电子、语音版

·综述·

内镜经鼻颅底重建技术研究进展

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摘 要：近年来，随着内镜设备和技术的发展，内镜经鼻颅底外科技术在临床得到了更为广泛的应用，术后脑脊液漏是其主要的并发症之一，是制约内镜经鼻颅底外科技术发展的重要因素。确切牢靠的颅底重建技术可有效降低术后脑脊液漏的发生，提高内镜经鼻颅底外科手术的效果。该文就颅底重建的材料和技术方法及其进展进行综述。

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关键词：内镜经鼻手术；颅底重建；脑脊液漏

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Advances in endoscopic transnasal skull base reconstruction

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Abstract: With the development of endoscopic equipment and technology in recent years, endoscopic transnasal skull base surgery has been more widely used in clinical practice. Postoperative cerebrospinal fluid leak is one of the main complications of this technique and is an important factor restricting the development of endoscopic transnasal skull base surgery. Accurate and reliable skull base reconstruction technique can effectively reduce postoperative cerebrospinal fluid leak and improve the effect of endoscopic transnasal skull base surgery. This article reviews the materials, technical methods, and related advances in skull base reconstruction.

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Keywords: endoscopic transnasal surgery; skull base reconstruction; cerebrospinal fluid leak

自 1992 年 Jankowski 等[1]首次报道内镜经鼻入路切除垂体腺瘤以来，内镜颅底外科技术的发展日新月异。与经颅入路相比较，内镜经鼻切除颅底肿瘤具有微创、早期视神经减压、对血管和脑组织骚扰小等优点[2-3]。随着内镜设备和技术的发展，使得内镜扩大经鼻入路切除鞍区巨大侵袭性垂体腺瘤以及鞍旁各种颅底病变成为可能[4]。而术后脑脊液漏是内镜经鼻和扩大经鼻常见的并发症之一，文献报道，内镜经鼻术后脑脊液露的发生率可达 5%~15%[5]。若处理不当，可导致颅内感染、颅内积气及需再次手术等并发症，严重者可致死亡[6-7]。有效的颅底重建技术对预防术后脑脊液漏至关重要。颅底重建的成败受到多种因素的影响，如术中脑脊液漏的发生及其分级、患者因素（肥胖伴高 BMI 指数等）和术者经验等[8-9]。

内镜经鼻及其扩大入路，术中去除颅底骨质，直达硬脑膜外甚至硬脑膜下，造成了一定程度的骨缺损及硬脑

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膜缺损,进而导致不同程度的脑脊液漏,颅底重建的目的主要是利用多种材料来分隔和封闭颅底,预防术后脑脊液漏的发生和颅内感染。随着内镜器械的发展以及多种新型材料的开发利用,颅底重建技术也有了大幅度的进步。现将当前颅底重建的材料和方法综述如下。

1　内镜经鼻蝶颅底重建材料

1.1　游离移植物

游离移植物可分为非细胞性游离移植物和细胞性游离移植物[10],非细胞性游离移植物主要由非细胞性真皮基质组成,如人工硬脑膜,可以用在缺损的内层或者外层,内层即硬脑膜下层,移植物放在脑组织与硬脑膜之间;外层即硬脑膜外层则放在骨性颅底与硬脑膜之间。胶原人工硬脑膜常覆盖颅底硬脑膜缺损的内层即硬脑膜下,较之其他移植物其具有更好的贴敷性和密闭性[11]。非细胞性游离移植物放置时每一边都应超过硬脑膜缘5~10 mm,以便消除死腔减少脑脊液漏。同时如果放在硬脑膜外时务必完全去除位于其下的黏膜,以防形成黏膜囊肿。细胞性游离移植物如鼻腔黏膜、脂肪、筋膜和肌肉等。游离鼻腔黏膜可来自鼻腔多个部位,一般取下鼻甲、中鼻甲或鼻中隔黏膜,置入颅底缺损处硬脑膜外,贴敷于颅底硬脑膜或者骨质外,常用于较小的颅底缺损。自体游离脂肪组织具有疏水性,且容易与周围组织粘连,常置入缺损处硬脑膜下,但是脂肪容易被吸收或者移位,对于大的颅底缺损易脱入颅内[12],从而造成颅底重建失败。大腿外侧阔筋膜容易获取,可取面积大,坚固似硬脑膜,愈合能力好,常与其他移植物合并用于颅底重建中[13],但有引起患者疼痛、皮神经感觉迟钝、局部肌肉脱垂等并发症[14]。临床有时候会被非细胞性游离移植物取代,如胶原人工硬脑膜等[15]。

