·综述·

内镜黏膜下剥离术治疗结直肠肿瘤的研究进展

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【提要】 随着内镜治疗技术的发展，内镜黏膜下剥离术（endoscopic submucosal dissection，ESD）被证实为一种治疗结直肠肿瘤的安全、有效的治疗技术。与内镜黏膜切除术相比，ESD可明显提高大直径病变的整块切除率，使充分病理评估成为可能。与传统外科手术相比，ESD具有创伤小、并发症少、恢复快、费用低等优势，且二者疗效相当，五年生存率均可达90%以上。本文就ESD治疗早期结直肠癌及癌前病变的最新进展进行综述。

【关键词】 结直肠肿瘤；　内镜黏膜切除术；　内镜黏膜下剥离术；　疗效；　安全性

Recent advances in endoscopic submucosal dissection for colorectal tumors

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随着人口老龄化、社会经济发展及生活习惯改变，癌症负担不断增加，癌症类型发生改变。2020年全球癌症数据显示，结直肠癌发病率为10.0%，仅次于乳腺癌和肺癌，病死率为9.4%，仅次于肺癌[1]。我国结直肠癌负担十分沉重，2020年我国结直肠癌新发病例达55万，占全部恶性肿瘤发病的12.16%。死亡病例约28万，占全部恶性肿瘤死亡的9.53%。新发和死亡病例均占世界结直肠癌病例的20%[2]。然而全球数据显示结直肠癌五年相对生存率从70年代中期的50%提高到65%，这可能归功于早期筛查、早期诊断治疗以及手术技术和全身疗法的进步，包括化疗、放疗、免疫治疗、靶向治疗等。Ⅰ期结肠癌和直肠癌的五年生存率>90%，但Ⅳ期则分别下降至11%和15%[3]。因此，普及结直肠癌筛查及推广内镜下早诊早治，是提高结直肠癌早期诊断率、降低结直肠癌死亡率的关键措施[4]。与传统外科手术相比，内镜下治疗具有创伤小、并发症少、恢复快、费用低等优势，且疗效相当，五年生存率可达90%[5]。目前常用的治疗早期结直肠癌及癌前病变的内镜技术为内镜黏膜切除术（endoscopic mucosal resection，EMR）和内镜黏膜下剥离术（endoscopic submucosal dissection，ESD），与EMR相比，ESD具有更高的整块切除率、完全切除率及更低的复发率[6]。不同地区ESD技术水平具有较大差异，本研究对结直肠ESD最新进展做一综述，对适应证、操作技术、有效性及并发症分别进行阐述，旨在提高结直肠ESD诊治水平。

一、适应证

日本胃肠内镜协会指南指出结直肠ESD适应证为要求整块切除的病变：（1）EMR难以整块切除，如LST-NG、pit pattern分型为Ⅴi型、黏膜下浅层浸润、大凹陷性病变、可疑癌变的大隆起型病变；（2）黏膜下纤维化的黏膜病变；（3）慢性炎症状态下的散发肿瘤（如溃疡性结肠炎）；（4）早期结直肠癌内镜切除后局部残留或复发的病变[7]。国内2020年《中国结直肠癌筛查与早诊早治指南》规定ESD适应证：（1）最大直径>20 mm难以使用EMR行一次性完全切除或抬举征阴性的病变；（2）>10 mm EMR残留或治疗后复发再次行EMR治疗困难的病变[5]。美国胃肠病协会最新临床实践建议结直肠ESD适应证为可疑黏膜下浸润需要整块切除的病变（PP分型为Ⅴ型；巴黎分型为Ⅱc类病变；复杂形态如0-Ⅰs型或0-Ⅱa+Ⅰs型；直肠乙状结肠病变；非颗粒型≥20 mm腺瘤；颗粒型≥20 mm腺瘤）及残留或复发腺瘤[8]。欧洲胃肠内镜学会建议结直肠ESD适应证为可疑黏膜下深浸润病变，如腺管不规则或凹陷性病变，尤其是>20 mm的病变或直肠病变；或不能用EMR完全切除的病变[9]。由此可见，目前国内外指南关于采用ESD对结直肠病变进行处理的适应证相对统一，术前可运用放大内镜、窄带成像、染色内镜等综合评估病变性质及浸润深度，ESD尤其适用于大

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直径、黏膜下深浸润及EMR难以切除的病变。

二、操作技术

1. 标准ESD：标准ESD又称为传统ESD（conventional ESD），主要步骤包括标记病变范围，黏膜下注射溶液使黏膜隆起，使用电刀切开病灶周边，逐渐剥离黏膜下层，直至病变完全切除。操作过程中，需充分利用重力及黏膜张力的牵引，充分暴露视野，实现病变的安全切除。充分视野暴露及黏膜下剥离是标准ESD操作的难点。

