

· 临床研究 ·

髓芯减压多孔钛笼架置入治疗早期股骨头坏死

王峰^a, 牛旭^b, 鲍哲明^a, 吴波^{**}, 付志厚^a, 冯晓雷^a, 康健^a, 刘江^a

(中国人民解放军联勤保障部队第九六〇医院, a: 骨科; b: 麻醉科, 山东济南 250031)

摘要: [目的] 探讨髓芯减压多孔钛笼架置入治疗早期股骨头坏死的近期临床疗效。[方法] 回顾性分析 2022 年 10 月—2023 年 3 月本科收治的 10 例 (12 髋) 早期股骨头坏死患者的临床资料, 均行髓芯减压多孔钛笼架置入治疗。评价临床与影像结果。[结果] 患者均顺利完成手术, 无重要血管、神经损伤等并发症。所有患者均获随访, 随访时间平均 (14.5±2.1) 个月。同术前相比, 末次随访时 VAS 评分显著减少 [(7.0±1.2), (2.0±1.0), $P<0.001$], Harris 评分 [(72.0±4.2), (91.0±3.5), $P<0.001$]、髋伸-屈 ROM [(54.8±3.7)°, (89.7±3.3)°, $P<0.001$]、髋内-外旋 ROM [(35.3±3.2)°, (60.7±2.9)°, $P<0.001$] 均显著增加。影像方面, 与术前相比, 末次随访时 ARCO 分期、JIC 分期无显著变化 ($P>0.05$)。末次随访时, 1 例股骨头坏死区域有加重表现。[结论] 髓芯减压多孔钛笼架置入治疗早期股骨头坏死近期临床疗效满意。

关键词: 股骨头坏死, 保髋, 髓芯减压, 多孔钛笼架, 近期疗效

中图分类号: R681.8 文献标志码: A 文章编号: 1005-8478 (2025) 06-0570-05

Core decompression combined with implantation of porous titanium cage for early femoral head necrosis // WANG Feng^a, NIU Xu^b, BAO Zhe-ming^a, WU Bo^a, FU Zhi-hou^a, FENG Xiao-lei^a, KANG Jian^a, LIU Jiang^a. a. Department of Orthopedics, b. Department of Anesthesiology, The 960th Hospital, PLA Joint Logistic and Support Force, Jinan 250031, Shandong, China

Abstract: [Objective] To investigate the short-term clinical consequence of core decompression combined with porous titanium cage implantation for early femoral head necrosis. [Methods] A retrospective study was conducted on 10 patients (12 hips) who had early-stage femoral head necrosis treated by core decompression combined with porous titanium cage implantation in our department from October 2022 to March 2023. The clinical and imaging documents were evaluated. [Results] All the patients had abovesaid surgical procedures performed successfully without important vascular and nerve injuries, and other complications, and were followed up for an average of (14.5±2.1) months. Compared with those before surgery, the VAS score was significantly decreased [(7.0±1.2), (2.0±1.0), $P<0.001$], whereas the Harris score [(72.0±4.2), (91.0±3.5), $P<0.001$], hip flexion-extension range of motion (ROM) [(54.8±3.7)°, (89.7±3.3)°, $P<0.001$], hip internal-external rotation ROM [(35.3±3.2)°, (60.7±2.9)°, $P<0.001$] were significantly increased at the last follow-up. As for imaging, there were no significant changes in ARCO stage and JIC stage at the last follow-up compared with those before surgery ($P>0.05$). At the last follow-up, 1 patient had aggravation in the necrotic area of the femoral head. [Conclusion] The core decompression and porous titanium cage implantation achieve satisfactory clinical outcome in the short term for the early-stage femoral head necrosis.