1.2　带血管的移植瓣

带血管的移植瓣自带血供,保留了与供体部位的连接(蒂),可通过滑动、翻转动作转移至邻近的受体部位。较之游离移植物,应用带血管的移植瓣进行颅底重建,具有恢复快,愈合好的优势。带血管的移植瓣可分为鼻内瓣和鼻外瓣。鼻内瓣典型的代表是鼻中隔黏膜瓣(又称Hadad-Bassagasteguy瓣)由Hadad团队[16]2006年最先报道。带蒂鼻中隔黏膜瓣的应用,明显降低了内镜经蝶术后脑脊液漏的发生,极大地促进了内镜经鼻颅底外科的发展。紧随鼻中隔黏膜瓣之后,文献报道了许多不同的或者改进的鼻内血管瓣[17],包括整合下鼻甲的鼻中隔黏膜瓣[18]和鼻中隔翻转瓣(Septal flip-flap)[19]。此两瓣常用于大的颅底缺损,前者整块获取下鼻甲、下鼻道、鼻底和鼻中隔黏膜,包括下鼻甲动脉和鼻中隔动脉2支供血动脉。后者基于对侧筛动脉的隔支,通过获取对侧鼻中隔黏膜骨膜,尽管需要去除鼻中隔上方,但其可以更大面积的覆盖前颅底前面的缺损,覆盖的缺损面积可达2~6 cm^2,颅底重建成功率可达96%。除带蒂鼻中隔黏膜瓣及其改进的瓣以外,尚有中鼻甲后部带蒂黏膜瓣[20]以及改进的中鼻甲后部带蒂黏膜瓣[21]和下鼻甲后部带蒂黏膜瓣[22]。中鼻甲后部带蒂黏膜瓣适合修补筛板、筛凹、蝶骨平台或者鞍结节的漏口,血供来自蝶腭动脉的中鼻甲分支,黏膜瓣的表面积约5.6 cm^2。此瓣的主要缺陷是游离过程技术难度大。Pistochini等[21]最近报道了改进的中鼻甲后部带蒂黏膜瓣,平均面积约5.33 cm^2。该瓣可用于上斜坡缺损的重建,斜坡覆盖率达70.66%。优点是上皮再生速度快,愈合快,并发症低;缺点是技术难度大,制作耗时。下鼻甲后部带蒂黏膜瓣血供来自蝶腭动脉分支,下鼻甲动脉—鼻后外侧动脉的一个终末支[22]。制作时应首先辨认蝶腭孔,沿其远端走行方向辨认鼻后外侧动脉。面积约4.97 cm^2。该瓣可修补大多数颅底缺损,缺点主要是术后下鼻甲表面结痂,下鼻甲萎缩或者既往曾行下鼻甲切除者属于相对禁忌证。

鼻内带蒂血管瓣可满足大多数颅底重建的需要,但是如果颅底缺损过大,或者缺损部位离鼻内瓣较远,以及患者既往曾行放射治疗等,则需要应用鼻外瓣(又称颅周瓣)重建颅底。常见的鼻外血管瓣有经额骨骨膜瓣和颞顶筋膜瓣。经额骨膜瓣血供来自眶上动脉和滑车上动脉,可取面积大,可通过传统的冠状头皮切口获取,也可通过内镜技术获取[23-24],获取的骨膜瓣常通过鼻根点上方开骨窗导入鼻腔内[23]或者经眶眼睑入路导入鼻腔[24]。Bresler等[25]报道了应用内镜辅助的旁正中额瓣成功修补了1例鼻窦鳞状细胞癌患者的顽固性脑脊液漏。颞顶筋膜瓣是常见的鼻外瓣,其血供来自颈外动脉的一终末支—颞浅动脉。该瓣蒂长,可旋转角度大,血供丰富,成活率高。在无法获取带蒂鼻中隔瓣时,颞顶筋膜瓣可作为理想的替代品用于中央颅底自筛板到斜坡的颅底缺损的修补重建或者侧颅底缺损的重建。制作时应注意勿损伤面神经分支,皮瓣通过颞下窝转移时注意不要损伤颌内动脉,对于颞浅动脉炎、颞叶外伤或者颞叶萎缩等患者不适合应用此瓣[26-27]。