2. 口袋法：口袋法ESD（pocket-creation method of ESD）是于2014年由日本Hayashi等[10]发明的ESD新方法，具体过程为黏膜下注射后首先在病变的一侧划开一小部分黏膜，在黏膜下层中使用小口径锥形透明帽制作口袋，沿口袋开口在黏膜下向病变对侧进行剥离，然后分别切开病变其余两侧的黏膜，从而完整地切除病变。口袋法ESD优势：（1）在剥离病变的过程中始终保持肌层在视野内，减少损伤；（2）保持黏膜下注射液不分散，有助于完整切除较大的病变；（3）对跨皱襞、游离或转角部位等较困难的结肠病变仍可保持良好视野。可提高病变的完全切除率及切缘阴性率，减少并发症发生。Takezawa等[11]在543处结肠病变中比较了口袋法和标准ESD。口袋法整块切除率和R0切除率均高于标准法（100%比96%，91%比85%），且病变解剖速度明显高于标准ESD，而两者并发症无明显差异。Pei等[12]对5项研究共1 481例患者进行meta分析显示，与标准ESD法相比，口袋法ESD有更高的R0切除率（93.5%比78.1%）、更高整块切除率（99.8%比92.8%），及更短手术时间和更低的总体不良事件发生率（4.4%比6.6%）。口袋法解决了标准ESD视野暴露不充分的问题，可能成为标准ESD的替代方法，但长期疗效还需进一步研究明确。

3. 隧道法：隧道内镜技术最初应用于经口内镜下肌切开术治疗食管贲门失弛缓症，适应证逐渐扩大至治疗黏膜下及黏膜层病变的切除[13]。内镜黏膜下隧道剥离术（endoscopic submucosal tunnel dissection，ESTD）不同于标准ESD，黏膜下注射后不先行环病变切开黏膜，而是首先标记病变的口侧及肛侧，分别在口侧及肛侧行弧形切开，再从肛侧切口剥离黏膜下层，建立黏膜下隧道，直至口侧，最后切开病灶左右两侧的黏膜完整切除病变[14]。与标准ESD相比，ESTD在隧道内视野清晰，可减少穿孔及出血的发生，更容易靠近固有肌层提高肿物的垂直切缘阴性率。Zou等[15]通过倾向得分匹配法比较了50例直肠LST行标准ESD与ESTD疗效及安全性，结果显示ESTD组病变解剖速度、整块切除率高于ESD组，且不良事件发生率更低。Cecinato等[16]分析了25例ESTD切除直径>40 mm的结直肠病变的临床结局，也得出相似结论，ESTD实现了较高的整块切除率且切除速度更快。对于直径较大或环周形LST或可应用双隧道法，可起到更好的支撑作用防止病变坍塌实现病变的整块切除[17-18]。因此对于更大直径病变尤其是环周形病变，相较于标准ESD，ESTD具有更大的优势。

4. 水下法：水下ESD（underwater ESD），是指通过向肠腔内注射盐水而非充气进行ESD的方法。Nagata[19]报道了24例水下ESD切除结直肠肿瘤，病变中位直径为30 mm，所有病变实现整块切除，无严重不良事件发生。肠腔内盐水不仅可提供更清晰的视野，且盐水的“浮力效应”有助于打开黏膜瓣，使黏膜下层充分显露，提供更好的黏膜下层牵引力，更安全有效切除病变，尤其适合于体积大、严重黏膜下层纤维化或手术和放疗后复发的病变[20-21]。此外，由于接触盐水，操作过程中的热效应可降低，可能减少术后电凝综合征及迟发性穿孔的发生。

5. 混合ESD：混合ESD（hybrid ESD，ESD-H）又称为简化ESD（simplified ESD）或带圈套器的ESD（ESD with snaring，ESD-S）[22]，为1986年Hirao等[23]在早期胃癌切除中首次使用。与标准ESD不同的是，混合ESD是进行部分黏膜下层剥离，然后应用圈套器将病灶全部圈套电凝切除，从而实现病变的整块切除。对于黏膜下层严重纤维化、操作性差的病灶，混合ESD可作为标准ESD的补救治疗[24]。多项研究及meta分析显示，混合ESD可缩短手术时间，且不会显著增加不良事件发生率，但由于圈套器直径有限，对于直径>30 mm的病灶，混合ESD整块切除率、R0切除率明显低于标准ESD[25-26]。Kang等[27]回顾性分析了混合ESD治疗早期结直肠癌的远期结局，发现混合ESD复发率较标准ESD高，非整块切除是复发的独立危险因素，混合ESD复发率高可能与作为补救治疗、内镜医师经验不足有关，还需要更多随机对照研究进一步明确。因此，对于直径20~30 mm的病变，ESD操作经验较少的内镜医师而言，混合ESD是有效、安全的选择。

6. 牵引辅助下ESD：牵引辅助下ESD（traction-assisted endoscopic submucosal dissection，T-ESD）可通过直接牵引病变黏膜，充分暴露黏膜下层手术视野，为黏膜下层提供足够的组织张力，降低手术难度。目前报道的牵引方法包括：外钳法、夹线法、SO夹法、止血夹-圈套器法、磁力牵引法、双内镜技术等[28-34]。近期，Liu等[35]报道了一种新型牵引装置，由三个夹子和一根橡皮筋组成，在手术过程中可通过活检通道，无须将牵引装置重新置入内镜，减少手术时间及不良事件发生。对于T-ESD的应用局限于单中心研究，尚无对不同牵引方式进行横向比较的研究。不同牵引方式具有不同优缺点，应根据病变解剖位置、大小及内镜医师操作习惯进行选择[36]。

