gastroscopy and the parent magnet was inserted by surgical way. The magnets were well coupled under X-ray. (c) Recanalization was confirmed by radiography (arrow: the new stoma; star: the magnets); (d) the appearance of new stoma; (e) a fully covered metallic stent was deployed across the new stoma; (f) the appearance of stoma after removing the stent

图 7 (网络版彩色)磁力疏通失败病例(病例11). (a) 术前评估狭窄段距离约11 mm; (b) 磁体间距大, 未形成配对耦合

Figure 7 (Color online) The failed case (the 11th case). (a) The stricture length was 11 mm in evaluation before procedure; (b) the distance between magnets was too far to couple

pancreatography, MRCP)是诊断胆道狭窄的首选, 但其不能区分狭窄是否完全梗阻, 亦不能精准测定狭窄段距离. 既往经验显示, 通过ERCP和PTCD同时对狭窄上下方胆道进行造影是评估候选者的最佳方法^[8]. 对于胃肠道狭窄, 内镜只能观察狭窄一端, 不能测定狭窄距离. CT虽能够提示狭窄段周围的比邻脏器, 但不能精确显示狭窄段距离. 与胆道类似, 我们认为胃肠道狭窄上下

端同时造影或探子指示仍为最佳评估方法. 对于拟避开狭窄处重新建立吻合者, 如磁压榨胆肠、胃肠吻合, 避免损伤其他肠管或血管尤为重要, 术前需对CT进行冠状位、矢状位重建, 从各个角度观察以保证安全. 由于胆道狭窄者能够置入的磁体较小, 多为5 mm以内^[6,7], 我们将狭窄距离限定于1 cm内, 这也与大部分文献报道相同^[13]. 失败的1例为行右半肝切除时误将部分左肝管切除, 狭窄胆管距离为1.1 cm. 虽超过入选标准, 鉴于有狭窄距离1.5 cm^[14]和2.7 cm^[15]的成功个案报道, 仍予尝试治疗. 失败原因可能与距离较长致磁力不足有关, 亦与胆道缺失而非狭窄致胆道回缩有关. 针对胃肠道狭窄者, 由于消化道能够置入较大的磁体, 狭窄相应的距离可以增加至3 cm以内^[16]. 对于婴幼儿食道闭锁的病例, 术前还可以通过牵拉技术将两端盲袋距离拉近而缩短缺失段^[17]. 在临床实践过程中, 胃肠道吻合口1 cm以上的狭窄相对较少, 而1 cm以上的磁体能够在1 cm以内的范围产生15 N以上的磁力^[18], 完全能够满足临床需求.

表2 磁力疏通技术相关指标及随访结果^{a)}

Table 2 Details of MRT and follow-up results

编号	磁体直径 (mm)	狭窄距离 (mm)	再通 时间(d)	磁体移除 方式	支架 类型	后继治疗 次数	支架放置 时间(月)	脱支架随访 时间(月)	复发	其他
1	5	2	7	内镜	MP	1次ERCP	9	70	无	64个月发作胆 管炎1次
2	5	3	9	内镜	MP	1次ERCP	7	68	无	
3	4.5	2	10	内镜	MP	1次ERCP	8	55	无	
4	4.5	3	12	内镜	M	1次ERCP	7	11	无	
5	4	2	12	内镜	M	1次ERCP	7	9	无	37个月后发现 肝内胆管结石
6	4	7	12	内镜	M	1次ERCP	8	6	无	
7	2	4	14	经皮	M	1次ERCP	7	7	无	
8	4	5	21	内镜	PTCD	2次PTCD	12	8	无	
9	4	4	50	内镜	MP	2次ERCP	7	6	无	
10	4	2	15	经皮	M	1次ERCP	3	NA	NA	
11	5	3	8	经皮	PTCD	1次PTCD	6	6	无	
12	7	7.1	15	自脱落	PTCD	2次PTCD	17	42	无	
13	6	3	9	内镜	MP	2次ERCP	2	19	无	
14	18	6.5	11	自脱落	M	6次球囊扩张 +1次金属支架	1	3	复发	
15	15	3.5	14	内镜	/	1次球囊扩张	NA	NA	NA	
16	20	7	28	内镜	M	3次球囊扩张 +1次金属支架	3	5	复发	

a) MP: multiple plastic stent, 塑料多支架; M: metallic stent, 金属支架; ERCP: endoscopic retrograde cholangiopancreatography, 逆行性胰胆管造影; PTCD: percutaneous tranhepatic cholangio drainage, 经皮经肝胆道引流; NA: not available, 不可得