2　内镜经鼻蝶颅底重建的方法

颅底重建的目的主要是修补硬脑膜缺损,防止术后脑脊液漏。术中硬脑膜缺损的大小以及由此而发生的脑脊液漏的程度对成功的颅底重建至关重要。Esposito等[8]将术中脑脊液漏分为4级(即kelly分级):0级,无脑脊液漏发生;1级,小的脑脊液渗漏,无或者有小的鞍膈缺损;2级,中等程度的脑脊液漏,有明显鞍膈缺损;3级,大的硬脑膜缺损,高流量的脑脊液漏,见于扩大经鼻蝶术中。影响颅底重建成功的因素很多,但其中最重要的是根据术中脑脊液漏的不同程度采取不同的重建方法,有效地降低术后脑脊液发生[28]。具体的方法有一般修复即单层修复、多层修复技术和颅底硬脑膜缝合技术。

2.1　一般修复技术

主要用于内镜经鼻蝶术中未见明确的脑脊液漏患者(Kelly分级为0级)[8]。瘤腔止血确切后,人工硬脑膜覆盖,生物蛋白胶封闭周边,外放置明胶海绵,继以膨胀海绵或者纳吸棉、凡士林纱条等填塞鼻腔。

2.2　多层修复技术

包括两种形式,一种是游离移植物多层修复技术,主要用于术中鞍膈蛛网膜菲薄,有隐性脑脊液漏风险,鞍膈表面有脑脊液渗漏或鞍膈蛛网膜有小的缺损,缺损<1 cm[29](Kelly分级为1级和2级)可供选择的颅底重建材料有人工硬脑膜、脂肪、阔筋膜、游离鼻腔黏膜和硬性支撑物(原位骨瓣、自体骨、游离的软骨等)[30]。游离移植物放置的顺序可以根据术中情况调整。一般情况下,人工硬脑膜置入硬脑膜缺损下,再置入脂肪组织,硬脑膜缺损外予以大腿阔筋膜、游离鼻腔黏膜或人工硬脑膜覆盖加固,此层外可根据情况覆盖硬性支撑物,最后用生物蛋白胶或者大腿肌肉浆封闭修补材料边缘,最外层覆盖明胶海绵或氧化再生纤维素。然后是球囊或者纱条支撑。"脂肪塞"技术[31]和"垫圈密封"技术[32]是文献报道的两种常用的多层游离物重建技术,前者是将脂肪组织当作颅内硬脑膜缺损下植入物,而后者是在硬脑膜缺损的移植物上放置硬性支撑物如自体骨或鼻中隔等固定在硬脑膜边缘以起到密闭作用。另一种多层重建形式是带血管蒂多层修复技术。适用于颅底硬脑膜或者蛛网膜缺损≥1 cm、涉及脑室、脑池的高流量脑脊液漏(Kelly分级为3级)[28-29,33]。可供选择的重建材料有前述的游离移植物和带血管蒂的组织瓣,带血管蒂组织瓣最常用的是带血管蒂的鼻中隔黏膜瓣[16],在无法获取带蒂鼻中隔瓣或者颅底缺损特别大的时候如前颅底、斜坡缺损或者二次手术,可应用其他带蒂组织瓣,如带蒂中鼻甲黏膜瓣、下鼻甲后部黏膜瓣和鼻腔外侧黏膜瓣[34],甚至颅周瓣[35]以及其与带血管蒂黏膜瓣联合应用[36]。带血管蒂组织瓣的多层重建技术与游离移植物多层重建大致相仿,第一层人工硬脑膜置入硬脑膜下,第二层可选择性置入脂肪组织、阔筋膜或硬性支撑物,也可直接放置带血管蒂的组织瓣,边缘用生物胶或者大腿肌肉浆封闭,最外层覆盖明胶海绵或氧化再生纤维素。Cavallo等[37]应用3F(fat, flap and flash)技术即脂肪、带蒂鼻中隔黏膜瓣、术后早期下床活动对25例内镜扩大经蝶进行颅底重建取得了良好的效果。