三、有效性

国内外多项研究证实了ESD的有效性。一项全球性研究纳入97个研究共18 764处结直肠病变的系统评价研究显示，标准ESD的R0切除率为82.9%，整块切除率为91.0%，非亚洲国家明显低于亚洲国家[37]。一项大型比较性荟萃分析显示，与EMR相比，ESD整块切除率（89%比47%）、完全切除率（82%比56%）更高，水平切缘阳性率更低（3%比14%）[38]。多项研究报道ESD治疗大型扁平结直肠病变（直径≥10 cm）、结直肠术后残留或局部复发性病变

以及炎症性肠病相关结直肠肿瘤均是有效、安全的[39-43]。远期疗效方面，研究显示，ESD 总体复发率为 1%~2%[8,44-45]。复发的危险因素包括直肠病变、直径≥4 cm 病变、非整块切除病变及水平切缘阳性病变[46-47]。最近一项 meta 分析总结了 ESD 的长期疗效，ESD 治疗后五年总体生存率和疾病特异性生存率分别为 89.6%~95.4% 和 99.1%~99.7%，异时性肿瘤发生率为 0.22%~1.1%[48]。良好的长期预后结局表明 ESD 可成为结直肠上皮肿瘤的标准治疗方法。

然而目前对于 ESD 非治愈性切除的定义、非治愈性切除的早期结直肠癌患者的后续治疗策略仍存在争议。具有淋巴结转移风险的病变被认为是非治愈性切除，按照目前非治愈性切除的定义，文献显示仅 14% 的患者发现存在淋巴结转移，相当一部分患者追加了不必要的手术。Tamaru 等[49]研究显示仅随访观察组五年总体生存率明显低于追加手术组，强调追加手术的必要性。而 Li 等[50]研究分析了 ESD 非治愈性切除患者的长期结局，发现追加手术组局部及转移复发率均低于仅随访观察组，但两者五年疾病特异性生存率无明显差异。一项多中心回顾性研究也得出类似结论，观察组和手术组肿瘤复发率和疾病特异性生存率无明显差异（中位随访时间 30 个月），对于年龄较大的患者，不追加手术可能是可行的选择[51]。因此，对于早期结直肠癌淋巴结转移的危险因素、治愈性切除的定义还需要进一步研究。对于非治愈性切除患者治疗，应综合考虑患者年龄、合并疾病、意愿、预期寿命及淋巴结转移的具体风险，进一步制定危险分层指导后续诊疗决策。

四、并发症

ESD 术后并发症包括出血、穿孔、电凝综合征及狭窄。出血无确切定义，多数研究将血红蛋白下降≥2 g/dL 或需要输血或内镜/手术干预定义为出血[7]。出血可分为术中出血、术后 24 h 内出血和术后迟发性出血。文献报道结直肠 ESD 相关出血率为 0.5%~9.5%[47,52-54]。术后出血的危险因素包括较大病灶（≥30 mm）、直肠位置、腺癌类型、抗栓药物使用等[54-56]。也有研究认为大病灶、抗血小板药物使用与术后出血无明显相关性，还需高质量、前瞻性研究进一步明确[57-58]。对于出血的防治，术前应评估危险因素，术中应仔细对黏膜下血管及创面渗血部位进行预防性电凝处理，可预防性闭合创面或采用止血材料覆盖创面，通过减少肠道内容物对创面的刺激而加速愈合，术后应注意观察患者症状以及时发现出血[59-62]。由于结直肠壁薄、空间狭窄，结直肠 ESD 穿孔率高，可引起严重并发症。穿孔定义为肠壁的完全缺损，分为术中穿孔和术后穿孔。文献报道结直肠 ESD 相关穿孔率为 2.0%~10.7%[7]，危险因素包括较大病灶（≥50 mm）、结肠位置、黏膜下层纤维化、内镜医师经验不足等[63-65]。随着 ESD 衍生技术的发展，多项研究显示牵引辅助 ESD、口袋 ESD 可明显缩短手术时间，降低穿孔发生率。对于穿孔的治疗，术中发生的小穿孔可通过术中止血夹夹闭、术后禁食抗生素应用及充分引流进行处理，较大的穿孔则需要进行缝合[11,63,66-68]。若缝合失败或术后出现腹膜炎等表现则应立即行急诊外科手术[69]。电凝综合征是指 ESD 术中因电凝导致肠壁固有肌层或浆膜层透壁性损伤的炎性反应综合征。临床表现为腹痛、腹膜刺激征，可伴有发热、白细胞或 C 反应蛋白升高，因与穿孔的临床表现相似，诊断时需行腹部影像学排除穿孔[70]。既往研究报道 ESD 术后电凝综合征发生率为 4.7%~14.2%[71-73]。危险因素包括高龄、女性、直径≥40 mm、盲肠位置、高焦耳热能、肌层损伤、黏膜下纤维化、操作时间过长等[73-76]。预防性使用抗生素和预防性夹闭创面对电凝综合征的预防作用仍存在争议[71,77-78]，从本中心的经验来看，预防性使用抗生素并不能减少电凝综合征的发生，但是多数电凝综合征患者可通过禁食、补液、抗生素等治疗后好转，预后良好，极少数患者可出现迟发性穿孔[7]，需要密切关注患者症状及体征，及时进行影像学检查，避免保守治疗无效时发生迟发性穿孔、感染性休克等并发症。另一并发症为术后狭窄，定义为 ESD 术后复查肠镜时普通内镜无法顺利通过肠腔。关于结直肠 ESD 术后狭窄的报道较少。两项研究显示环周病变（>90%）术后狭窄发生率分别为 11%、52.2%[79-80]。大部分术后狭窄可通过多次内镜球囊扩张治疗后改善，改善不佳者可考虑行内镜切开术[81-82]。口服或局部应用糖皮质激素预防狭窄是可尝试的方法，但有效性仍需前瞻性研究证实。

