

## 经动脉途径血管内治疗 51 例外伤性直接性颈动脉海绵窦瘘

王 武, 李明华, 李永东, 谭华桥, 顾斌贤, 方 淳, 徐浩文, 王 珏, 张培蕾

**【摘要】 目的** 推介最近 5 年经动脉途径使用可脱球囊、弹簧圈和 Willis 覆膜支架血管内治疗外伤性直接性颈动脉海绵窦瘘(TDCCFs)和保留颈内动脉(ICA)的经验。**方法** 回顾性分析经动脉途径血管内治疗的 51 例患者的 54 处 TDCCFs,均首选可脱球囊作为治疗方法,Willis 覆膜支架和弹簧圈作为备选方法,术后 3~48 个月行脑血管造影和临床随访评价所有患者的治疗效果。**结果** 一期单纯性可脱球囊成功治疗 46 处(85.2%)TDCCFs,并保留了 ICA。使用可脱球囊、弹簧圈和 Willis 覆膜支架合计保留了 53 处(98.1%)TDCCFs 的 ICA,同时成功闭塞瘘口,仅 1 例闭塞了单侧 ICA 和瘘口。单纯可脱球囊治疗 40 处 TDCCFs,单纯 Willis 覆膜支架治疗 2 处 TDCCFs,单纯弹簧圈治疗 1 处 TDCCF,可脱球囊联合 Willis 覆膜支架治疗 8 处 TDCCFs,联合弹簧圈治疗 3 处 TDCCFs,其中 1 处使用了 Willis 覆膜支架治疗。12 处 TDCCFs 进行了二期和三期治疗。除外 5 例患者单侧视力损害和(或)脑神经麻痹无明显改善外,术后 1 d~6 个月其他病例症状呈阶梯型改善,直到消失。术中无一例患者血管破裂、无远端脑栓塞和新发神经系统症状等并发症。51 处 TDCCFs 在最后 1 次治疗后 6 个月随访无复发。**结论** 经动脉途径使用可脱球囊栓塞 TDCCFs 的瘘口和保留 ICA 仍然是其首选的方法,但当这个方法失败时,Willis 覆膜支架和弹簧圈可以作为有效的替换方法或补救措施闭塞瘘口和保留 ICA,而使用 Willis 覆膜支架是有效、安全和经济实用的治疗方法,但需更多的病例作远期随访,以进一步拓展它的适应证。

**【关键词】** 外伤性直接性颈动脉海绵窦瘘;血管内治疗;外伤;可脱球囊;Willis 覆膜支架

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**Transarterial endovascular treatment of traumatic direct carotid-cavernous fistulas: a report of 51 cases** WANG Wu, LI Ming-hua, LI Yong-dong, TAN Hua-qiao, GU Bin-xian, FANG Chun, XU Hao-wen, WANG Ju, ZHANG Pei-lei. Department of Diagnostic and Interventional Radiology, the Affiliated Sixth People's Hospital, School of Medicine, Shanghai Jiaotong University, Shanghai 200233, China

Corresponding author: LI Ming-hua, E-mail: liminghuaradio@online.sh.cn

**【Abstract】 Objective** To present our single-center experience in treating traumatic direct carotid-cavernous fistulas (TDCCFs) by using detachable balloon, coil and Willis covered stent via arterial route. **Methods** During the last five years, transarterial endovascular treatment by using detachable balloon, coil and Willis covered stent was performed in fifty-one consecutive patients of traumatic direct carotid-cavernous fistulas, with a total of 54 TDCCFs. The detachable balloon was the material of first choice, while Willis covered stents and coils were regarded as the back-up materials. A clinical and angiographic follow-up for 3~48 months (mean 20.8 months) was conducted to evaluate the arterial patency and the stability of embolization. The clinical data were retrospectively analyzed. **Results** By using the detachable balloon alone via transarterial route, 85% TDCCFs were successfully treated with good preservation of ICA. A total of 98% TDCCFs in this study were successfully treated by using detachable balloon, coil and/or Willis covered stent, the fistulas became occluded, and ICAs were preserved except one patient. Forty TDCCFs were treated with detachable balloons alone, two TDCCFs with the Willis covered stent alone, and one DCCF with coils alone. Eight TDCCFs were treated with detachable balloons together with Willis covered stent. Of these eight TDCCFs, two were treated with a single session, three were treated with detachable balloons in combination with coils, and one had to receive Willis covered stent. Second and third times of endovascular treatment

