

· 临床研究 ·

全膝假体周围感染的清创抗生素假体保留治疗

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摘要: [目的] 探讨初次全膝置换术后假体周围感染(periprosthetic joint infection, PJI)的清创抗生素假体保留(debridement, antibiotics, and implant retention, DAIR)治疗的临床效果。[方法] 回顾性分析2016年1月—2020年6月在本科采用DAIR治疗的33例初次全膝置换术后感染患者的临床资料,其中术后3个月内感染28例,术后4~6个月内感染5例。评价临床及检验结果。[结果] 所有患者均顺利完成手术,手术时间平均(113.5±12.4)min,术中失血量平均(43.5±7.4)ml。随访(44.1±11.7)个月,28例手术成功,成功率84.8%;5例手术失败,其中初次置换术后3个月内感染2例,术后4~6个月内感染3例,失败率15.2%。与术前相比,末次随访时,患者疼痛VAS评分[(5.1±1.4), (1.4±0.9), $P<0.001$]显著降低,膝关节KSS功能评分[(43.0±9.9), (81.8±11.3), $P<0.001$]、KSS临床评分[(37.8±14.9), (84.0±7.0), $P<0.001$]均显著增加。检验方面,15例(45.5%)细菌培养结果阴性,18例(54.5%)细菌培养阳性。随时间推移,WBC、CRP、ESR均显著降低($P<0.05$)。[结论] 采用DAIR治疗PJI可取得较好的早期疗效。相比术后3个月内PJI,术后4~6个月内的PJI,失败率较高。

关键词: 全膝关节置换术, 假体周围感染, 清创, 抗生素假体保留

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Abstract: [Objective] To investigate the clinical outcomes of debridement, antibiotics, and implant retention (DAIR) for periprosthetic joint infection (PJI) after primary total knee arthroplasty (TKA). [Methods] A retrospective study was conducted on 33 patients who received DAIR for PJI in our hospital from January 2016 to June 2020, including 28 patients suffered from PJI within 3 months after TKA, and 5 patients in 4~6 months after surgery. The clinical and laboratory results were evaluated. [Results] All patients had DAIR performed successfully with operation time of (113.5±12.4) min, and intraoperative blood loss of (43.5±7.4) ml, and were followed up for (44.1±11.7) months. Of them, 28 cases were successful with the success rate of 84.8%, whereas 5 cases were of surgical failure, including 2 cases infected within 3 months after the initial replacement, 3 cases infected in 4 to 6 months after the operation, with the failure rate of 15.2%. Compared with those before DAIR, the VAS score for pain [(5.1±1.4), (1.4±0.9), $P<0.001$] significantly reduced, while the KSS functional score [(43.0±9.9), (81.8±11.3), $P<0.001$] and KSS clinical score [(37.8±14.9), (84.0±7.0), $P<0.001$] significantly increased at the latest follow-up. In term of lab test, bacterial culture were negative in 15 cases (45.5%), whereas positive in 18 cases (54.5%). The WBC, CRP and ESR were significantly decreased over time ($P<0.05$). [Conclusion] The DAIR does achieve satisfactory early clinical consequences for PJI. However, its failure rate for PJI in 4 to 6 months after primary TKA is relatively higher than that within 3 months after the surgery.

Key words: total knee arthroplasty (TKA), periprosthetic joint infection (PJI), debridement, antibiotics and implant retention (DAIR)

全膝关节置换术(total knee arthroplasty, TKA)是治疗晚期膝骨关节炎最有效的方式,对于缓解疼痛、改善关节功能效果明显。随着TKA手术量增多,假体相关并发症也在不断出现。假体周围感染

(periprosthetic joint infection, PJI)作为TKA术后最严重的并发症,往往会造成灾难性后果。据相关文献报道,PJI的发生率为0.4%~2%^[1]。目前对于PJI的治疗方式主要有保留假体清创术(debridement, antibiot-

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ics, and implant retention, DAIR)、一期翻修、二期翻修及单纯应用抗菌药物治疗4种方式^[2]。DAIR作为治疗早期PJI的方式,具有创伤小、恢复时间快、费用低等优点,但是据相关文献报道,DAIR成功率差异较大^[3]。本研究通过回顾性分析本科2016年1月—2020年6月采用DAIR治疗的初次膝关节置换术后感染的33例患者,探讨DAIR的疗效,为临床评价该手术方式提供参考。

1 临床资料

1.1 一般资料

回顾性分析2016年1月—2020年6月本科收治的诊断为PJI的33例患者的临床资料,患者均为膝关节置换术后被诊断为PJI的患者,诊断基于美国肌肉骨骼感染协会PJI诊断标准,均采用DAIR进行治疗,术中均确认假体稳定性良好,无松动。其中男11例,女22例,年龄55~78岁,平均(65.5±5.5)岁,初次置换术后3个月内感染28例,术后4~6个月内感染5例。DAIR术前7例出现窦道,2例假体外露。本研究经医院伦理委员会审批,所有患者被告知治疗方案后均签字同意。