五、总结

ESD 治疗早期结直肠癌及癌前病变可获得较好的疗效，尤其是对于大直径扁平型病变。ESD 相关新技术可显著缩短手术时间，减少并发症发生。不同国家及地区应不断优化 ESD 操作过程，增加操作经验，提高 ESD 的治愈性切除率。未来研究应致力于明确 ESD 非治愈性切除的危险分层，规范 ESD 治疗的流程、方法及术后管理。

利益冲突　所有作者声明不存在利益冲突

参　考　文　献

[1] Sung H, Ferlay J, Siegel RL, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries[J]. CA Cancer J Clin, 2021, 71(3):209-249. DOI: 10.3322/caac.21660.

[2] Cao W, Chen HD, Yu YW, et al. Changing profiles of cancer burden worldwide and in China: a secondary analysis of the global cancer statistics 2020[J]. Chin Med J (Engl), 2021, 134(7):783-791. DOI: 10.1097/CM9.0000000000001474.

[3] Miller KD, Nogueira L, Devasia T, et al. Cancer treatment and survivorship statistics, 2022[J]. CA Cancer J Clin, 2022, 72(5): 409-436. DOI: 10.3322/caac.21731.

[4] 国家消化系统疾病临床医学研究中心(上海), 中华医学会消化内镜学分会, 中国抗癌协会肿瘤内镜专业委员会, 等. 中国结直肠癌癌前病变和癌前状态处理策略专家共识[J]. 中华消化内镜杂志, 2022, 39(1):1-18. DOI: 10.3760/cma.j.cn321463-20211111-00661.

[5] 国家癌症中心中国结直肠癌筛查与早诊早治指南制定专家组. 中国结直肠癌筛查与早诊早治指南(2020,北京)[J]. 中华肿瘤杂志, 2021, 43(1): 16-38. DOI: 10.3760/cma.j.cn112152-20210105-00010.

[6] Yahagi N. Development of colorectal endoscopic submucosal dissection[J]. Dig Endosc, 2022, 34 Suppl 2: 95-98. DOI: 10.1111/den.14229.

[7] Tanaka S, Kashida H, Saito Y, et al. Japan Gastroenterological Endoscopy Society guidelines for colorectal endoscopic submucosal dissection/endoscopic mucosal resection[J]. Dig Endosc, 2020, 32(2):219-239. DOI: 10.1111/den.13545.

[8] Draganov PV, Wang AY, Othman MO, et al. AGA institute clinical practice update: endoscopic submucosal dissection in the United States[J]. Clin Gastroenterol Hepatol, 2019, 17(1): 16-25.e1. DOI: 10.1016/j.cgh.2018.07.041.

[9] Pimentel-Nunes P, Libânio D, Bastiaansen B, et al. Endoscopic submucosal dissection for superficial gastrointestinal lesions: European Society of Gastrointestinal Endoscopy (ESGE) guideline - update 2022[J]. Endoscopy, 2022, 54(6):591-622. DOI: 10.1055/a-1811-7025.

[10] Hayashi Y, Sunada K, Takahashi H, et al. Pocket-creation method of endoscopic submucosal dissection to achieve en bloc resection of giant colorectal subpedunculated neoplastic lesions[J]. Endoscopy, 2014, 46 Suppl 1 UCTN: E421-422. DOI: 10.1055/s-0034-1377438.

[11] Takezawa T, Hayashi Y, Shinozaki S, et al. The pocket-creation method facilitates colonic endoscopic submucosal dissection (with video)[J]. Gastrointest Endosc, 2019, 89(5):1045-1053. DOI: 10.1016/j.gie.2019.01.022.

[12] Pei Q, Qiao H, Zhang M, et al. Pocket-creation method versus conventional method of endoscopic submucosal dissection for superficial colorectal neoplasms: a meta-analysis[J]. Gastrointest Endosc, 2021, 93(5): 1038-1046. e4. DOI: 10.1016/j.gie.2021.01.007.

