

股动脉穿刺并发症的危险因素

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摘要

股动脉逐渐成为血管介入的主要通路, 穿刺部位出血、血肿、假性动脉瘤、腹膜后血肿等是其常见的并发症, 严重影响患者的生存质量, 增加额外卫生费用支出。因此, 早期识别可能导致股动脉穿刺并发症的危险因素, 并提前制定决策, 早期识别, 早期干预, 对改善患者预后, 降低致死、致残率具有重要意义。本文结合目前国内外研究进展, 对股动脉穿刺并发症的危险因素进行综述, 从而为临床医生早期识别股动脉穿刺并发症提供理论依据。

关键词

股动脉, 穿刺, 并发症, 危险因素

Risk Factors for Complications of Femoral Artery Puncture

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Abstract

The femoral artery has emerged as a primary access route for vascular interventions. However, complications associated with the puncture site, such as bleeding, hematoma, pseudoaneurysm, and retroperitoneal hematoma, are common. These complications significantly impair patients' quality of life and impose additional healthcare costs. Consequently, the early identification of risk factors potentially leading to femoral artery puncture complications, proactive decision-making, early recognition, and timely intervention are of paramount importance for improving patient

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outcomes and reducing mortality and disability rates. This article reviews the current research advances, both domestic and international, concerning the risk factors for femoral artery puncture complications. The aim is to provide a theoretical foundation to assist clinicians in the early identification of these complications.

Keywords

Femoral Artery, Puncture, Complications, Risk Factors

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1. 引言

全球每年实施的经皮血管介入手术超过 700 万例。股总动脉因其管径粗大、位置表浅利于触摸与穿刺,且位于股骨头前方的解剖特性,已成为最常用的穿刺靶血管。然而,临床数据显示约 5%~10%的患者出现穿刺点并发症,如穿刺部位渗血、血肿、假性动脉瘤甚至腹膜后血肿等[1][2],严重影响患者的生存质量,增加额外卫生费用支出。尤其是随着经导管主动脉瓣置换术(TAVR)及胸主动脉夹层腔内隔绝术(TEVAR)等技术的推广,更大外径器械经股动脉入路的需求显著增加,进一步提高了血管并发症的潜在风险。因此,对于穿刺点并发症影响因素的了解非常重要。大量临床研究表明,高血压、肥胖、穿刺点与股骨头的相对位置关系、糖尿病史、穿刺位置钙化、术中最大鞘管尺寸等都是股动脉穿刺术后并发症发生率的危险因素[3][4]。因此,早期识别可能导致股动脉穿刺并发症的危险因素,并提前制定决策,早期识别,早期干预,对改善患者预后,降低致死、致残率具有重要意义。本文结合目前国内外研究进展,对股动脉穿刺并发症的影响因素进行综述,希望能为临床医生的治疗决策提供参考。

2. 解剖因素

2.1. 肥胖

肥胖(OR: 2.33, 95% CI: 1.59~3.42)患者腹股沟区域存在大量皮下脂肪组织,显著增加了股动脉穿刺的操作难度和并发症风险。皮下脂肪堆积使得触诊股动脉搏动变得困难甚至无法实现,这不仅导致首次穿刺失败率升高,还显著增加了误穿股静脉或股神经的风险,反复穿刺更易造成血管及周围组织损伤[5]。且过厚的皮下脂肪层要求使用更长的穿刺针方能抵达股动脉,标准长度的穿刺针常不适用,易因穿刺角度过陡而穿透血管后壁或导致鞘管打折,同时术后压迫止血的难度和效果也大打折扣[6]。虽然超声引导是克服触诊困难的首选方法,但极度肥胖患者的脂肪组织使得超声波束显著衰减,导致图像质量降低,影响对股动脉及其分支(股深动脉、股浅动脉)的清晰辨识;此外,透视下脂肪组织对骨性标志(如股骨头)的遮挡,也干扰了在关键“安全区”(股骨头中下 1/3)内精准定位穿刺点[7]。肥胖患者腹股沟区域因皮肤皱褶多、局部环境温暖潮湿,成为细菌滋生的有利场所,加之与之相关的穿刺时间延长、多次尝试以及血肿形成,共同导致穿刺部位感染(如蜂窝织炎、脓肿)和导管相关血流感染的风险显著加剧[8]。