Key words: femoral head necrosis, hip preservation, core decompression, porous titanium cage, short-term outcome

缺血性股骨头坏死 (osteonecrosis of the femoral head, ONFH) 是由于股骨头内血供受损, 引起股骨头形态改变, 导致髋关节功能障碍的一种常见、难治性疾病^[1-2]。引起 ONFH 的原因很多, 其中激素诱导的发病率逐年上升, 已成为主要原因^[3]。早期 ONFH 可以采用药物或者冲击波等物理治疗^[4], 对保守治疗无效或晚期患者, 则需手术治疗。人工全髋关节置换术是目前治疗晚期 ONFH 最有效的方法^[5], 尤其适用于老年患者。然而, 大量 ONFH 发病于 40 岁左右

的中青年, 甚至年龄更小^[6, 7]。对于这类患者采用人工关节置换术并非最佳选择, 保髋手术应运而生。目前保髋手术方法众多, 各有利弊。近期, 积水潭医院报告的一种新型多孔钛笼架置入治疗早期股骨头坏死获得良好的临床疗效^[8]。现将本科室应用此法保髋患者的近期疗效报告如下。

1 临床资料

1.1 一般资料

DOI:10.20184/j.cnki.issn1005-8478.110295

作者简介: 王峰, 主治医师, 研究方向: 骨关节疾病与运动医学, (电子信箱) medouwo@163.com

* 通信作者: 吴波, (电话) 0531-51619779, (电子信箱) wubo578@163.com

回顾性分析 2022 年 10 月—2023 年 3 月解放军联勤保障部队第九六〇医院骨科收治的 10 例早期 ONFH 病例的临床资料, 共 12 髌, 其中男 8 例 (9 髌), 女 2 例 (3 髌)。年龄 21~60 岁, 平均 (39.8±14.6) 岁, 按国际骨循环研究协会 (Association Research Circulation Osseous, ARCO) 分期: II 期 9 髌, III A 期 3 髌, 日本骨坏死研究会 (Japanese Investigation Committee, JIC) 分期: B 型 3 髌, C1 型 4 髌, C2 型 5 髌。本研究已通过解放军第九六〇医院伦理审查委员会审批, 所有患者均签署知情同意书。

1.2 手术方法

根据文献报道方法^[8]进行手术: 全麻成功后, 患者取平卧位, 患髌适度垫高。以大转子下 5 cm 左右处为进针点, C 形臂 X 线机透视下调整导针穿刺位置, 确保导针沿股骨颈纵轴方向缓慢进至股骨头坏死中央区域, 针尖抵达股骨头软骨下 5 mm。C 形臂 X 线机透视确认导针进针位置满意 (图 1a) 后, 以导针为中心做长约 3 cm 纵行切口, 逐层切开, 置入工作套筒保护软组织。分别以 7.5 mm、9.5 mm 空心钻头进行皮质开口, 再以 9.5 mm 环钻钻取大转子区及股骨颈内正常松质骨条备用 (图 1b)。再用 9.5 mm 空心钻沿导针钻透坏死区域进行髓芯减压, 深达软骨下 5 mm 靶点位置, 避免突破软骨下骨板。经由骨隧道再用刮匙进一步清除部分坏死骨组织。取部分自体松质骨植入骨隧道末端并夯实, 支撑软骨下骨板。将部分自体松质骨填充多孔钛金属笼内部 (图 1c)。攻丝骨隧道后旋入多孔钛金属笼抵至骨隧道末端、软骨下植骨处 (图 1d)。反复冲洗骨隧道, 大转子区域骨隧道残腔充填夯实人工骨。C 形臂 X 线机透视确认多孔钛金属笼位置满意。冲洗缝合切口, 结束手术。术后常规给予抗生素预防感染、非甾体消炎药止痛及双磷酸盐类药物治疗。术后 1.5 个月内避免患肢负重活动, 期间髌关节允许主被动活动, 可适度坐、站立及拄拐行走, 但患肢严禁负重。术后 1.5 个月开始拄拐保护下患肢部分负重行走。术后 3 个月视复查情况逐渐弃拐负重行走, 并逐步恢复日常生活及工作。如果复查后恢复缓慢者可适当延长扶拐时间, 术后 1 年内不得进行剧烈运动及重体力劳动。

1.3 评价指标

记录手术时间、术中失血量、切口长度及相关并发症, 采用疼痛视觉模拟评分 (visual analogue scale, VAS)、髌关节 Harris 功能评分、髌伸-屈活动度 (range of motion, ROM), 内-外旋 ROM 评价临床效果。行影像学检查, 按 ARCO 分期评价股骨头坏死