1.2 治疗方法

术前行影像检查,确认假体无松动(图1a)。患者均取仰卧位,全麻,原手术切口逐层切开显露关节,取深部关节液送细菌培养,不同部位感染组织(至少5处)送病理(图1b),测试假体稳定性(图1c),取出聚乙烯衬垫,使用组织剪、刮匙、咬骨钳彻底清除感染及坏死组织,至出现新鲜组织。有窦道的予以切除并探查内外口。使用过氧化氢溶液及碘伏溶液反复浸泡冲洗3次。术区再次消毒,加盖无菌单,更换手套、手术衣。大量生理盐水冲洗后毕更换聚乙烯衬垫,留置负压引流管1根,关节腔内撒入万古霉素粉剂,逐层缝合,加压包扎。引流管夹闭4h后打开,常规放置至少72h,最长可达1周,引流<50 ml/24 h时拔除。根据药敏结果选择敏感性抗生素进行治疗,培养阴性者选择经验性抗生素进行治疗。术后12h卧床期间进行股四头肌的等长等张收缩、踝泵运动等功能锻炼,72h后开始进行患侧膝关节的主被动功能锻炼并早期下床活动,预防血栓形成。

1.3 评价指标

记录临床结果,包括膝关节协会评分(knee society score, KSS)、采用疼痛视觉模拟评分(visual an-

alogue scale, VAS)及DAIR情况。记录检验结果,包括细菌培养、WBC、ESR、CRP,观察术后伤口愈合、术后是否感染复发及并发症情况,双下肢动静脉彩超判断有无血栓形成。

DAIR治愈标准:(1)伤口愈合良好,无膝关节静息痛,关节活动功能基本正常;(2)停用抗生素后,持续2年无复发症状出现^[4];(3)X线片示假体无松动。DAIR失败标准:(1)DAIR后感染症状仍存在;(2)需再次清创或行二期翻修术;(3)因感染原因导致死亡或截肢。

1.4 统计学方法

采用SPSS 22.0统计软件对数据进行统计处理,计量数据均以 $\bar{x} \pm s$ 表示,采用两独立样本 t 检验或ANOVA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,术中无血管及神经损伤等并发症。手术时间平均(113.5±12.4)min,术中失血量平均(43.5±7.4)ml,引流管拔除时间平均(5.6±1.3)d,初次下地行走时间平均(8.9±2.5)d。

患者均获随访22~76个月,平均(44.1±11.7)个月。28例手术成功,其中初次置换术后3个月内感染26例,术后4~6个月内感染2例,成功率84.8%(28/33);5例手术失败,其中初次置换术后3个月内感染2例,术后4~6个月内感染3例,失败率15.2%(5/33);1例术后发生深静脉血栓。33例患者术后随访结果见表1,术后随时间推移,患者疼痛VAS评分显著降低($P < 0.05$),膝关节KSS功能评分、KSS临床评分均显著增加($P < 0.05$),膝外观见图1d。

2.2 检验结果

33例患者细菌培养结果阴性15例(45.5%),细菌培养阳性18例(54.5%),其中甲氧西林敏感金黄色葡萄球菌培养阳性11例(61.1%),耐甲氧西林金黄色葡萄球菌培养阳性5例(27.8%),表皮葡萄球菌培养阳性2例(11.1%)。实验室检查结果见表1,随时间推移,WBC、CRP、ESR较术前均显著降低($P < 0.05$)。