3.2 磁体选择

狭窄距离确定后, 选定合适的磁铁非常关键, 因为合适的磁力强度是完成磁力疏通或磁吻合的关键. 磁体大小、形状的选择与所应用的环境及后期脱落方向相关. 对于胆道, 由于胆道多经ERCP-经PTCD窦道完成, 考虑到十二指肠乳头及PTCD窦道的通过性, 多使用直径5 mm以下带杯装外壳的柱形磁体, 便于内镜下抓持. 4 mm以下磁体因能够通过十二指肠镜钳道, 使用更为方便. 若狭窄末端细长扭曲, 应选择能通过胆道狭窄最远端的小直径磁体(如2~3 mm), 以缩短磁体间的距离. 完成胃肠道疏通时, 多选择环状磁体, 直径多在15 mm以上, 以保证完成较大的吻合口. 为增大磁力或便于后期的磁体取出, 子母磁体大小亦可不相同. 在完成胆肠吻合时, 肠侧磁体直径大于胆道侧; 胃肠或食管-食管吻合时, 近端磁体直径大于远端, 就是为了后期取出磁体方便, 避免磁体脱落入胆道或远端肠道.

3.3 磁体输送路径选择

完成磁力疏通技术需要在狭窄两端建立输送子母磁体的路径, 有的是天然路径, 如胃肠道; 有的是术后残余通道, 如T管窦道、引流管窦道、胃肠道造口等; 有的需要借助穿刺或手术建立, 如PTCD、经皮内镜引导下胃造瘘术等. 对于胆道狭窄, 可供选择的路径包括经口ERCP-经皮PTCD通路^[6-8]、经口内镜-经皮PTCD通路^[19]、经小肠造瘘内镜-经皮PTCD通路^[20]、经皮PTCD-经皮PTCD通路^[20]. 针对胆道狭窄完成胆道-胆道吻合者, 多采用的是经口ERCP-经皮PTCD通路. 若需完成胆道-十二指肠吻合, 经口胃镜-经皮PTCD通路即可完成. 我们完成的两例胆道十二指肠吻合充分利用术后残余的胆道引流管窦道, 进一步简化了操作. 若需完成胆道空肠吻合, 由于既往手术史多为胆肠Roux-En-Y吻合, 经口通过小肠镜将母磁体输送至胆肠吻合口下方具有挑战性, 目前报道成功的病例不多^[14,21,22],

部分报道借助手术行小肠造口完成。完成食管-食管或胃吻合口狭窄、食管闭锁等多选用经口内镜-经胃造瘘途径完成^[11,12,16,17]。考虑到减少手术创伤,在完成食管-食管吻合口狭窄再通时采用经口胃镜-经口胃镜通路完成,首先利用球囊扩张狭窄处,置入远端母磁体,等待狭窄回缩后再置入子磁体至食管内完成食管-食管吻合口再通。该思路亦可应用于胃出口梗阻时完成磁压榨胃肠吻合或肠肠吻合^[10,23]。对于无胃造瘘的食管吻合口完全闭塞者,亦可采用腹壁小切口或腹腔镜下直接打开胃壁完成下通路的建立,优点是无需间断扩张窦道直接一期送入母磁体完成磁吻合,但是由于此类患者多有复杂手术史,腹腔内粘连重,应尽量规避手术相关并发症的发生。对于结肠相关梗阻,多需利用第一次手术遗留的小肠或结肠造口,目前已有经双腔造口置入磁环完成小肠/结肠造口还纳的报道^[24,25]。

3.4 磁力疏通技术的应用

目前磁力疏通技术多应用于胆道狭窄、食管闭锁、食管狭窄、胃出口恶性梗阻、肠道造口还纳等,以胆道狭窄应用最为广泛,成功率为77.7%~89.7%^[6,7],本组胆道病例成功率为92.8%。胃肠道梗阻者完成胃肠吻合成功率为66.7%~86.7%^[9,10]。食道吻合口狭窄/闭锁多以成功个案报道为主^[11,12,16,17]。本组食管胃肠道狭窄者,磁力疏通技术均获得成功。本组总体成功率94.1%,为术后消化道狭窄提供了一种全新的微创技术,特别是针对经历了复杂手术的患者,让患者免于再次手术。

Jang等人^[7]报道了目前病例数最大的胆道磁力疏通研究,大部分为肝移植术后患者,采用4~5 mm磁铁,33例患者平均52(13~182) d再通。若肝移植术后胆道-胆道吻合口完全脱开,在磁力疏通技术出现之前,只有再次手术完成吻合。Ersoz等人^[26]对6例肝移植术后胆道完全分离的患者采用磁力疏通技术,13~42 d的时间内完成胆道再通。若远端胆道已缺失或距离太远,不能完成胆道-胆道重建,胆道-十二指肠吻合亦为一种有效的胆汁内引流方式。Saito等人^[15]曾报道1例活体肝移植病人行胆道-十二指肠磁吻合术。该病人因移植术后出现绞榨性肠梗阻行大面积小肠切除术,仅遗留70 cm小肠,不适合于再次手术完成胆肠重建。通过在胆道狭窄末端和十二指肠球腔内各置入1枚磁体,25 d后完成胆道-十二指肠吻合。本组胆道狭窄者大部分为肝移植术后胆道吻合口狭窄,再次手术困难,磁力疏通技术在平均15 d左右完成了胆汁的内引流,并且胆肠吻合再通时