进展及股骨头塌陷等情况。

1.4 统计学方法

采用 SPSS 26.0 软件进行统计学分析, 计量数据以 $\bar{x} \pm s$ 表示, 资料呈正态分布时采用单因素方差分析, 两两比较采用 LSD 法, 资料呈非正态分布时, 采用秩和检验。等级资料采用 Kendall 检验。P<0.05 为差异有统计学意义。

2 结果

2.1 临床结果

所有患者均顺利完成手术, 手术时间 85~93 min, 平均 (89.5±2.6) min; 切口长度 2.7~3.2 cm, 平均 (3.0±0.2) cm; 术中失血量 15~30 mL, 平均 (23.3±5.0) mL。术中无重要血管、神经损伤等严重并发症, 所有患者术中亦未发生穿透软骨、导针断裂、骨折等相关并发症。其中 1 例患者术后出现切口愈合不良, 切口少量渗血及清亮液体渗出, 细菌培养阴性, 给予清创后切口愈合, 考虑术中骨道封闭不严所致, 术后复查过程中可见骨道逐渐愈合封闭。

本组患者全部获得 12 个月以上随访, 随访时间 12~17 个月, 平均 (14.5±2.1) 个月。随访结果详见表 1, 与术前相比, 末次随访时 VAS 评分显著减少 (P<0.05), Harris 评分、髌伸-屈 ROM、内-外旋 ROM 均显著增加 (P<0.05)。所有患者至末次随访时均无需手术干预, 近期保髌成功率达 91.7%。

2.2 影像评估

影像评估结果详见表 1, 与术前相比, 末次随访时 ARCO 分期、JIC 分期无显著变化 (P>0.05)。至末次随访时, 影像学资料示所有病例中钛金属笼架位置良好, 骨整合情况满意, 未有松动、移位等情况。1 例患者股骨头坏死区病变有所进展, 由 ARCO II 期进展至 III A 期, 且有进一步塌陷加重的可能, 其余病例坏死区病变未见进展。所有患者至末次随访时未有股骨头塌陷情况发生。

表 1. 12 髌临床和影像资料

Table 1. Clinical and imaging data of 12 hips

指标	术前	末次随访	P 值
VAS 评分 (分, $\bar{x} \pm s$)	7.0±1.2	2.0±1.0	<0.001
Harris 评分 (分, $\bar{x} \pm s$)	72.0±4.2	91.0±3.5	<0.001
髌伸-屈 ROM (°, $\bar{x} \pm s$)	54.8±3.7	89.7±3.3	<0.001
髌内-外旋 ROM (°, $\bar{x} \pm s$)	35.3±3.2	60.7±2.9	<0.001
ARCO 分期 (髌, I/II/III A)	0/9/3	0/8/4	0.471
JIC 分期 (髌, B/C1/C2)	3/4/5	3/3/6	0.889
股骨头塌陷 (例, 无/轻度/明显)	12/0/0	12/0/0	ns