[13] Tan Y, Lu J, Lv L, et al. Current status of endoscopic submucosal tunnel dissection for treatment of superficial gastrointestinal neoplastic lesions[J]. Expert Rev Gastroenterol Hepatol, 2020, 14(6): 453-462. DOI: 10.1080/17474124.2020.1766967.

[14] Yang JL, Gan T, Zhu LL, et al. Endoscopic submucosal tunnel dissection: a feasible solution for large superficial rectal neoplastic lesions[J]. Dis Colon Rectum, 2017, 60(8):866-871. DOI: 10.1097/DCR.0000000000000805.

[15] Zou J, Chai N, Linghu E, et al. Efficacy and safety of endoscopic submucosal tunnel dissection for rectal laterally spreading tumors[J]. Surg Endosc, 2021, 35(8): 4356-4362. DOI: 10.1007/s00464-020-07927-4.

[16] Cecinato P, Lucarini M, Azzolini F, et al. Endoscopic submucosal tunnel dissection vs conventional endoscopic submucosal dissection for large colorectal neoplasms: a single-centre retrospective study[J]. Tech Coloproctol, 2023, 27(4):317-323. DOI: 10.1007/s10151-022-02732-8.

[17] 黄思霖. 隧道内镜技术用于治疗消化道肿瘤的系列临床研究[D]. 广州:南方医科大学, 2017.

[18] Stasinos I, Toyonaga T, Suzuki N. Double-tunneling butterfly method for endoscopic submucosal dissection of extensive rectal neoplasms[J]. VideoGIE, 2020, 5(2): 80-85. DOI: 10.1016/j.vgie.2019.11.003.

[19] Nagata M. Usefulness of underwater endoscopic submucosal dissection in saline solution with a monopolar knife for colorectal tumors (with videos)[J]. Gastrointest Endosc, 2018, 87(5):1345-1353. DOI: 10.1016/j.gie.2017.11.032.

[20] Ramos-Zabala F, García-Mayor M, Domínguez-Pino A, et al. Combination of immersion in saline solution, pocket-creation method, water-jet hydrodissection, and hybrid knife "probe mode" simplifies endoscopic submucosal dissection in giant rectal polyp[J]. VideoGIE, 2019, 4(10): 478-480. DOI: 10.1016/j.vgie.2019.05.009.

[21] Mascarenhas A, Figueiredo N, Macedo D, et al. Underwater endoscopic submucosal dissection of a relapsing neoplastic colorectal lesion after surgery and radiotherapy: water to the rescue! [J]. Endoscopy, 2023, 55(S 01): E238-239. DOI: 10.1055/a-1965-3827.

[22] Byeon JS, Yang DH, Kim KJ, et al. Endoscopic submucosal dissection with or without snaring for colorectal neoplasms[J]. Gastrointest Endosc, 2011, 74(5):1075-1083. DOI: 10.1016/j.gie.2011.03.1248.

[23] Hirao M, Masuda K, Nakamura M. Endoscopic resection with local injection of HSE (ERHSE) in early gastric carcinomas[J]. Gan No Rinsho, 1986, 32(10):1180-1184.

[24] Okamoto K, Muguruma N, Kagemoto K, et al. Efficacy of hybrid endoscopic submucosal dissection (ESD) as a rescue treatment in difficult colorectal ESD cases[J]. Dig Endosc, 2017, 29 Suppl 2:45-52. DOI: 10.1111/den.12863.

[25] Okamoto Y, Oka S, Tanaka S, et al. Indications and outcomes of colorectal hybrid endoscopic submucosal dissection: a large multicenter 10-year study[J]. Surg Endosc, 2022, 36(3): 1894-1902. DOI: 10.1007/s00464-021-08471-5.

[26] McCarty TR, Bazarbashi AN, Thompson CC, et al. Hybrid endoscopic submucosal dissection (ESD) compared with conventional ESD for colorectal lesions: a systematic review and meta-analysis[J]. Endoscopy, 2021, 53(10): 1048-1058. DOI: 10.1055/a-1266-1855.

[27] Kang DU, Park JC, Hwang SW, et al. Long-term clinical outcomes of endoscopic submucosal dissection for colorectal neoplasia with or without the hybrid technique[J]. Colorectal Dis, 2020, 22(12):2008-2017. DOI: 10.1111/codi.15339.

[28] Imaeda H, Hosoe N, Ida Y, et al. Novel technique of endoscopic submucosal dissection by using external forceps for early rectal cancer (with videos)[J]. Gastrointest Endosc, 2012, 75(6):1253-1257. DOI: 10.1016/j.gie.2012.02.018.

[29] Yamasaki Y, Takeuchi Y, Uedo N, et al. Efficacy of traction-assisted colorectal endoscopic submucosal dissection using a clip-and-thread technique: a prospective randomized study[J]. Dig Endosc, 2018, 30(4): 467-476. DOI: 10.1111/den.13036.

[30] Fujinami H, Teramoto A, Takahashi S, et al. Effectiveness of S-O clip-assisted colorectal endoscopic submucosal dissection [J]. J Clin Med, 2021, 11(1):141. DOI: 10.3390/jcm11010141.