2.3　内镜经鼻颅底硬脑膜缝合技术

颅底多层重建技术的应用显著降低了内镜扩大经蝶术后脑脊液漏的发生,但是自体移植物以及带蒂血管组织瓣的获取不可避免会产生一些重建后的并发症,如供体局部疤痕、疼痛、脑脊液漏以及皮瓣坏死等[14,38]。简单、高效、损伤小的颅底重建技术是内镜颅底外科医师努力的目标,随着内镜设备和技术的发展,内镜下颅底硬脑膜缝合技术成为可能[39-44]。硬脑膜缝合缩小或消除了硬脑膜缺损;同时为移植物提供固定和支撑,有效地降低术后脑脊液漏的发生。不足之处是内镜经鼻蝶空间狭小,硬脑膜缝合困难,文献报道了各种缝合技术,如硬脑膜间断缝合技术[40,42]、硬脑膜连续缝合技术[39,41-42],两种方法均有效降低了术后脑脊液的发生,连续硬脑膜缝合术后脑脊液的发生要低于间断硬脑膜缝合者[42]。Sakamoto等[44]报道的滑动打结技术解决了内镜下缝合打结的技术难题,明显提高了硬脑膜缝合的速度。然而,内镜经鼻颅底硬脑膜缝合技术并不是单一的重建技术,其需要和其他重建技术相结合,方能达到有效的颅底重建。

综上所述,随着内镜设备和修补材料技术的发展,内镜颅底重建技术取得了长足的进步,术后脑脊液漏的发生明显降低。解剖研究发现3D打印的颅底重建模型,神经导航辅助下进行颅底重建可以达到更好的效果[45]。未来科技的发展,简单、高效、便捷的颅底重建技术,需要内镜颅底外科医师不断地去学习,尽可能缩短学习曲线[46],以造福更多的患者。

参　考　文　献

[1] JANKOWSKI R, AUQUE J, SIMON C, et al. Endoscopic pituitary tumor surgery[J]. Laryngoscope, 1992, 102(2): 198-202.

[2] LIU JK, CHRISTIANO LD, PATEL SK, et al. Surgical nuances for removal of tuberculum sellae meningiomas with optic canal involvement using the endoscopic endonasal extended transsphenoidal transplanum transtuberculum approach[J]. Neurosurg Focus, 2011, 30(5): E2.

[3] ATTIA M, KANDASAMY J, JAKIMOVSKI D, et al. The importance and timing of optic canal exploration and decompression during endoscopic endonasal resection of tuberculum sella and planum sphenoidale meningiomas[J]. Neurosurgery, 2012, 71(1 Suppl Operative): 58-67.

[4] KASSAM AB, PREVEDELLO DM, CARRAU RL, et al. The front door to Meckel's cave: an anteromedial corridor *via* expanded endoscopic endonasal approach- technical considerations and clinical series[J]. Neurosurgery, 2009, 64(3 Suppl): ons71-ons82.

[5] FRASER S, GARDNER PA, KOUTOUROUSIOU M, et al. Risk factors associated with postoperative cerebrospinal fluid leak after endoscopic endonasal skull base surgery[J]. J Neurosurg, 2018, 128(4): 1066-1071.

[6] KONO Y, PREVEDELLO DM, SNYDERMAN CH, et al. One thousand endoscopic skull base surgical procedures demystifying the infection potential: incidence and description of postoperative meningitis and brain abscesses[J]. Infect Control Hosp Epidemiol, 2011, 32(1): 77-83.

[7] LEE SJ, COHEN J, CHAN J, et al. Infectious complications of expanded endoscopic transsphenoidal surgery: a retrospective

cohort analysis of 100 cases[J]. J Neurol Surg B Skull Base, 2020, 81(5): 497-504.

[8] ESPOSITO F, DUSICK JR, FATEMI N, et al. Graded repair of cranial base defects and cerebrospinal fluid leaks in transsphenoidal surgery[J]. Neurosurgery. 2007, 60(4 Suppl 2):295-304.

[9] DLOUHY BJ, MADHAVAN K, CLINGER JD, et al. Elevated body mass index and risk of postoperative CSF leak following transsphenoidal surgery[J]. J Neurosurg, 2012, 116(6): 1311-1317.

[10] KLATT-CROMWELL CN, THORP BD, DEL SIGNORE AG, et al. Reconstruction of skull base defects[J]. Otolaryngol Clin North Am, 2016, 49(1): 107-117.

[11] OAKLEY GM, CHRISTENSEN JM, WINDER M, et al. Collagen matrix as an inlay in endoscopic skull base reconstruction[J]. J Laryngol Otol, 2018, 132(3): 214-223.