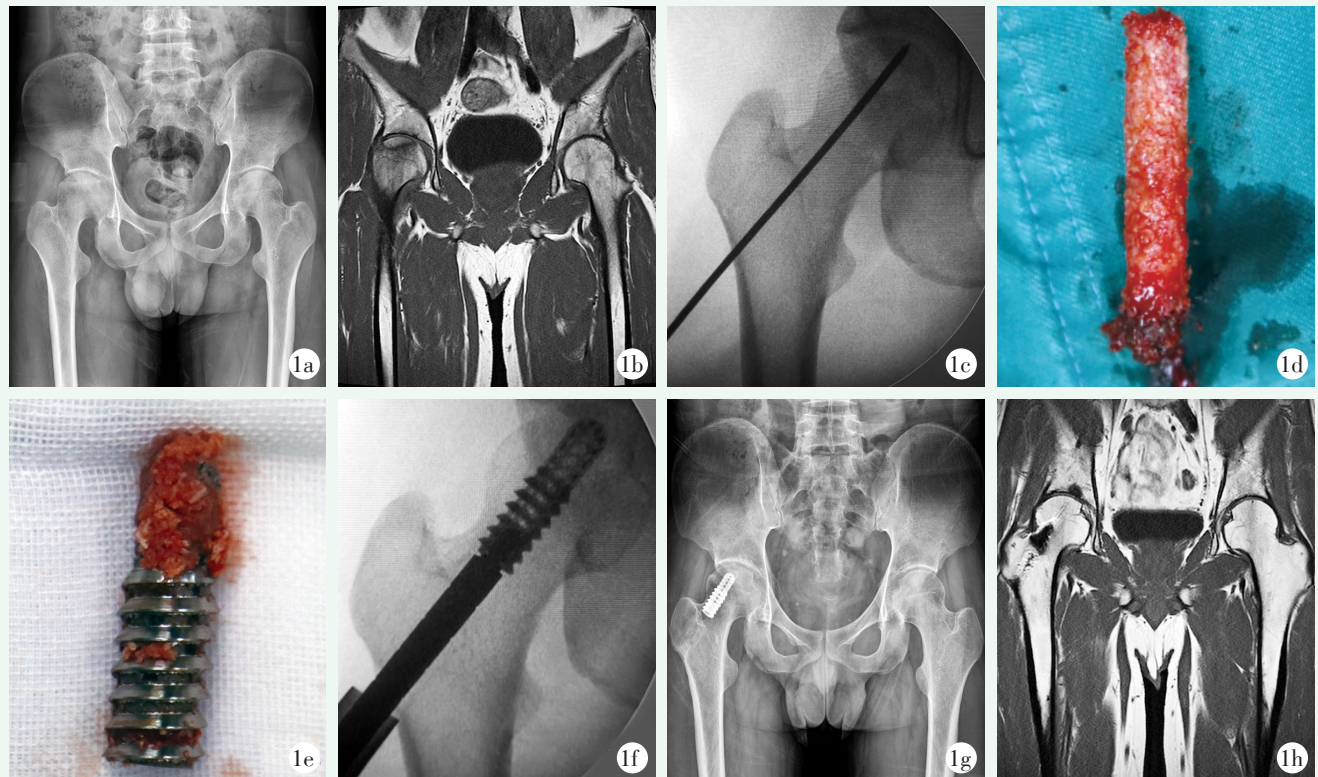


图 1. 患者男性, 21 岁。1a: 术前髋关节正位 X 线片示右侧股骨头负重区密度不均; 1b: 术前 MRI 示右侧股骨头负重区信号改变; 1c: 术中导针透视定位, 位置满意; 1d: 环锯钻取松质骨骨条; 1e: 多孔钛笼架内填充松质骨; 1f: 术中透视见多孔钛笼架置入股骨头内, 位置满意; 1g: 术后 12 月髋关节正位 X 线片可见多孔钛笼架位置满意, 软骨下骨支撑良好, 右侧股骨头形态良好, 坏死区无进展, 骨隧道愈合良好; 1h: 术后 12 个月髋关节 MRI 示股骨头形态良好, 多孔钛笼架在位, 原坏死区信号较术前明显改善。

Figure 1. A 21-year-old male. 1a: Preoperative anteroposterior radiograph showed uneven density in weight-bearing area of the right femoral head; 1b: Preoperative MRI showed signal changes in weight-bearing area of the right femoral head; 1c: Intraoperative fluoroscopy revealed the guide pin in satisfactory position; 1d: Cancellous bone column removed in core decompression with trephine; 1e: The porous titanium cage filled with cancellous bone would be implanted into the femoral head; 1f: Intraoperative fluoroscopy showed the cage placed into the femoral head in satisfactory position; 1g: X ray 12 months after surgery showed the cage remained in good position, with proper subchondral bone support and the femoral head in good shape, no progression in the necrotic area, and bone tunnel healed well; 1h: MRI 12 months after surgery showed the femoral head in good shape, the cage in place, and the signal in the primary necrotic area significantly improved compared with that before surgery.