[31] Yamada S, Doyama H, Ota R, et al. Impact of the clip and snare method using the prelooping technique for colorectal endoscopic submucosal dissection[J]. Endoscopy, 2016, 48(3): 281-285. DOI: 10.1055/s-0034-1393241.

[32] Matsuzaki I, Hattori M, Yamauchi H, et al. Magnetic anchor-guided endoscopic submucosal dissection for colorectal tumors (with video)[J]. Surg Endosc, 2020, 34(2): 1012-1018. DOI: 10.1007/s00464-019-07127-9.

[33] Ye L, Yuan X, Pang M, et al. Magnetic bead-assisted endoscopic submucosal dissection: a gravity-based traction method for treating large superficial colorectal tumors[J]. Surg Endosc, 2019, 33(6): 2034-2041. DOI: 10.1007/s00464-019-06799-7.

[34] Chou CK, Tsai KF, Tseng CH, et al. Novel colorectal endoscopic submucosal dissection with double-endoscope and snare-based traction[J]. Dis Colon Rectum, 2022, 65(7): 936-945. DOI: 10.1097/DCR.0000000000002355.

[35] Liu X, Yu X, Wang Y, et al. Effectiveness of a novel traction device in endoscopic submucosal dissection for colorectal lesions[J]. Surg Endosc, 2022, 36(11): 8021-8029. DOI: 10.1007/s00464-022-09228-4.

[36] Abe S, Wu S, Ego M, et al. Efficacy of current traction techniques for endoscopic submucosal dissection[J]. Gut Liver, 2020, 14(6):673-684. DOI: 10.5009/gnl19266.

[37] Fuccio L, Hassan C, Ponchon T, et al. Clinical outcomes after endoscopic submucosal dissection for colorectal neoplasia: a systematic review and meta-analysis[J]. Gastrointest Endosc, 2017, 86(1):74-86.e17. DOI: 10.1016/j.gie.2017.02.024.

[38] Lim XC, Nistala K, Ng CH, et al. Endoscopic submucosal dissection vs endoscopic mucosal resection for colorectal polyps: a meta-analysis and meta-regression with single arm analysis[J]. World J Gastroenterol, 2021, 27(25): 3925-3939. DOI: 10.3748/wjg.v27.i25.3925.

[39] Lu J, Tan Y, Liu D, et al. Endoscopic submucosal dissection for rectal-sigmoid laterally spreading tumors ⩾10 cm: an analysis of 10 cases[J]. Transl Cancer Res, 2021, 10(2): 867-875. DOI: 10.21037/tcr-20-2659.

[40] Chiba H, Ohata K, Tachikawa J, et al. The feasibility of endoscopic submucosal dissection for colorectal lesions larger than 10 cm[J]. Surg Endosc, 2022, 36(7): 5348-5355. DOI: 10.1007/s00464-021-08916-x.

[41] Tanaka H, Oka S, Tanaka S, et al. Salvage endoscopic submucosal dissection for local residual/recurrent colorectal tumor after endoscopic resection: large multicenter 10-year study[J]. Dig Endosc, 2021, 33(4): 608-615. DOI: 10.1111/den.13797.

[42] Akiyama S, Hamdeh S, Sakamoto T, et al. The feasibility, safety, and long-term outcomes of endoscopic submucosal dissection for colorectal neoplasia in patients with inflammatory bowel disease: a systematic review and meta-analysis[J]. J Clin Gastroenterol, 2023, 57(7): 721-730. DOI: 10.1097/MCG.0000000000001740.

[43] Lightner AL, Vaidya P, Allende D, et al. Endoscopic submucosal dissection is safe and feasible, allowing for ongoing surveillance and organ preservation in patients with inflammatory bowel disease[J]. Colorectal Dis, 2021, 23(8): 2100-2107. DOI: 10.1111/codi.15746.

[44] Yamada M, Saito Y, Takamaru H, et al. Long-term clinical outcomes of endoscopic submucosal dissection for colorectal neoplasms in 423 cases: a retrospective study[J]. Endoscopy, 2017, 49(3):233-242. DOI: 10.1055/s-0042-124366.

[45] Ohata K, Kobayashi N, Sakai E, et al. Long-term outcomes after endoscopic submucosal dissection for large colorectal epithelial neoplasms: a prospective, multicenter, cohort trial from Japan[J]. Gastroenterology, 2022, 163(5): 1423-1434. e2. DOI: 10.1053/j.gastro.2022.07.002.

[46] Oka S, Tanaka S, Saito Y, et al. Local recurrence after endoscopic resection for large colorectal neoplasia: a multicenter prospective study in Japan[J]. Am J Gastroenterol, 2015, 110(5):697-707. DOI: 10.1038/ajg.2015.96.

[47] Shigita K, Oka S, Tanaka S, et al. Long-term outcomes after endoscopic submucosal dissection for superficial colorectal tumors[J]. Gastrointest Endosc, 2017, 85(3): 546-553. DOI: 10.1016/j.gie.2016.07.044.

[48] Nishizawa T, Ueda T, Ebinuma H, et al. Long-term outcomes of endoscopic submucosal dissection for colorectal epithelial neoplasms: a systematic review[J]. Cancers (Basel), 2022, 15(1):239. DOI: 10.3390/cancers15010239.