间(10.7 d)短于胆道-胆道吻合(16.2 d)。Avaliani等人^[19]采用磁压榨胆道-十二指肠吻合缓解胆道下端恶性梗阻,胆道-十二指肠吻合口形成时间则为15~22 d,短于Jang等人^[7]报道的胆道-胆道再通时间,与我们经验类似。我们认为该现象除了磁力大小的因素外,胆道吻合口致密的瘢痕纤维组织可能是最主要的原因。

在胃肠道方面,食管狭窄治疗的再通多在9 d内完成。Zaritzky等人^[16]报道了5例食管闭锁幼儿,平均4.8(2~7) d完成食管-食管重新吻合。Parlak等人^[27]报道了1例成人术后咽-食管吻合口狭窄,4 d完成新吻合口。我们治疗的2例食管吻合口狭窄疏通再通时间分别为14和28 d,比文献时间长,与狭窄纤维组织致密有关,其中1例术前经历严重的吻合口瘘和腹腔感染,另1例术前接受过多次的扩张治疗。磁力疏通胃肠吻合目前多应用于各种恶性肿瘤引起的胃出口梗阻。Chopita等人^[9]于2005年报道了13例患者成功完成磁压榨胃空肠吻合。此后, van Hooft等人^[10]报道了12例胃出口梗阻手术成功,8~21 d完成再通。我们曾对2例胰头癌致十二指肠梗阻者尝试磁压榨胃空肠吻合,但未能将母磁体推送通过狭窄处,空肠磁体放置失败,磁体设计及操作流程还需优化。结肠直肠吻合闭塞采用磁力疏通目前尚无文献报道,我们为首例报道,11 d获得再通。

3.5 磁力疏通技术的安全性及有效性

磁力疏通技术的主要并发症包括吻合口瘘、感染、出血、穿孔及消化道梗阻。针对胆道狭窄,本组有两例轻度并发症:急性胆管炎及胆道出血。胆道感染与过多注入造影剂有关,而胆道出血主要为经皮扩张窦道引起胆道损伤所致。总结目前文献,磁力疏通胆道技术安全性较高^[8,20],与我们的经验类似,无严重并发症报道。食管疏通技术目前无严重并发症报道^[11,12,16,17],部分患儿术后存在感染迹象,但无穿孔证据,予保守治疗后好转。胃出口梗阻行磁压榨胃肠吻合时,吻合口瘘、其他肠道医源性损伤、出血、穿孔等均有报道^[4,9,10]。本组3例胃肠道梗阻疏通者,有1例严重并发症——结肠瘘,为手术时分离粘连所致,予保守治疗后好转。无论哪种吻合,完成再通后,磁体脱落入远端消化道是否会导致梗阻?结合我们多年的经验,2 cm以下磁体多能自行排出体外,未见梗阻发生^[18]。总体来讲,因胃肠道血供丰富、肠壁相对脆弱,磁力疏通技术在胃肠道上应用时需特别注意预防并发症发生。

胆道狭窄完成磁力疏通后,多数专家建议再次使

用胆道支架支撑6月以上以减少狭窄复发率^[6-8]。本研究中,胆道组患者绝大多数支架放置时间均大于6月,无支架移位发生;脱支架后随访6~70月,未见狭窄复发。2例患者发现胆道结石,考虑与胃肠液反流有关,再次予内镜治愈。文献报道胆道磁力疏通后平均随访41.9(7.1~73.4)月,磁力胆道再通术后的狭窄复发率为3.9%^[8],低于常规ERCP(3%~37.5%)^[28]或PTCD(5%~17.1%)^[29]的复发率。

胃肠再通术后的进一步治疗方案目前存在争议。Zaritzky等人^[16]报道的5例食管闭锁幼儿,再通后未予球囊扩张,术后随访发现2例能够经口进食,2例需要扩张治疗,1例扩张治疗效果差转外科治疗。Yamanouchi等人^[4]报道了51例磁压榨胃肠或肠肠吻合术,再通后无其他治疗,20%~25%术后随访中出现吻合口狭窄。以上研究提示,胃肠道磁力疏通后吻合口狭窄复发率较高。

van Hooft等人^[10]研究了预防性置入消化道支架在降低术后狭窄复发中的作用,但发现支架移位率(25%)及消化道穿孔率(8.3%)较高。考虑到覆膜金属支架诸多的严重并发症,我们主要采用定期球囊扩张,容易实施且相对安全,但是目前2例已狭窄复发。胃肠道管腔大,血运丰富,非密闭的空间,磁力疏通后的新吻合口相对较小,周围炎性增生反应活跃,胃肠道腔内无气/液体压力维持,再加上术前吻合口完全炎性梗阻等原因,可能导致目前胃肠道疏通后复发率较高,如何降低远期复发率,仍需进一步研究。