were needed in 12 TDCCFs. The TDCCF-related symptoms were gradually

作者单位:200233 上海交通大学附属第六人民医院介入影像科  
通信作者:李明华 E-mail:liminghua@online.sh.cn

relieved or improved within 1 day to 6 months after treatment, except for five patients who suffered from ipsilateral moderate visual loss or cranial nerve deficit. No perioperative complications, such as vessel rupture, distal embolization or new neurologic deficits, occurred. During the follow-up period lasting for six months, neither delayed neurologic or vascular complications nor recurrence of the lesions developed.

**Conclusion** Via the transarterial route, using detachable balloon to occlude the fistula and at the same time to preserve ICA remains the optimal treatment for TDCCFs. When the standard treatment fails, various coils and the Willis covered stents can be used as an effective alternative or remedial tool in the treatment of TDCCFs, which can preserve ICA. Willis covered stent deployment seems to be an effective, safe, feasible and economical endovascular treatment for TDCCF, but more clinical studies are needed before we can further clarify its specifications and indications. (J Intervent Radiol, 2010, 19: 281-286)

**【Key words】** traumatic direct carotid-cavernous fistula; endovascular treatment; trauma; detachable balloon; Willis covered stent

颈动脉的钝性或穿透性损伤很少见,常由颅面部外伤或颅底骨折所致,可导致颈动脉瘘口或假性动脉瘤,后两者具有严重的致残性和致死性。外科手术修补颈动脉具有一定的难度,往往需要结扎或弃用颈动脉。血管内治疗是一先进的技术,以微创为特点,以选择性闭塞瘘口、假性动脉瘤和夹层瘤,并保留颈动脉功能,维护正常的脑组织血供为最大目标<sup>[1-3]</sup>。最常见的外伤性颈动脉静脉瘘是 Barrow's 分型 A 型,即直接性颈内动脉(ICA)海绵窦瘘(trumatic direct carotid-cavernous fistulas, TDCCFs)。该病仅占颅面部外伤的 0.2%~0.3%,由于海绵窦的特殊解剖和海绵窦内 ICA 的撕裂形成这种瘘口<sup>[1-5]</sup>,其临床症状包括搏动性突眼、球结膜充血、视力下降、眼肌麻痹等,当出现视力进行性下降、鼻出血、皮层静脉引流和海绵窦增大时需要急症治疗<sup>[6]</sup>。自 1974 年 Serbinenko<sup>[7]</sup>首次报道可脱球囊闭塞 TDCCFs 瘘口和保留 ICA 技术以来,经动脉途径使用可脱球囊技术迅速成为首选的和经典的 TDCCFs 的治疗方法,大宗病例报道其成功率达到 75%~88%<sup>[1,7-10]</sup>,然而外伤性瘘口是不规则的,球囊有时无法完全覆盖瘘口导致瘘口残留或复发,有时需要闭塞 ICA;近年来,发展了新的技术和材料闭塞瘘口和保留 ICA,如:经动脉和(或)静脉途径使用弹簧圈技术,联合球囊辅助和(或)支架辅助技术,提高了 TDCCFs 的治愈率,但一些报道中的困难病例仍需要闭塞 ICA<sup>[11-19]</sup>;最近,越来越多的难治性 TDCCFs 病例经动脉途径得到了有效的治疗,尤其是覆膜支架的应用,它通过瘘口的两端,既闭塞了瘘口,又重建和保留了病变的 ICA,简化了操作,缩短了手术时间和节约了费用,但仍具有一定的挑战<sup>[20-25]</sup>。本研究回顾性总结我科 5 年来经动脉途径使用可脱球囊、弹簧圈和

