

## . 论 著 .

3D Slicer 三维重建技术辅助显微手术治疗  
头皮动静脉瘘 1 例并文献复习

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**【摘要】目的** 总结 3D Slicer 三维重建技术辅助显微手术治疗头皮动静脉瘘(sAVF)的治疗经验。**方法** 回顾性分析 1 例 15 岁男性 sAVF 的临床资料并结合相关文献进行分析。**结果** 本文报道的病例为 15 岁男性,因发现右侧颞部头皮肿物 15 年伴增大 1 个月入院。右侧颞部头皮肿物最初大小约 1 cm,逐渐增至大约 3 cm,皮肤颜色正常,可闻及明显血流冲击声,明显感觉到血流搏动。术前 CTA 检查可见右侧颞上线水平处头皮下粗大畸形血管团,颞弓水平处颞浅动脉与颞浅静脉之间不排除有瘘口存在。利用 3D Slicer 软件对 CTA 数据进行三维重建,显示颞浅动脉与颞浅静脉在颞上线水平处相沟通,明确诊断 sAVF。术前充分评估后,选择显微手术彻底切除畸形血管团,出院后随访 2 年,头皮状况良好,无复发。**结论** 根据 CTA 数据,应用 3D Slicer 软件进行三维重建,对明确 sAVF 瘘口有一定辅助作用,可协助明确诊断,辅助显微手术彻底切除动静脉瘘,达到治愈效果。

**【关键词】** 头皮动静脉瘘;显微手术;3D Slicer 三维重建技术;CTA

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**Microsurgical resection assisted by 3D Slicer three-dimensional reconstruction technology for scalp arteriovenous fistula: a case report and literature review**

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**【Abstract】 Objective** To summarize the experience of 3D Slicer three-dimensional reconstruction technology-assisted microsurgery in the treatment of scalp arteriovenous fistula (sAVF). **Methods** The clinical data of a 15-year-old male with sAVF were retrospectively analyzed, and relevant literatures were reviewed and analyzed. **Results** The case reported in this paper was a 15-year-old male who was admitted to the hospital due to a right temporal scalp mass found for 15 years and an increase for 1 month. The initial size of the right temporal scalp mass was approximately 1 cm and gradually increased to approximately 3 cm. The skin color was normal, a vascular murmur can be heard and a blood flow pulsation can be felt. Preoperative CTA examination revealed a large and abnormal vascular mass under the scalp at the level of the right temporal superior line, and a suspected fistula between the superficial temporal artery and the superficial temporal vein at the level of the zygomatic arch. Three-dimensional reconstruction of CTA data using 3D Slicer software showed that the superficial temporal artery and the superficial temporal vein communicated at the level of the temporal line, confirming the diagnosis of sAVF. After adequate preoperative assessment, microsurgery was selected to completely resect the abnormal vascular mass. After discharge, the patient was followed up for 2 years, and the scalp condition was favorable with no recurrence. **Conclusion** Based on CTA data, the application of 3D Slicer software for three-dimensional reconstruction can assist in identifying the fistula of sAVF, help confirm the diagnosis, and assist in the complete removal of the arteriovenous fistula through microsurgery, achieving a curative effect.

**【Key words】** Scalp arteriovenous fistula; Microsurgery; 3D Slicer three-dimensional reconstruction technology; Computed Tomography Angiography (CTA)

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头皮动静脉瘘(scalp arteriovenous fistula, sAVF)是头皮下动脉与静脉之间无毛细血管的异常连接,为头皮血管畸形的一种罕见类型,可由先天性或外伤、医源性损伤等引起,常见临床症状包括头皮搏动性包块、头痛、杂音、耳鸣和出血等。脑血管造影是 sAVF 诊断金标准,可清晰显示瘘口、供血动脉以及引流静脉位置和数目<sup>[1-5]</sup>。目前,手术是治疗这种罕见血管疾病的主要方式,包括显微手术切除和血管内栓塞治疗<sup>[6,7]</sup>。本文报道 1 例 Yokouchi 分型<sup>[7]</sup>A 型 sAVF,利用 3D Slicer 软件根据术前 CTA 数据进行三维重建,再行显微手术切除治愈。