综上所述,对于术后消化道梗阻,在常规治疗方法无效或无法实施的情况下,内镜下磁力疏通技术具有重要的临床价值。对于胆道狭窄者,磁力疏通技术可获得非常好的近期和长期效果;对于胃肠道狭窄者,治疗流程还需更多优化,以提高远期效果。

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Summary for “磁力疏通技术在术后消化道狭窄中的应用”

Magnetic recanalization technique for the treatment of alimentary tract stricture: A clinical study

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Magnetic compression anastomosis or magnetic recanalization technique is a revolutionary minimally invasive method to perform re-anastomosis in patients with alimentary strictures. We conduct magnetic recanalization for the treatment of severe alimentary strictures that cannot be treated by conventional methods. Data are analysed retrospectively in order to investigate the safety and efficiency of this method. From 2012 January to 2019 October, 17 patients with alimentary stricture after operation were enrolled in the first affiliated hospital of Xi'an Jiaotong University and the Chinese PLA General Hospital. The ages were 47 ± 16.8 years, and 11 cases were men. 17 cases include 14 benign biliary strictures, two esophageal strictures and one colorectal anastomosis strictures. 14 cases are complete strictures, and the others are refractory one. Strictures are found 0–120 months after the last operation. All the patients have undergone 2–8 times unsuccessful standard treatments, including endoscopic retrograde cholangiopancreatography (ERCP), percutaneous transhepatic cholangial drainage (PTCD) or endoscopic balloon dilation. Magnetic recanalization technique (MRT) is proposed. The MRT device consists of two identical, nickel-plated NdFeB magnets (rating, N45) termed the parent magnet and the daughter magnet. Each magnet shapes like a cylinder or annular. The daughter and parent magnet are delivered to the proximal and distal end of stricture respectively via different routes. The attraction force between the two magnets leads to necrosis of the fibrotic stricture tissue and the creation of a new transmural anastomosis. Thereafter, stent deployment or balloon dilation is performed to the new anastomosis. Data about stricture length, recanalization time, side effects in 30 days, time to remove the biliary stent and stricture recurrence are collected. All the patients are followed-up to 2019 December by telephone or outpatients service. After the MRT, 1 case fails. Magnets can couple stably in 16 patients (successful rate 94.1%), including 10 cases of choledoch-choledochostomy, 3 cases of bilio-enteric anastomosis, 1 case of esophago-esophagostomy, 1 case of esophago-gastrostomy and 1 case of colo-proctostomy. The delivery routes are per-PTCD/per-ERCP, per-PTCD or drainage tube sinus/per-gastroscope, per-gastroscope/per-gastroscope, per-gastroscope/per-operation and per-enterostomy/per-anus respectively. The daughter and parent magnets detach from each other in 3 patients after days post-MRT. The magnets couple automatically in 2 patients without any interventions. In the other patient, another daughter magnet is added through PTCD, and the magnets are again tightly approximated. Three adverse events are found (cholangitis, 1 patient; biliary bleeding, 1 patient; colon leakage, 1 patient), but are resolved with conservative treatment. The stricture length is $2-7.1(4 \pm 1.9)$ mm in successful cases, and recanalization occurs after $7-50(15.5 \pm 10.6)$ days. Biliary multiple plastic stents (4 patients), biliary fully covered self-expandable metallic stent (5 patients), percutaneous trans-hepatic cholangiodrainage catheter (4 patients), balloon dilation plus metallic stent (2 patients), or balloon dilation alone (1 patient) is used after recanalization. Stents are retrieved after 6.9 ± 4.0 months in 14 patients, and 1 patient is still in stent period. During 3–70 months of stent-free follow-up, no stenosis is found in 13 biliary stricture patients, but 2 cases are found biliary stones and cured by endoscopic treatment. Two of three patients with esophageal or colorectal anastomosis stricture experience recurrence in follow up, and are still managed by endoscopic ways. In conclusion, magnetic recanalization technique is a minimally invasive, effective and safe method to complicated alimentary stricture, and can serve as a remedial method when conventional ways fail.

magnetic compression anastomosis, biliary stricture, esophageal stricture, gastrointestinal anastomosis stricture, colorectal anastomosis stricture, recanalization