[12] LAM K, LUONG AU, YAO WC, et al. Use of autologous fat grafts for the endoscopic reconstruction of skull base defects: indications, outcomes, and complications[J]. Am J Rhinol Allergy, 2018, 32(4): 310-317.

[13] MESSERER M, MADURI R, DANIEL RT. Extended endoscopic endonasal approach for craniopharyngioma removal[J]. J Neurol Surg B Skull Base, 2018, 79(2): S199-S200.

[14] GIOVANNETTI F, BARBERA G, PRIORE P, et al. Fascia lata harvesting: the donor site closure morbidity[J]. J Craniofac Surg, 2019, 30(4): e303-e306.

[15] YOUNGERMAN BE, KOSTY JA, GERGES MM, et al. Acellular dermal matrix as an alternative to autologous fascia lata for skull base repair following extended endoscopic endonasal approaches[J]. Acta Neurochir (Wien), 2020, 162(4): 863-873.

[16] HADAD G, BASSAGASTEGUY L, CARRAU RL, et al. A novel reconstructive technique after endoscopic expanded endonasal approaches: vascular pedicle nasoseptal flap[J]. Laryngoscope, 2006, 116(10): 1882-1886.

[17] MOON JH, KIM EH, KIM SH. Various modifications of a vascularized nasoseptal flap for repair of extensive skull base dural defects[J]. J Neurosurg, 2019, 132(2): 371-379.

[18] BOETTO J, LABIDI M, WATANABE K, et al. Combined nasoseptal and inferior turbinate flap for reconstruction of large skull base defect after expanded endonasal approach: operative technique[J]. Oper Neurosurg (Hagerstown), 2019, 16(1): 45-52.

[19] BOZKURT G, LEONE F, AROSIO AD, et al. Septal flip flap for anterior skull base reconstruction after endoscopic transnasal craniectomy: Long-Term outcomes[J]. World Neurosurg, 2019, 128: e409-e416.

[20] PREVEDELLO DM, BARGES-COLL J, FERNANDEZ-MIRANDA JC, et al. Middle turbinate flap for skull base reconstruction: cadaveric feasibility study[J]. Laryngoscope, 2009, 119(11): 2094-2098.

[21] PISTOCHINI A, RUSSO F, CODEN E, et al. Modified posterior pedicle middle turbinate flap: an additional option for skull base resurfacing[J]. Laryngoscope, 2021, 131(3): E767-E774.

[22] FORTES FSG, CARRAU RL, SNYDERMAN CH, et al. The posterior pedicle inferior turbinate flap: a new vascularized flap for skull base reconstruction[J]. Laryngoscope, 2007, 117(8): 1329-1332.

[23] ZANATION AM, SNYDERMAN CH, CARRAU RL, et al. Minimally invasive endoscopic pericranial flap: a new method for endonasal skull base reconstruction[J]. Laryngoscope, 2009, 119(1): 13-18.

[24] REVUELTA BARBERO JM, SORIANO RM, BRAY DP, et al. The transorbital pericranial flap[J]. World Neurosurg, 2021, 152: e241-e249.

[25] BRESLER AY, MIR G, GRUBE J, et al. Endoscopic paramedian forehead flap reconstruction of the anterior skull base for recalcitrant cerebrospinal fluid leaks: minimally invasive adaptation of ancient flap[J]. World Neurosurg, 2019, 130: 37-41.

[26] VEYRAT M, VERILLAUD B, HERMAN P, et al. How I do it. The pedicled temporoparietal fascia flap for skull base reconstruction after endonasal endoscopic approaches[J]. Acta Neurochir (Wien), 2016, 158(12): 2291-2294.

[27] SIU A, RANGARAJAN SV, RABINOWITZ MR, et al. Quantitative determination of the optimal temporoparietal fascia flap necessary to repair skull-base defects[J]. Int Forum Allergy Rhinol, 2020, 10(11): 1249-1254.

[28] CONGER A, ZHAO F, WANG XW, et al. Evolution of the graded repair of CSF leaks and skull base defects in endonasal endoscopic tumor surgery: trends in repair failure and meningitis rates in 509 patients[J]. J Neurosurg, 2018, 130(3): 861-875.

[29] KIM GG, HANG AX, MITCHELL CA, et al. Pedicled extranasal flaps in skull base reconstruction[J]. Adv Otorhinolaryngol, 2013, 74: 71-80.

[30] JIN B, WANG XS, HUO G, et al. Reconstruction of skull base bone defects using an in situ bone flap after endoscopic endonasal transplanum-transtuberculum approaches[J]. Eur Arch Otorhinolaryngol, 2020, 277(7): 2071-2080.