Willis 覆膜支架治疗 54 处 TDCCFs 的经验。

## 1 材料与方法

### 1.1 一般资料

收集我院神经介入诊治中心 2004 年 11 月到 2009 年 10 月间经动脉途径血管内治疗的 51 例、54 处 TDCCFs,男 43 例,女 8 例,年龄 8~54 岁,中位年龄 30.5 岁。继发于摩托车事故 43 例,其他交通事故 8 例。导致颅底骨折和(或)颅面部损伤 46 例,搏动性突眼 42 例,球结膜充血 40 例,视力下降 29 例,伴发蛛网膜下腔出血 5 例,颅内血肿 10 例,脊柱骨折 3 例。所有病例的症状、诊断和治疗均延迟(10 d~8 个月)。术前所有病例行 6 支颅脑血管造影评价瘘口、脑循环和其他伴发的病变,所有病例血管无明显动脉硬化,3 例为两侧 TDCCFs,5 例伴发同侧或对侧夹层瘤或间接性动静脉瘘。本组有 4 例病例出现在我们以前的报道中<sup>[26-27]</sup>。按照 von Rooij 分级<sup>[28]</sup>,高等流量 26 例,中等流量 22 例,低等流量 3 例,而且 80%的瘘口位于 ICA 海绵窦内水平段和以下部位<sup>[29]</sup>。

### 1.2 方法

**1.2.1 血管内治疗技术** 经动脉途径血管内治疗 TDCCFs 的原则是闭塞瘘口,重建和保留 ICA,首选治疗方法是局部麻醉下可脱球囊栓塞瘘口,类似于以往大多数报道,而在可脱球囊失败闭塞瘘口或 ICA 明显受压或狭窄的病例中,在实施永久性闭塞 ICA 之前,全身麻醉下尝试使用 Willis 覆膜支架或弹簧圈进行血管内治疗。

所有操作经单侧股动脉穿刺入路,引入 6F~8F 导引导管(90 cm, Cordis Corp, Miami Lakes, FL, USA)于病变侧 ICA 岩骨段,并实施全身肝素化,静

脉团注肝素首次剂量 3 000 ~ 4 000 u, 随后追加 1 000 ~ 1 500 u/h 肝素维持防止血栓形成(活化凝血酶时间 ACT 超过基础水平的 2 倍)。在可脱球囊治疗之前确认暂时性球囊闭塞试验(temporary balloon occlusion, TBO)阴性。使用的可脱球囊是单个微导管输送的 (Goldbal, BALT extrusion, France), 使用高渗性对比剂(370 mg)稀释充盈球囊。安装可脱球囊后的球囊导管在血流的导向下缓慢进入瘘口, (有时需要部分充盈球囊以方便球囊进入瘘口, 有时需要微导丝加强支撑力)当球囊进入瘘口后需要造影证实其位置, 一旦球囊位置合适, 缓慢充盈球囊闭塞瘘口, 有时球囊需要反复充盈调整位置闭塞瘘口, 反复造影确认瘘口的闭塞和 ICA 的通畅, 随后张力性解脱球囊; 有时需要多个球囊闭塞瘘口。若需要弹簧圈或 Willis 覆膜支架治疗时, 则需要全身麻醉, 其操作过程参考文献[30-32]。

1.2.2 围手术期处理 所有患者绝对卧床至少 48 h, 尤其是头部制动, 术后第 1、3、7 天复查头颅 X 线摄片及时发现球囊早泄和移位。使用覆膜支架的病例至少术前 3 d 开始口服阿司匹林 100 mg/d 和氯吡格雷 75 mg/d 抗血小板聚集治疗, 但本组中 4 例在术中通过胃管注入负荷剂量抗血小板聚集药物;

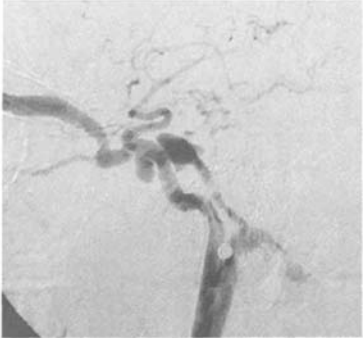
术后所有病例至少 48 h 低分子肝素 5 000 u/12 h 皮下注射。术后口服氯吡格雷至少 12 周, 阿司匹林长期应用。

1.2.3 随访 术后 3 ~ 48 个月临床随访所有病例, 术后 1、3、6 和 12 个月复查脑血管造影评价瘘口闭塞、ICA 通畅以及假性动脉瘤形成和支架内狭窄, 必要时进一步处理。