2.2. 血管钙化

血管钙化,根据其发生部位可分为与动脉粥样硬化相关的内膜钙化,以及主要导致血管硬度增加与顺应性降低的非闭塞性中膜钙化。临床研究证实,严重血管钙化可显著影响血管闭合器械(VCD)的使用效

果,是限制其成功应用的独立危险因素[9]。钙化本质上是钙盐在血管壁的异常沉积,导致管壁硬度显著增高、弹性纤维功能丧失,致使穿刺针穿透阻力显著增加,引发反复穿刺所致的血管周围组织损伤与血肿形成;同时,血管顺应性下降使得穿刺点难以有效闭合,显著增加假性动脉瘤的风险[10]。此外,钙化斑块造成管壁不规则,易诱发内膜撕裂、斑块破裂,进而导致血栓或脂质成分脱落栓塞;伴随的管腔狭窄可因血流动力学紊乱诱发血栓形成[11][12]。钙化斑块还会干扰超声对血管的准确定位[13],并导致血管走行相对固定,增加操作难度。特定部位(如主动脉、透析通路血管)的严重钙化更易引发缺血甚至致死性并发症,若合并存在高血压或凝血功能异常,相关风险将进一步加剧[14][15]。因此,股动脉前壁钙化已被国外研究明确报道为血管穿刺并发症和血管缝合器使用失败等不良事件的独立危险因素[16]。

2.3. 股动脉分叉位置异常

股动脉分叉异常破坏标准体表定位的可靠性。一方面股动脉分叉位置过高可导致穿刺点更易位于股浅动脉或者股深动脉,其管径较细,管壁较薄,提高了误穿后鞘管损伤及压迫止血等风险,是假性动脉瘤最常见原因之一。另一方面股动脉分叉位置过高可导致更高的股动脉穿刺点,使得有效压迫点上移至腹股沟韧带区域,缺乏骨性支撑,压力难以有效传导至血管破口,出血易向缺乏压迫点的腹膜后间隙扩散,形成腹膜后血肿[17]。若穿刺点恰在分叉处时,针尖可能直接刺破分叉嵴(Carina)或损伤分支开口。

3. 患者疾病状态

3.1. 高血压

长期高血压状态(OR: 2.48, 95% CI: 1.00~3.15)导致血管壁持续承受过高压,引发血管内膜损伤、弹性降低及脆性增加[18]。在股动脉穿刺操作中,机械性损伤作用于已存在病理改变的血管,显著增加血管破裂、出血及夹层形成的风险[19]。此外,高血压所致的血管内皮损伤使内皮下胶原暴露,激活血小板并启动凝血级联反应,促进血栓形成[20]。穿刺部位内膜受损处也成为血栓形成的易发部位,一旦血栓脱落,可随血流栓塞远端血管,引发下肢动脉栓塞等并发症,严重损害下肢血液灌注,甚至导致肢体缺血坏死。同时,高血压常伴随血流动力学改变,如血流冲击力增强及流速/方向异常,促使血液有形成分(如血小板、红细胞)与血管壁的接触频率和强度增加,进一步升高血栓形成风险[21]。另一方面,高血压诱导血管壁重构,表现为血管中膜平滑肌细胞增生肥大及细胞外基质沉积,导致管壁增厚、僵硬,损害其正常修复功能[22]。

3.2. 糖尿病

长期高血糖(OR: 1.78, 95% CI: 1.11~2.85)状态通过多重病理机制加剧血管病变。其首要效应是诱导内皮细胞功能障碍,增加血管通透性,促进低密度脂蛋白胆固醇(LDL-C)渗入内膜并氧化,形成动脉粥样硬化早期病变[23]。同时,高血糖环境产生过量活性氧(ROS),加速 LDL-C 氧化,进一步推动动脉粥样硬化进展[24]。此外,持续高血糖促使糖基化终末产物(AGEs)蓄积,通过激活 RAGE 受体途径:一方面增加血管壁胶原交联并减少弹性纤维,导致血管硬化[25]-[27];另一方面刺激血管平滑肌细胞增殖与迁移,加速血管钙化进程[27]。钙化性斑块的形成不仅显著提升血管脆性,增加穿刺操作中血管撕裂或穿破的风险[28][29],还削弱血管收缩止血能力,并降低血管闭合装置(VCD)的闭合效能。