[31] WORMALD PJ, MCDONOGH M. 'Bath-plug' technique for the endoscopic management of cerebrospinal fluid leaks[J]. J Laryngol Otol, 1997, 111(11): 1042-1046.

[32] GARCIA-NAVARRO V, ANAND VK, SCHWARTZ TH. Gasket seal closure for extended endonasal endoscopic skull base surgery: efficacy in a large case series[J]. World Neurosurg, 2013, 80(5): 563-568.

[33] MUNICH SA, FENSTERMAKER RA, FABIANO AJ, et al. Cranial base repair with combined vascularized nasal septal flap and autologous tissue graft following expanded endonasal endoscopic neurosurgery[J]. J Neurol Surg A Cent Eur Neurosurg, 2013, 74(2): 101-108.

[34] MACARTHUR FJD, MCGARRY GW. The radioanatomy of endonasal flap coverage of skull base defects: a tool for preoperative planning[J]. Laryngoscope, 2018, 128(6): 1287-1293.

[35] GARCÍA-FERNÁNDEZ A, GARCÍA-GONZÁLEZ E, PAREDES-SANSINENEA I, et al. Hidden port approach to endoscop-

ic pericranial scalp flap for anterior skull base reconstruction[J]. Laryngoscope, 2021, 131(8): 1749-1752.

[36] GABRIEL PJ, KOHLI G, HSUEH WD, et al. Efficacy of simultaneous pericranial and nasoseptal "double flap" reconstruction of anterior skull base defects after combined transbasal and endoscopic endonasal approaches[J]. Acta Neurochir (Wien), 2020, 162(3): 641-647.

[37] CAVALLO LM, SOLARI D, SOMMA T, et al. The 3F (fat, flap, and flash) technique for skull base reconstruction after endoscopic endonasal suprasellar approach[J]. World Neurosurg, 2019, 126: 439-446.

[38] NAKAMURA R, TAKANARI K, NAKAMURA Y, et al. Increased defect size is associated with increased complication rate after free tissue transfer for midanterior skull-base reconstruction[J]. J Neurol Surg B Skull Base, 2020, 81(2): 121-127.

[39] 刘俊, 湛允波, 马斯奇, 等. 硬脑膜连续缝合技术在神经内镜经鼻手术切除颅内肿瘤后高流量脑脊液漏修补中的作用[J]. 中华神经外科杂志, 2021, 37(3): 286-290.

[40] OGIWARA T, NAGM A, HASEGAWA T, et al. Pitfalls of skull base reconstruction in endoscopic endonasal approach[J]. Neurosurg Rev, 2019, 42(3): 683-689.

[41] ISHIKAWA T, TAKEUCHI K, NAGATA Y, et al. Three types of dural suturing for closure of CSF leak after endoscopic transsphenoidal surgery[J]. J Neurosurg, 2019, 131(5): 1625-1631.

[42] HARA T, AKUTSU H, YAMAMOTO T, et al. Cranial base repair using suturing technique combined with a mucosal flap for cerebrospinal fluid leakage during endoscopic endonasal surgery [J]. World Neurosurg, 2015, 84(6): 1887-1893.

[43] XUE H, YANG ZJ, LIU J, et al. Continuous dural suturing for closure of grade 3 leaks after tumor removal *via* an endoscopic endonasal approach[J]. Neurosurg Rev, 2021, 44(1): 373-380.

[44] SAKAMOTO N, AKUTSU H, TAKANO S, et al. Useful ′sliding-lock-knot′ technique for suturing dural patch to prevent cerebrospinal fluid leakage after extended transsphenoidal surgery[J]. Surg Neurol Int, 2013, 4: 19.

[45] ESSAYED WI, UNADKAT P, HOSNY A, et al. 3D printing and intraoperative neuronavigation tailoring for skull base reconstruction after extended endoscopic endonasal surgery: proof of concept[J]. J Neurosurg, 2018, 130(1): 248-255.

[46] PARK W, NAM DH, KONG DS, et al. Learning curve and technical nuances of endoscopic skull base reconstruction with nasoseptal flap to control high-flow cerebrospinal fluid leakage: reconstruction after endoscopic skull base surgery other than pituitary surgery[J]. Eur Arch Otorhinolaryngol, 2022, 279(3): 1335-1340.

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