2 结果

本组中单纯性可脱球囊成功闭塞 46 处(85.1%)的 TDCCFs 瘘口, 并保留了 ICA。28 处 TDCCFs 使用了 1 枚球囊(图 1), 9 处 TDCCFs 使用了 2 个球囊, 7 处 TDCCFs 使用了 3 枚球囊, 在 1 处 TDCCFs 最多使用了 8 枚球囊。一期治疗所有 54 处 TDCCFs 均尝试可脱球囊栓塞治疗, 但球囊失败进入瘘口 3 例(小瘘口, ICA 狭窄, 血管成角锐利各 1 例), 球囊失败闭塞瘘口 5 例(部分残留 3 例, 大瘘口和海绵窦增大各 1 例)。二期球囊栓塞了 7 处 TDCCFs(球囊早泄或移位 4 例, 假性动脉瘤形成 2 例, 反复球囊破裂 1 例)(图 2), 二期成功治疗 5 处 TDCCFs。

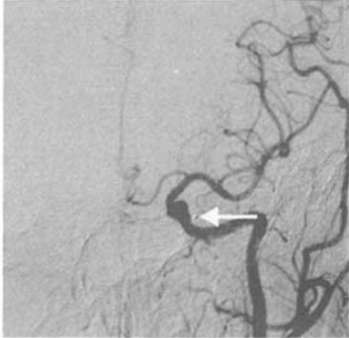
使用可脱球囊、弹簧圈和 Willis 覆膜支架总计成功闭塞了 53 处(98.1%)的 TDCCFs 瘘口, 而且保



a 左侧 ICA 造影侧位示中等流量的 TDCCF, 向眼上静脉和岩下窦引流

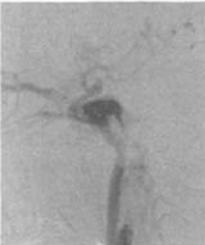


b 单个可脱球囊栓塞后即刻造影, 显示瘘口完全闭塞, ICA 轻度狭窄(箭)

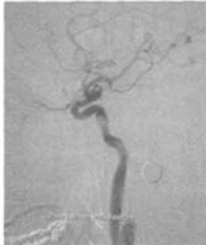


c 术后 6 个月造影显示瘘口消失, ICA 无明显狭窄, 球囊萎缩(箭)

图 1 外伤性颈动脉海绵窦瘘治疗前后



a 左侧 ICA 造影显示向眼上静脉和岩下窦引流的中等流量 TDCCF



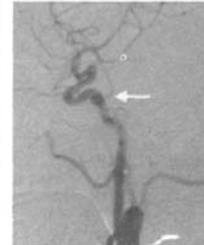
b 单个球囊栓塞后即刻造影示瘘口闭塞, ICA 通畅



c 术后 2 d 复发性 TDCCF, 球囊早泄(箭)



d 再次球囊栓塞后造影示瘘口闭塞, ICA 通畅(箭)



e 术后 6 个月复查造影示瘘口完全消失, 见小的无症状假性动脉瘤形成(箭)

图 2 外伤性海绵窦瘘治疗及中期随访

留和重建了 ICA。一期治疗弹簧圈成功栓塞了 3 处 TDCCFs 中的 2 处瘘口,平均使用 5 枚弹簧圈;所有经球囊和弹簧圈治疗失败的 TDCCFs (包括 2 例症状性假性动脉瘤、3 枚渐进性增大的假性动脉瘤)尝

试 Willis 覆膜支架治疗,一期治疗 4 例(图 3),二期治疗 7 例。所有 Willis 覆膜支架成功植入,最多使用 3 枚支架,完全闭塞了瘘口,重建了 10 支 ICA,另 1 例由于急性血栓形成闭塞了单侧 ICA。