3 讨论

ONFH 是骨科难治性疾病之一, 如未能及时诊断并有效治疗, 80%左右的 ONFH 会在发病后 1~4 年内出现股骨头变形塌陷, 最终不得不接受人工髋关节置换手术治疗^[7, 9]。因此, 对于 ONFH 患者不仅要早诊断, 尽快进行有效的保髋治疗也刻不容缓。

目前保髋手术方法众多, 如髓芯减压术、骨移植术、截骨术等, 但效果不一, 且暂没有任何一种保髋手术被完全接受认可^[10]。髓芯减压术可以降低股骨头内的压力, 改善股骨头的血供, 促进新骨的生长, 延缓或避免骨坏死进一步发展^[11-13]。但此术式虽然

简单易操作, 也存在诸多缺陷。Omran^[14]发现单隧道因隧道直径过大, 术后容易造成医源性塌陷。而细针多隧道虽然降低了塌陷的发生率, 但却因针道过细而无法完全清除死骨^[15]。除此之外, 单纯髓芯减压保髋治疗的 10 年生存率仅约为 50%^[16, 17], 故目前单纯的髓芯减压术应用已逐渐减少。但髓芯减压术在减压过程中的骨隧道, 为人工材料等置入创造了必要条件。髓芯减压联合钽棒治疗早期股骨头坏死有一定的成效^[18], 但却为后续的全髋关节置换带来诸多不便。与钽棒一样, 钛笼架具有与松质骨相似的蜂窝状结构, 疏松多孔, 且弹性模量与正常骨骼接近, 良好的生物相容性不仅能为股骨头提供稳定的力学支撑, 还有利于骨长入, 所以选择髓芯减压联合多孔钛笼架

置入进行保髋治疗,既可以最大程度上减轻股骨头坏死区的压力,还可以增强股骨头处的生物力学强度,减少术后塌陷的发生率。且多孔钛笼架避免了钽棒转为全髋关节置换所存在的手术难度。本研究在短期内均有不错的临床效果,所以笔者认为髓芯减压多孔钛笼架置入治疗早期股骨头坏死是一种有效的方法,但对于年龄>50岁且ARCO III A期以上患者应慎重选择;对于年轻患者,合并其他股骨头疾病者也应慎重考虑;但对于单纯股骨头坏死的年轻患者,ARCO III A期患者也可以作为一种尝试。

本研究为单中心回顾性研究,样本量较小、随访时间较短,尚需要大样本、多中心及更长时间的随访研究,来进行进一步的评价。

利益冲突声明 所有作者声明无利益冲突。

作者贡献声明 王峰: 酝酿和设计实验、实施研究、数据采集及分析和解释、起草文章、文章审阅、统计分析、支持性贡献; 吴波、付志厚、冯晓雷、康健: 酝酿和设计实验、实施研究、分析及解释数据、文章审阅、获取研究经费、提供行政及技术或材料支持、指导、支持性贡献; 牛旭、鲍哲明、刘江: 实施研究、数据采集及分析和解释、文章审阅、统计分析、支持性贡献