AGEs 同时抑制内皮祖细胞(EPCs)功能,延缓血管损伤修复,导致止血延迟并延长压迫时间,从而升高穿刺部位血肿及假性动脉瘤发生率。高血糖还可直接激活血小板,促进血栓素 A2 (TXA2)释放,增强血小板聚集与黏附[15][30][31];研究证实糖尿病患者血小板反应性显著高于非糖尿病患者[32]。伴随的内皮损伤会减少一氧化氮(NO)和前列环素(PGI2)分泌,并引发红细胞/血小板形态与功能异常,导致血液

高凝状态[33]-[35]。在此背景下,股动脉穿刺后局部血流动力学改变极易诱发穿刺部位血栓形成,进而引发下肢动脉栓塞及循环障碍。值得注意的是,糖尿病特有的周围神经与微血管病变可造成局部组织灌注不足及营养缺乏,显著延缓伤口愈合进程,增加伤口裂开、感染等并发症风险。

4. 凝血功能异常

4.1. 抗凝/抗血小板治疗

抗凝和抗血小板治疗(OR: 2.95, 95% CI: 2.24~3.89)通过抑制凝血级联反应和血小板功能这两个止血的核心环节,极大地削弱了机体对股动脉穿刺所致血管损伤的自我修复能力。这使得出血、血肿、假性动脉瘤、动静脉瘘和腹膜后出血等并发症的发生率显著升高,且一旦发生,往往更严重、更难处理。在进行股动脉穿刺操作前,必须仔细评估患者的抗栓治疗方案及其带来的出血风险,并采取相应的预防、监测和应对措施。

4.2. 肝肾功能不全

肝脏是凝血因子(II, VII, IX, X 纤维蛋白原)和抗凝蛋白(蛋白 C/S/AT-III)的主要合成场所。肝功能不全时,凝血因子合成减少,PT/INR 延长,穿刺部位止血困难[36]。肾功能不全时,尿素等毒素蓄积抑制血小板聚集和黏附功能,血管内皮释放 NO 增加,导致止血障碍[37]。

5. 操作者相关因素

穿刺点位置选择

研究表明,股动脉穿刺点应选择在股骨头中线水平,该水平是股动脉走行的关键骨性标志,其中心平面与股动脉解剖位置高度吻合,Schnyder 等[38] [39]研究发现 98%的患者股动脉分叉位于或稍低于股骨头中线水平,于股骨头中线水平穿刺可避免因高位穿刺误入髂外动脉引发腹膜后出血[10]。Ahn 等发现当穿刺点位于股骨头中线水平时,穿刺点与股动脉分叉点的安全距离最大,并发症风险最低,且股动脉钙化常集中于分叉处,而股骨头中线水平的血管壁钙化程度较低[10]。钙化血管穿刺时易出现针尖偏移或穿透不全,导致反复穿刺和血肿形成[40]。近年来在彩超引导下的穿刺,一定程度上减小上述并发症,但因受其探头扫描范围所限,无法在同一界面监控长段血管的引导及评估。且股骨头作为术后压迫血管穿刺点的坚硬骨性支撑,可通过压迫装置或手动压迫有效闭合血管破口,显著缩短止血时间,同时减少血管移位[41]-[44]。此外,该水平股神经与血管间距最大(外侧 1~2 cm),可规避神经损伤[45]。

6. 小结与展望

股动脉穿刺并发症的危险因素涉及多个方面,高血压、肥胖、穿刺点与股骨头的相对位置关系、抗凝及抗血小板治疗、糖尿病史、穿刺位置钙化、术中最大鞘管尺寸等都是股动脉术后并发症的危险因素。有研究表明,穿刺并发症的危险因素具有叠加效应,特别是高龄、女性、低体重、糖尿病、抗凝治疗、大鞘管等危险因素叠加时为高危级别,当肥胖(BMI 高)+ 高血压 + 手术时间长等危险因素叠加时,则为中危级别,而当只有 1 种危险因素时则为低危级别。

目前大多数研究聚焦于并发症的即时处理和短期效果,长期结局数据的缺乏与标准化随访体系的缺失是未来的研究重点。目前,人工智能(AI)在医学领域的应用越发广泛。未来,人工智能(AI)在术前规划(基于 CT 血管成像自动识别最佳穿刺点)、术中引导(实时超声图像识别与导航)、并发症风险预测(整合多指标构建预测模型)以及术后影像学筛查(自动识别超声或 CT 中的并发症迹象)中的应用,是我们重要的研究方向。

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