[49] Tamaru Y, Oka S, Tanaka S, et al. Long-term outcomes after treatment for T1 colorectal carcinoma: a multicenter retrospective cohort study of Hiroshima GI Endoscopy Research Group[J]. J Gastroenterol, 2017, 52(11): 1169-1179. DOI: 10.1007/s00535-017-1318-1.

[50] Li J, Huang F, Cheng P, et al. Patient outcomes after non-curative endoscopic submucosal dissection for early colorectal cancer: a single-center, retrospective cohort study [J]. Transl Cancer Res, 2021, 10(12): 5123-5132. DOI: 10.21037/tcr-21-1545.

[51] Spadaccini M, Bourke MJ, Maselli R, et al. Clinical outcome of non-curative endoscopic submucosal dissection for early colorectal cancer[J]. Gut, 2022 : gutjnl-2020-323897 [pii]. DOI: 10.1136/gutjnl-2020-323897.

[52] Boda K, Oka S, Tanaka S, et al. Clinical outcomes of endoscopic submucosal dissection for colorectal tumors: a large multicenter retrospective study from the Hiroshima GI Endoscopy Research Group[J]. Gastrointest Endosc, 2018, 87(3):714-722. DOI: 10.1016/j.gie.2017.05.051.

[53] Ninomiya Y, Oka S, Tanaka S, et al. Risk of bleeding after endoscopic submucosal dissection for colorectal tumors in patients with continued use of low-dose aspirin[J]. J Gastroenterol, 2015, 50(10): 1041-1046. DOI: 10.1007/s00535-015-1053-4.

[54] Okamoto K, Watanabe T, Komeda Y, et al. Risk factors for postoperative bleeding in endoscopic submucosal dissection of colorectal tumors[J]. Oncology, 2017, 93 Suppl 1:35-42. DOI: 10.1159/000481228.

[55] Seo M, Song EM, Cho JW, et al. A risk-scoring model for the prediction of delayed bleeding after colorectal endoscopic submucosal dissection[J]. Gastrointest Endosc, 2019, 89(5): 990-998.e2. DOI: 10.1016/j.gie.2018.11.029.

[56] Chiba H, Ohata K, Tachikawa J, et al. Delayed bleeding after colorectal endoscopic submucosal dissection: when is emergency colonoscopy needed?[J]. Dig Dis Sci, 2019, 64(3): 880-887. DOI: 10.1007/s10620-018-5310-2.

[57] Harada H, Nakahara R, Murakami D, et al. The effect of anticoagulants on delayed bleeding after colorectal endoscopic submucosal dissection[J]. Surg Endosc, 2020, 34(8): 3330-3337. DOI: 10.1007/s00464-019-07101-5.

[58] Terasaki M, Tanaka S, Shigita K, et al. Risk factors for delayed bleeding after endoscopic submucosal dissection for colorectal neoplasms[J]. Int J Colorectal Dis, 2014, 29(7): 877-882. DOI: 10.1007/s00384-014-1901-3.

[59] 芦家明, 于红刚. 结直肠内镜黏膜下剥离术后不良事件的危险因素分析与诊疗进展[J]. 武汉大学学报(医学版), 2023, 44(12): 1532-1537. DOI: 10.14188/j. 1671-8852. 2022.0226.

[60] Kobara H, Tada N, Fujihara S, et al. Clinical and technical outcomes of endoscopic closure of postendoscopic submucosal dissection defects: Literature review over one decade[J]. Dig Endosc, 2023, 35(2):216-231. DOI: 10.1111/den.14397.

[61] Martines G, Picciariello A, Dibra R, et al. Efficacy of cyanoacrylate in the prevention of delayed bleeding after endoscopic mucosal resection of large colorectal polyps: a pilot study[J]. Int J Colorectal Dis, 2020, 35(11): 2141-2144. DOI: 10.1007/s00384-020-03678-9.

[62] Subramaniam S, Kandiah K, Chedgy F, et al. A novel self-assembling peptide for hemostasis during endoscopic submucosal dissection: a randomized controlled trial[J]. Endoscopy, 2021, 53(1):27-35. DOI: 10.1055/a-1198-0558.

[63] Takamaru H, Saito Y, Yamada M, et al. Clinical impact of endoscopic clip closure of perforations during endoscopic submucosal dissection for colorectal tumors[J]. Gastrointest Endosc, 2016, 84(3): 494-502. e1. DOI: 10.1016/j. gie. 2016. 01.014.

[64] Imai K, Hotta K, Ito S, et al. A risk-prediction model for en bloc resection failure or perforation during endoscopic submucosal dissection of colorectal neoplasms[J]. Dig Endosc, 2020, 32(6):932-939. DOI: 10.1111/den.13619.

[65] Hong SN, Byeon JS, Lee BI, et al. Prediction model and risk score for perforation in patients undergoing colorectal endoscopic submucosal dissection[J]. Gastrointest Endosc, 2016, 84(1):98-108. DOI: 10.1016/j.gie.2015.12.011.