参考文献

- [1] Guggenbuhl P, Robin F, Cadiou S, et al. Etiology of avascular osteonecrosis of the femoral head [J]. *Morphologie*, 2021, 105 (349): 80-84. DOI:10.1016/j.morpho.2020.12.002.
- [2] Zhao D, Zhang F, Wang B, et al. Guidelines for clinical diagnosis and treatment of osteonecrosis of the femoral head in adults (2019 version) [J]. *J Orthop Translat*, 2020, 21: 100-110. DOI: 10.1016/j.jot.2019.12.004.
- [3] 张杰, 曹建泽, 刘永飞, 等. 激素性股骨头坏死发病机制的研究进展 [J]. *中国矫形外科杂志*, 2024, 32 (7): 620-624, 630. DOI: 10.3977/j.issn.1005-8478.2024.07.08.
Zhang J, Cao JZ, Liu YF, et al. Research progress on pathogenesis of steroid-induced osteonecrosis of the femoral head [J]. *Orthopedic Journal of China*, 2024, 32 (7): 620-624, 630. DOI: 10.3977/j.issn.1005-8478.2024.07.08.
- [4] 王学文, 韦标方. 冲击波治疗不同面积股骨头坏死的疗效比较 [J]. *中国矫形外科杂志*, 2022, 30 (8): 700-705. DOI: 10.3977/j.issn.1005-8478.2022.08.06.
Wang XW, Wei BF. Comparison of extracorporeal shock wave therapy for ARCO stage II femoral head necrosis with different lesion areas [J]. *Orthopedic Journal of China*, 2022, 30 (8): 700-705. DOI: 10.3977/j.issn.1005-8478.2022.08.06.
- [5] Learmonth ID, Young C, Rorabeck C. The operation of the century: total hip replacement [J]. *Lancet*, 2007, 370 (9597): 1508-1519. DOI: 10.1016/S0140-6736(07)60457-7.
- [6] Tan B, Li W, Zeng P, et al. Epidemiological study based on China Osteonecrosis of the Femoral Head Database [J]. *Orthop Surg*, 2021, 13 (1): 153-160. DOI: 10.1111/os.12857.
- [7] Zhao DW, Yu M, Hu K, et al. Prevalence of nontraumatic osteonecrosis of the femoral head and its associated risk factors in the Chinese population: results from a nationally representative survey [J]. *Chin Med J (Engl)*, 2015, 128 (21): 2843-2850. DOI: 10.4103/0366-6999.168017.
- [8] 杨德金, 郭邵逸, 邓旺, 等. 多孔钛金属笼(AVN CAGE)保髋治疗早期股骨头坏死的短期疗效 [J]. *中华骨与关节外科杂志*, 2022, 15 (6): 417-423. DOI: 10.3969/j.issn.2095-9958.2022.06.04.
Yang DJ, Gguo SY, Deng W, et al. Short-term clinical outcomes of AVN CAGE for hip preservation in early-stage osteonecrosis of the femoral head [J]. *Chinese Journal of Bone and Joint Surgery*, 2022, 15 (6): 417-423. DOI: 10.3969/j.issn.2095-9958.2022.06.04.
- [9] Hong YC, Luo RB, Lin T, et al. Efficacy of alendronate for preventing collapse of femoral head in adult patients with nontraumatic osteonecrosis [J]. *Biomed Res Int*, 2014, 2014: 716538. DOI: 10.1155/2014/716538.
- [10] Gharanizadeh K, Ravanbod H, Aminian A, et al. Simultaneous femoral head reduction osteotomy (FHRO) combined with periacetabular osteotomy (PAO) for the treatment of severe femoral head asphericity in Perthes disease [J]. *J Orthop Surg Res*, 2022, 17 (1): 461. DOI: 10.1186/s13018-022-03351-7.
- [11] Hua KC, Yang XG, Feng JT, et al. The efficacy and safety of core decompression for the treatment of femoral head necrosis: a systematic review and meta-analysis [J]. *J Orthop Surg Res*, 2019, 14 (1): 306. DOI: 10.1186/s13018-019-1359-7.
- [12] Pierce TP, Jauregui JJ, Elmallah RK, et al. A current review of core decompression in the treatment of osteonecrosis of the femoral head [J]. *Curr Rev Musculoskelet Med*, 2015, 8 (3): 228-232. DOI: 10.1007/s12178-015-9280-0.
- [13] Hines JT, Jo WL, Cui Q, et al. Osteonecrosis of the femoral head: an updated review of ARCO on pathogenesis, staging and treatment [J]. *J Korean Med Sci*, 2021, 36 (24): e177. DOI: 10.3346/jkms.2021.36.e177.
- [14] Al Omran A. Multiple drilling compared with standard core decompression for avascular necrosis of the femoral head in sickle cell disease patients [J]. *Arch Orthop Trauma Surg*, 2013, 133 (5): 609-613. DOI: 10.1007/s00402-013-1714-9.
- [15] 赵德伟, 程亮亮. 国内股骨头坏死保留髋关节手术治疗的十年回顾 [J]. *中华骨科杂志*, 2017, 37 (3): 183-192. DOI: 10.3760/cma.j.issn.0253-2352.2017.03.008.
Zhao DW, Cheng LL. Past decade on hip-preserving surgery for osteonecrosis of femoral head treatment in China [J]. *Chinese Journal of Orthopaedics*, 2017, 37 (3): 183-192. DOI: 10.3760/cma.j.issn.0253-2352.2017.03.008.
- [16] Martinot P, Dartus J, Leclerc JT, et al. Hip survival after plain core decompression alone versus bone morphogenetic protein and/or bone marrow reinjection with core decompression for avascular osteonecrosis of the femoral head: a retrospective case control study in ninety two patients [J]. *Int Orthop*, 2020, 44 (11): 2275-2282. DOI: 10.1007/s00264-020-04692-w. (下转 576 页)