1 病例资料

15 岁男性,因发现右侧颞部头皮肿物 15 年伴增大 1 个月于 2021 年 7 月入院。出生后月余,无明显诱因出现右侧颞部头皮肿物,大小约 1 cm,触之搏动感明显,表面无红肿、破溃。2021 年 6 月,发现肿物逐渐变大,2021 年 7 月增至大约 3 cm,触之搏动感明显,表面皮肤完好。入院体格检查可见右侧颞顶部约 3.0 cm×3.0 cm 大小肿块,表面皮肤颜色正常,可闻及明显血流冲击声,明显感觉到血流搏动。术前 CTA 检查可见右侧颞上线水平处头皮下粗大畸形血管团(图 1A、1B、1D、1E),颞弓水平处颞浅动脉与颞浅静脉之间亦不排除有瘘口存在(图 1A、1B、1D、1E),颅内未见畸形血管。利用 3D Slicer 软件对 CTA 数据进行三维重建,显示颞浅动脉与颞浅静脉在颞上线水平处相沟通,明确诊断 sAVF,颞弓水平处不存在瘘口(图 1G~I)。彩色多普勒超声检查显示瘘口与 3D Slicer 软件三维重建结果一致(图 1C)。术前评估考虑供血动脉和引流静脉相对单一,但病史长,皮下可能存在一些影像学不易显现的变异畸形血管,为彻底治疗并减少并发症和复发风险,选择显微手术切除(图 1I)。术中切开皮肤,仔细暴露颞浅动脉、颞浅静脉,可见动脉与静脉直接相通,并可见动静脉瘘口(图 1K),血管阻断夹夹闭瘘口处供血动脉(颞浅动脉)、畸形引流静脉(颞浅静脉),阻断 10 min 后,发现粗大的畸形引流静脉直径变化不明显,以防后期形成新的 sAVF,电凝并丝线结扎动脉残端,完全切除动静脉瘘管(图 1L)。出院后随访 2 年,头皮状况良好,动静脉瘘无复发。

2 讨论

动静脉瘘是指动脉与静脉之间存在的异常通道,是动静脉畸形的一种,分为先天性和后天性两

种,大多为先天性,后天性多数由外伤引起。sAVF 是一种罕见的血管病变,目前无明确指南,治疗方案因病变的类型而异<sup>[8]</sup>。sAVF 的手术方法包括结扎供血动脉、手术切除、病灶内直接注射硬化剂和血管内栓塞,其中血管内治疗越来越多用作为主要治疗方式或术前辅助手术<sup>[9,10]</sup>。血管内栓塞可以确保病灶体积的缩小,从而改善相关的并发症,但不能达到病灶完全消除带来的美容效果,且复发率高。手术切除可以使病变及其并发症完全消失,再通过后期美容修复,达到良好美容效果,且复发率低;此外,手术切除还可以在术前或术中通过血管内栓塞、经皮栓塞、近端动脉闭塞和经皮供血血管结扎作为单一或分期手术来达到治愈效果<sup>[9,11]</sup>。

对于复杂的 sAVF,需与皮下血肿、脂肪瘤、表皮样囊肿、脓肿、海绵状血管瘤、毛细血管瘤等仔细鉴别。如果误诊,尤其在术前准备不充分的情况下,贸然行手术切除,可能导致灾难性后果<sup>[12]</sup>。虽然目前血管内栓塞的病例较以往有所增加,但根治性手术切除仍是很必要的治疗方法。为了降低并发症发生风险,术前需要全面了解 sAVF 的供血动脉、引流静脉和病灶,对于多供血动脉和头皮病灶直径>4 cm 的 sAVF,手术切除是首选治疗方法<sup>[13]</sup>。

3D Slicer 软件是由哈佛医学附属 Brigham & Woman's 医学院的手术规划实验室与麻省理工学院人工智能实验室在 1998 年联合发起并共同开发的 3D 医学影像研究平台,其目标是研发一个易于使用的可视化分析软件工作平台<sup>[14]</sup>。该软件可对病人颅脑 CT 数据进行二次处理,构建血管、肿瘤、神经、颅内血肿等三维模型<sup>[15-17]</sup>,从而为手术治疗提供重要指导。

DSA 是诊断动静脉瘘的金标准。但本文病人因个人及家庭经济原因未能行 DSA 检查,因此未将介入栓塞治疗列入首选方案。本文病人病灶范围较小,在不违背临床诊疗规范前提下,我们在完善脑血管 CTA 的基础上,初步标记畸形血管团范围及动静脉瘘口数量、位置,通过彩色多普勒超声对可疑瘘口位置进行探查,最后用 3D Slicer 软件对 CTA 数据进行的三维重建,清晰显示瘘口位置,最终行手术彻底切除病灶。

综上所述,本文病例通过 3D Slicer 三维重建技术辅助显微手术治疗成功。这提示对于不能行 DSA 检查的动静脉瘘病人,3D Slicer 三维重建技术可以辅助确定瘘口数量及位置,为该类病人的诊疗提供了一个新方案。