[66] Lopimpisuth C, Simons M, Akshintala VS, et al. Traction-assisted endoscopic submucosal dissection reduces procedure time and risk of serious adverse events: a systematic review and meta-analysis[J]. Surg Endosc, 2022, 36(3):1775-1788. DOI: 10.1007/s00464-021-08452-8.

[67] Yoshida N, Naito Y, Yasuda R, et al. The efficacy of the pocket-creation method for cases with severe fibrosis in colorectal endoscopic submucosal dissection[J]. Endosc Int Open, 2018, 6(8):E975-983. DOI: 10.1055/a-0593-5818.

[68] 李冰, 周平红, 姚礼庆, 等. 内镜黏膜下剥离治疗结直肠黏膜病变术后肛管引流减压疗效分析[J]. 中国实用外科杂志, 2017, 37(7): 802-805. DOI: 10.19538/j. cjps. issn1005-2208.2017.07.26.

[69] Misumi Y, Nonaka K. Prevention and management of complications and education in endoscopic submucosal dissection[J]. J Clin Med, 2021, 10(11): 2511. DOI: 10.3390/jcm10112511.

[70] Qiu J, Ouyang Q, Zhang Y, et al. Post-endoscopic submucosal dissection electrocoagulation syndrome: a clinical overview[J]. Expert Rev Gastroenterol Hepatol, 2022, 16(11-12): 1079-1087. DOI: 10.1080/17474124.2022.2156858.

[71] Shichijo S, Takeuchi Y, Shimodate Y, et al. Performance of perioperative antibiotics against post-endoscopic submucosal dissection coagulation syndrome: a multicenter randomized controlled trial[J]. Gastrointest Endosc, 2022, 95(2): 349-359. DOI: 10.1016/j.gie.2021.08.025.

[72] Arimoto J, Higurashi T, Kato S, et al. Risk factors for post-colorectal endoscopic submucosal dissection (ESD) coagulation syndrome: a multicenter, prospective, observational study[J]. Endosc Int Open, 2018, 6(3): E342-349. DOI: 10.1055/s-0044-101451.

[73] Kim SJ, Kim SY, Lee J. Prognosis and risk factors of electrocoagulation syndrome after endoscopic submucosal dissection in the colon and rectum. Large cohort study[J]. Surg Endosc, 2022, 36(8): 6243-6249. DOI: 10.1007/s00464-022-09060-w.

[74] Omori T, Funasaka K, Horiguchi N, et al. Injury to the muscle layer, increasing the risk of post-colorectal endoscopic submucosal dissection electrocoagulation syndrome[J]. J Gastroenterol Hepatol, 2023, 38(1): 87-93. DOI: 10.1111/jgh.16021.

[75] Ochi M, Kawagoe R, Kamoshida T, et al. High total Joule heat increases the risk of post-endoscopic submucosal dissection electrocoagulation syndrome after colorectal endoscopic submucosal dissection[J]. World J Gastroenterol, 2021, 27(38): 6442-6452. DOI: 10.3748/wjg.v27.i38.6442.

[76] Ito S, Hotta K, Imai K, et al. Risk factors of post-endoscopic submucosal dissection electrocoagulation syndrome for colorectal neoplasm[J]. J Gastroenterol Hepatol, 2018, 33(12): 2001-2006. DOI: 10.1111/jgh.14302.

[77] Lee SP, Sung IK, Kim JH, et al. A randomized controlled trial of prophylactic antibiotics in the prevention of electrocoagulation syndrome after colorectal endoscopic submucosal dissection[J]. Gastrointest Endosc, 2017, 86(2): 349-357.e2. DOI: 10.1016/j.gie.2016.11.022.

[78] Nomura S, Shimura T, Katano T, et al. A multicenter, single-blind randomized controlled trial of endoscopic clipping closure for preventing coagulation syndrome after colorectal endoscopic submucosal dissection[J]. Gastrointest Endosc, 2020, 91(4): 859-867. e1. DOI: 10.1016/j.gie.2019.11.030.

[79] Hayashi T, Kudo SE, Miyachi H, et al. Management and risk factor of stenosis after endoscopic submucosal dissection for colorectal neoplasms[J]. Gastrointest Endosc, 2017, 86(2): 358-369. DOI: 10.1016/j.gie.2016.11.032.

[80] Ohara Y, Toyonaga T, Tanaka S, et al. Risk of stricture after endoscopic submucosal dissection for large rectal neoplasms [J]. Endoscopy, 2016, 48(1): 62-70. DOI: 10.1055/s-0034-1392514.

[81] Biraima M, Adamina M, Jost R, et al. Long-term results of endoscopic balloon dilation for treatment of colorectal anastomotic stenosis[J]. Surg Endosc, 2016, 30(10): 4432-4437. DOI: 10.1007/s00464-016-4762-8.

[82] Liang C, Tan Y, Lu J, et al. Endoscopic incision for treatment of benign gastrointestinal strictures[J]. Expert Rev Gastroenterol Hepatol, 2020, 14(6): 445-452. DOI: 10.1080/17474124.2020.1766966.