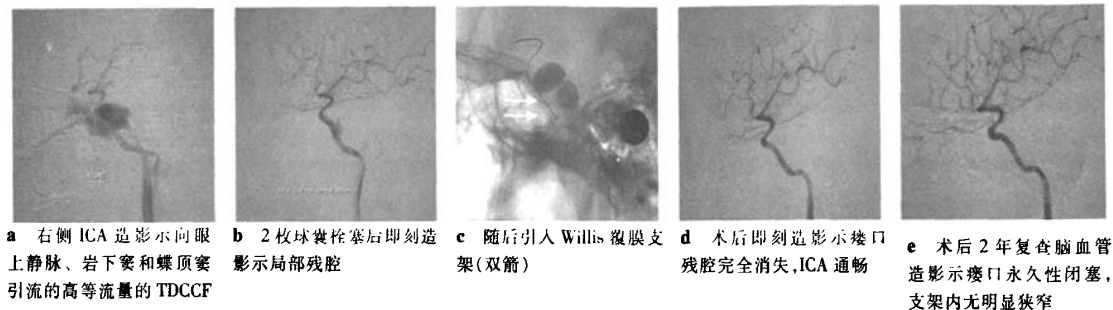


图 3 外伤性海绵窦瘘治疗及远期随访

术后 12 个月复查脑血管造影示 51 处 TDCCFs 瘘口完全闭塞,ICA 通畅,支架内无明显狭窄。本组中,单纯可脱球囊栓塞 44 处 TDCCFs 中出现 8 处假性动脉瘤,其中 5 处经 Willis 覆膜支架处理,其余 3 处仍在随访中。

术后 1 d ~ 6 个月,除外 5 例单侧视力损害和或脑神经麻痹无明显改善外,其他病例症状早阶梯型改善,直到消失。术中无一例患者血管破裂,也无远端脑栓塞和新发神经系统症状等并发症。所有病变在最后一次治疗后 6 个月无复发。

### 3 讨论

TDCCFs 是颅脑外伤后罕见的并发症。熟悉颅底 ICA 及其周围的解剖结构对该病至关重要。海绵窦是一对位于中颅窝前部蝶骨内的静脉丛,呈类似横“S”形的 ICA 是通过海绵窦的唯一动脉。颅底骨折常因导致海绵窦内的 ICA 薄弱处撕裂或破裂引起 TDCCFs<sup>[2,3]</sup>。消除瘘口和保持 ICA 通畅的血管内治疗技术明显优于其他的治疗方法,尤其在青年人群。经动脉途径可脱球囊栓塞 TDCCFs 已经成为绝大多数中心首选的方法,其优势在于操作简便,球囊能随着血流进入瘘口,能反复充盈和调整位置闭塞瘘口和保留 ICA,疗效确切<sup>[1,8-10,29,33]</sup>。成功地栓塞 TDCCFs 取决于瘘口和海绵窦的大小及选择合适球囊。

本组 85% 的 TDCCFs 仅使用可脱球囊成功闭塞了瘘口和保留了 ICA。文献报道仍有 5% ~ 25% 的病例不能达到闭塞瘘口和保留 ICA 的双重疗效,其复发率超过 11.2%<sup>[8-10,34]</sup>。本组的结果分别是 16% 和 11%。就保留 ICA 而言,在一些情况下使用可脱球囊仍然存在技术难度:①小瘘口或小的海绵窦瘘,

球囊无法进入。②海绵窦内碎骨片刺破球囊。③多个球囊无法完全充填明显增大的海绵窦,可能出现脑神经压迫症状。④球囊本身早泄和移位导致复发或假性动脉瘤的形成。⑤球囊无法治疗 ICA 横切伤和合并夹层的瘘口。另外,复发性瘘口更加难以栓塞,其成功率仅为 1/3,因此单纯使用可脱球囊无法进一步提高远期双重疗效<sup>[8-9,11,22,34-35]</sup>。对于这些球囊栓塞困难的病例需要其他的栓塞材料进行治疗,如:弹簧圈、液体胶等,但有时仍然需要弃用 ICA。自从 Halbach 和 Guglielmi<sup>[36-37]</sup>使用动脉和静脉途径弹簧圈栓塞 TDCCFs 以来,弹簧圈能够闭塞大多数的瘘口,日益成为另外一种疗效显著、甚至可能为首选的治疗方法,一些学者认为弹簧圈容易操作,可控性强,而且可回收,尤其是 2 ~ 3 mm 的中小瘘口,疗效确切,有报道其治愈率达到 98%<sup>[1,12-13,15,18-20,34-35]</sup>。然而弹簧圈不总是安全、有效,有时需要球囊辅助或支架辅助,在一些大的瘘口或者高流量的瘘口仍然需要弃用 ICA<sup>[9,11,13,15-16,35]</sup>。Luo 等<sup>[9,34]</sup>探索了其他方法,使用 60%NBCA 治疗球囊栓塞后局部残留和复发的瘘口,取得满意的结果,但是这一操作复杂了血管内治疗,具有潜在的误栓风险,而且当这个方法失败时,仍需要弃用 ICA。