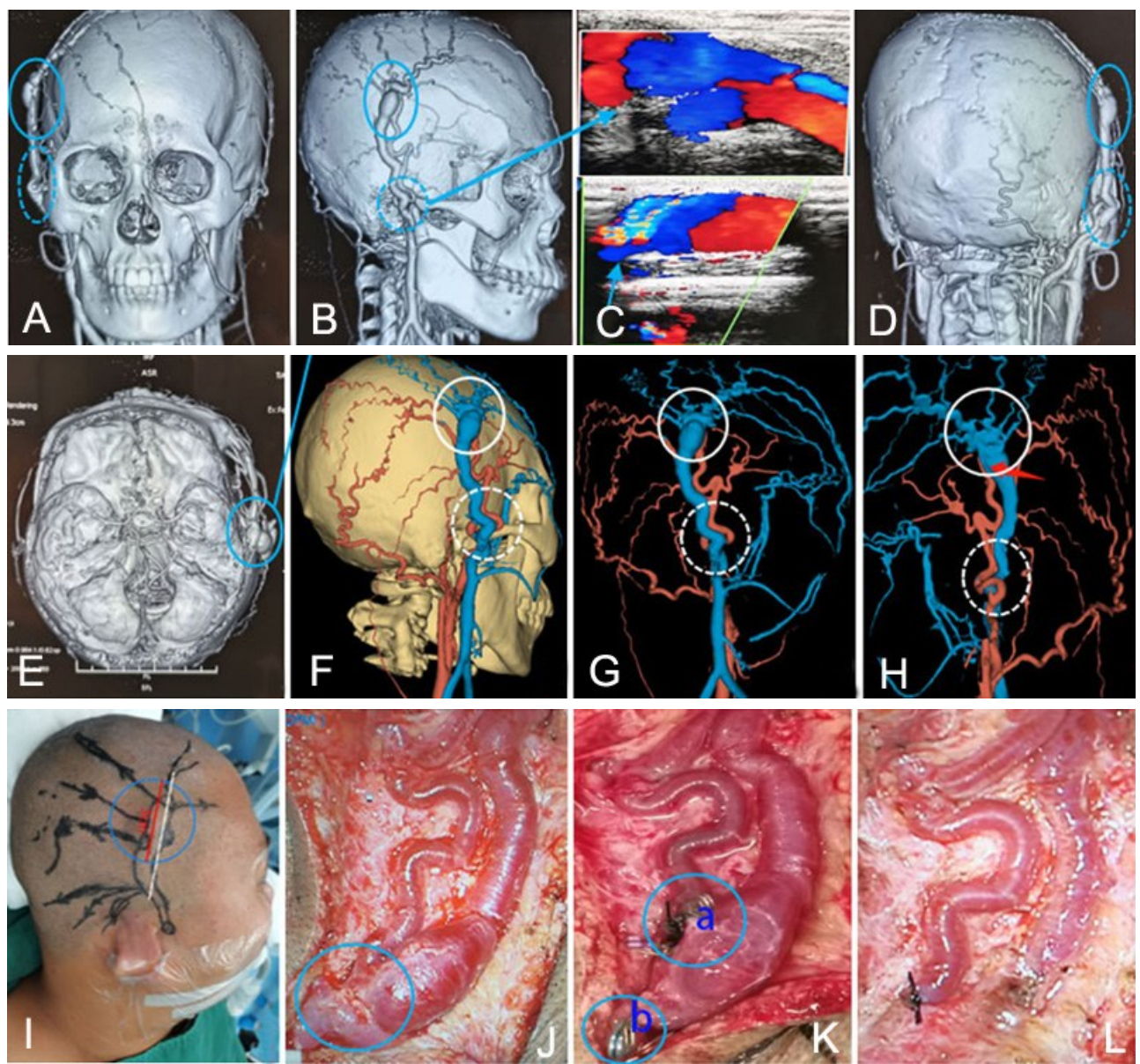


图 1 头皮动静脉瘘显微手术前后影像及术中表现

A~E. 术前 CTA 及彩色多普勒超声影像,实线蓝色圆图为动静脉瘘的瘘口位置,虚线蓝色圆图为非瘘口;F~H. 根据 CTA 数据,应用 3D Slicer 软件进行三维重建影像,实线白色圆图为动静脉瘘的瘘口位置,虚线白色圆图为非瘘口;I. 手术切口示意图,蓝色圆图为头皮肿物范围、直径约 3 cm,白色虚线为手术切口;J. 术中暴露颞浅动脉、颞浅静脉、动静脉瘘管;K. 术中结扎供血动脉(a),术中结扎引流静脉(b);L. 术中观察显示畸形畸形血管被完全切除

**Figure 1 Images and intraoperative manifestations before and after microsurgery for a patient with scalp arteriovenous fistula**

A~E: Preoperative CTA and color Doppler ultrasound images show taht the solid blue circle indicates the location of the arteriovenous fistula orifice, and the dashed blue circle indicates the non-fistula orifice. F~H: Three-dimensional reconstruction images using 3D Slicer software based on CTA data show taht the solid white circle indicates the location of the arteriovenous fistula orifice, and the dashed white circle indicates the non-fistula orifice. I: Schematic diagram of the surgical incision shows taht the blue circle indicates the range of the scalp mass with a diameter of approximately 3 cm, and the white dashed line indicates the surgical incision. J: Exposure of the superficial temporal artery, superficial temporal vein, and arteriovenous fistula tube during the operation. K: Intraoperative ligation of the feeding artery (a) and ligation of the draining vein (b). L: Intraoperative observation shows that the abnormal vascular structure has been completely resected.

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