- [4] Zimmerman GA, Lipow KI. Pneumocephalus with neurological deficit from hydrogen peroxide irrigation. Case illustration [J]. *J Neurosurg*, 2004, 100 (6) : 1122. DOI: 10.3171/jns.2004.100.6.1122.
- [5] Despond O, Fiset P. Oxygen venous embolism after the use of hydrogen peroxide during lumbar discectomy [J]. *Can J Anaesth*, 1997, 44 (4) : 410-413. DOI: 10.1007/BF03014463.
- [6] Zhao SL, Zhang XY, Xiao Y, et al. Gas embolism after hydrogen peroxide use during spine surgery: case report and literature review [J]. *World Neurosurg*, 2020, 143: 228-231. DOI: 10.1016/j.wneu.2020.07.210.
- [7] Wu T, Wang Q, Zhao M, et al. Two cases of fatal iatrogenic air embolism confirmed by autopsies [J]. *J Forensic Leg Med*, 2021, 82: 102209. DOI: 10.1016/j.jflm.2021.102209.
- [8] Imlay JA, Chin SM, Linn S. Toxic DNA damage by hydrogen peroxide through the Fenton reaction in vivo and in vitro [J]. *Science*, 1988, 240 (4852) : 640-642. DOI: 10.1126/science.2834821.
- [9] Linley E, Denyer SP, McDonnell G, Simons C, Maillard JY. Use of hydrogen peroxide as a biocide: new consideration of its mechanisms of biocidal action [J]. *J Antimicrob Chemother*, 2012, 67 (7) : 1589-1596. DOI: 10.1093/jac/dks129.
- [10] Presterl E, Suchomel M, Eder M, et al. Effects of alcohols, povidone-iodine and hydrogen peroxide on biofilms of *Staphylococcus epidermidis* [J]. *J Antimicrob Chemother*, 2007, 60 (2) : 417-420. DOI: 10.1093/jac/dkm221.
- [11] Thomas GW, Rael LT, Bar-Or R, et al. Mechanisms of delayed wound healing by commonly used antiseptics [J]. *J Trauma*, 2009, 66 (1) : 82-91. DOI: 10.1097/TA.0b013e31818b146d.
- [12] Prabhakar H, Rath GP, Dash HH. Bradycardia following hydrogen peroxide irrigation during posterior fossa surgery [J]. *Anaesthesia*, 2006, 61 (9) : 914. DOI: 10.1111/j.1365-2044.2006.04772.x.
- [13] Ho AM. Is emergency thoracotomy always the most appropriate immediate intervention for systemic air embolism after lung trauma [J]. *Chest*, 1999, 116 (1) : 234-237. DOI: 10.1378/chest.116.1.234.
- (收稿:2024-01-12 修回:2024-06-17)
(同行评议专家: 吴波, 高金亮, 袁永建)
(本文编辑: 闫承杰)

(上接 573 页)

- [17] Li M, Ma Y, Fu G, et al. 10-year follow-up results of the prospective, double-blinded, randomized, controlled study on autologous bone marrow buffy coat grafting combined with core decompression in patients with avascular necrosis of the femoral head [J]. *Stem Cell Res Ther*, 2020, 11 (1) : 287. DOI: 10.1186/s13287-020-01810-8.
- [18] 胡焜, 王杨, 周才盛, 等. 两种保髋手术治疗成人股骨头坏死初步结果比较 [J]. *中国矫形外科杂志*, 2021, 29 (21) : 2005-2008. DOI: 10.3977/j.issn.1005-8478.2021.21.20.
- Hu K, Wang Y, Zhou CS, et al. Comparison of preliminary clinical outcomes of two hip-preserving surgeries for femoral head necrosis in adult [J]. *Orthopedic Journal of China*, 2021, 29 (21) : 2005-2008. DOI: 10.3977/j.issn.1005-8478.2021.21.20.
- (收稿:2024-04-17 修回:2024-10-30)
(同行评议专家: 谭洪波, 王富友)
(本文编辑: 郭秀婷)