近年来,覆膜支架已经广泛应用于颅内动脉瘤、假性动脉瘤、夹层动脉瘤和 TDCCFs 的治疗。覆膜支架治疗球囊和或弹簧圈失败栓塞的 TDCCFs 病例的目的在于闭塞瘘口,重建和改善 ICA,维持正常脑血流模式。文献中应用覆膜支架治疗 TDCCFs 基于联合的因素:现有的材料和方法不能有效栓塞 TDCCFs 和保留 ICA,不能保持合适的 ICA 形态等。文献报道 2 种支架:球扩式冠状动脉覆膜支架(Jo Med and Jostent)和自膨式覆膜支架(Symbiot stent)。

Felber 等<sup>[20]</sup>首先报道了 2 例球囊栓塞失败的 TDCCFs 应用覆膜支架治疗,其结果是瘘口完全闭塞,术后随访 11 和 14 个月无明显并发症。随后 Madan 等<sup>[21]</sup>报道了 2 例受难于严重脑损伤的高流量 TDCCFs 病例,在球囊和弹簧圈失败闭塞瘘口后使用自膨式覆膜支架成功闭塞瘘口,他们认为覆膜支架代表了一种新的治疗方法。Gomez 等<sup>[22]</sup>报道了覆膜支架成功治疗 7 例 TDCCFs 的中期随访结果 (3 ~ 42 个月),认为覆膜支架通过重建病变的 ICA 来治疗瘘口,可以作为球囊栓塞失败病例的选择。Archondakis 等<sup>[23]</sup>报道了 8 例经覆膜支架治疗的 TDCCFs,1 年随访示 6 例瘘口完全闭塞,并且保留了 ICA。最近 Wang 等<sup>[25]</sup>报道覆膜支架治疗的 10 例 DCCFs,其中 7 例是外伤性的,其结果 6 例获得了技术成功,并且瘘口完全闭塞和 ICA 通畅,随访 5 ~ 48 个月显示无明显支架内狭窄。Hoit 等<sup>[24]</sup>报道了覆膜支架成功治疗血管壁缺陷的病变,包括 1 例 TDCCF,认为该支架是有用的血管保留工具。本组的结果完全支持以上学者的结论。

本组中,我们成功处理了 2 枚症状性和 3 枚渐进性增大的假性动脉瘤。然而到目前为止文献中尚无明确的或指导性治疗假性动脉瘤的方法和措施。虽然一些报道涉及 30% ~ 44% 病例出现假性动脉瘤<sup>[8,9,29]</sup>,不像颅内假性动脉瘤,位于海绵窦内的假性动脉瘤很少危及生命,常常是增大后导致占位效应,破裂后导致 DCCF,血栓形成导致脑梗死<sup>[33]</sup>。结合文献和我科经验,在保留载瘤动脉的前提下,应用覆膜支架治疗 TDCCFs 的主要适应证有:小瘘口或小的海绵窦,球囊栓塞后残留的瘘口或假性动脉瘤和复发性瘘口,骨刺反复刺破球囊的瘘口,球囊栓塞失败的大瘘口,伴有 ICA 夹层的瘘口,多发性瘘口,一些合并 ICA 横断伤的瘘口。

虽然覆膜支架成功治疗了一些难治的 TDCCFs,但仍存在短期和长期通畅性、支架源性血栓事件和支架内漏等问题。在文献报道的随访过程中未发现明显支架内狭窄,类似于本组的结果;2 例在 1 个月随访中发现无症状性 ICA 闭塞,而本组 1 例在充分肝素化的情况下发生支架内急性血栓,可能由于支架的移位和血管再损伤所致,这是首次报道覆膜支架内急性血栓形成导致无症状的瘘口和 ICA 闭塞;至于覆膜支架的长期通畅性仍然需要进一步研究。

我科过去 5 年经动脉途径使用可脱球囊、弹簧圈和 Willis 覆膜支架治疗 TDCCFs 的初步结果令人

振奋,相似于文献报道,但仍需要远期的大宗病例研究和长期随访。

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作者: 王武, 李明华, 李永东, 谭华桥, 顾斌贤, 方淳, 徐浩文, 王珏, 张培蕾, WANG Wu, LI Ming-hua, LI Yong-dong, TAN Hua-qiao, GU Bin-xian, FANG Chun, XU Hao-wen, WANG Ju, ZHANG Pei-lei  
作者单位: 上海交通大学附属第六人民医院介入影像科, 200233  
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