3 讨论

DAIR作为治疗急性PJI的经典手术方式,因治

疗成功率的波动较大，许多人对其治疗效果仍然存在疑问。波动的原因尚无明确定论。如何提高 DAIR 的

成功率仍值得探索。

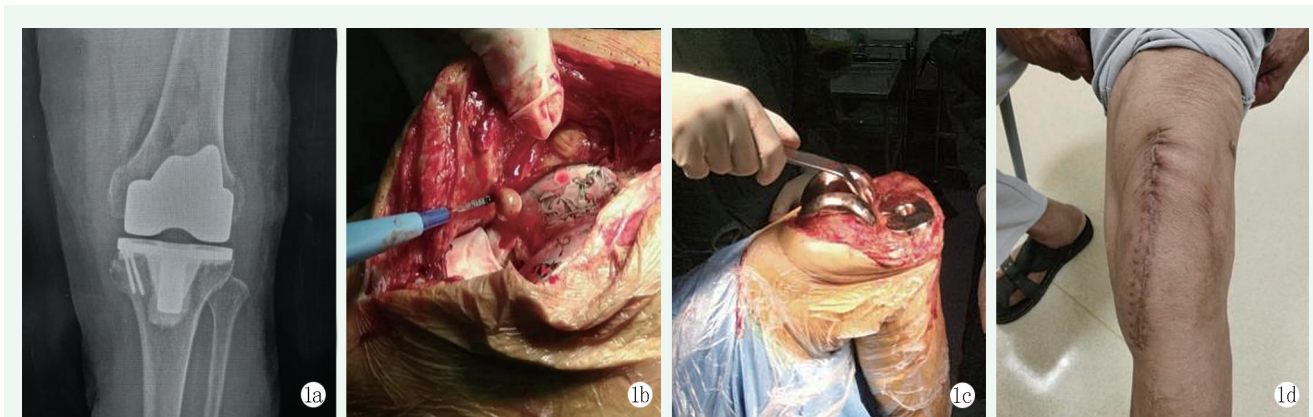


图 1 患者，男，70 岁，全膝关节置换术后 1 个月，刀口处肿胀，局部渗出，曾于外院行“刀口清创+VSD 负压吸引及抗感染治疗”，效果不佳。1a: 入院后左膝关节正位 X 线片显示假体位置良好，无松动；1b: 术中可见关节腔内大量脓性液体，假体表面有脓苔覆盖；1c: 术中检查假体稳定性，屈曲膝关节，取出聚乙烯垫片，彻底清除周围感染及坏死组织；1d: 术后 6 个月，无关节红肿，无渗出，手术切口愈合良好，关节活动度可。

Figure 1. A 70-year-old male suffered from swelling and local exudation of the incision 1 month after total knee arthroplasty, had received debridement, vacuum sealing drainage and antibiotic therapy in another hospital, but the results were not satisfactory. 1a: At admission into our hospital, the anteroposterior X-ray of the left knee joint showed that the prosthesis was in good position without loosening. 1b: A large amount of purulent fluid could be seen in the joint cavity, and the surface of the prosthesis was covered with purulent fur. 1c: Intraoperatively, stability of prosthesis was checked. With knee flexion, polyethylene insert was removed, and surrounding infection and necrotic tissue were completely removed. 1d: Six months after surgery, no redness, exudation and swelling of the joint were seen, with good healing of the surgical incision and good joint motion.

表 1 33 例患者临床资料 ($\bar{x} \pm s$) 比较

Table 1 Comparison of clinical documents ($\bar{x} \pm s$) in the 33 patients

指标	术前	出院时	末次随访	P 值
疼痛 VAS 评分(分)	5.1±1.4	2.8±1.0	1.4±0.9	<0.001
KSS 功能评分(分)	43.0±9.9	66.2±10.5	81.8±11.3	<0.001
KSS 临床评分(分)	37.8±14.9	61.9±10.6	84.0±7.0	<0.001
WBC (10 ⁹ /L)	9.1±3.7	8.7±1.9	7.2±1.1	<0.001
ESR (mm/h)	59.0±27.4	57.9±21.0	11.8±7.0	<0.001
CRP (g/L)	68.1±53.1	59.6±17.0	5.4±3.0	<0.001

细菌附着在假体表面，3 周时间可形成成熟的生物膜^[5]，生物膜的存在为细菌提供良好的生存环境，相关研究报告对比了生物膜内的细菌和分散状态的细菌，细菌的耐药性增强了 10~1 000 倍^[6]。近些年，生物膜的形成也被认为能导致病原体检出率不佳^[7, 8]。在 Ottesen 等^[9]的一项研究中表明，患者在症状出现后 42 d 内行 DAIR 的成功率达 88%，该研究还报道了 10 例症状持续超过 90 d 的患者，DAIR 成功率为 60%。本研究中初次 TKA 后 3 个月内感染行 DAIR 成功率达 92.9%。DAIR 对于晚期感染或慢性感染的效果还有待探究。

本研究所纳入 33 例患者中，细菌培养阳性 18 例 (54.5%)，近年来新兴技术如二代测序分子诊断技术

(metagenomic next generation sequencing, mNGS) 的应用对明确感染病原体也有帮助。Street^[10] 通过 mNGS 和超声处理液培养的对比表明在物种水平上，mNGS 组诊断敏感性 88%，特异性 88%；属级敏感性达 93%，证明了此技术能在 PJI 中提供较高的诊断准确性，另有研究表明此项技术可提高病原微生物检出率^[11-13]，mNGS 因其检测速度快，特异性和敏感性较高^[14]，有望成为 PJI 快速诊断工具的潜力。

术后抗生素的使用，根据细菌培养及药敏结果针对性使用敏感抗生素，采用个体化抗生素治疗方案。根据美国传染病学会在 2013 年提出的针对急性 PJI 的治疗指南，建议静脉使用抗生素 2~6 周，膝关节感染口服抗生素 6 个月。针对提高抗生素局部浓度及持续时间，近年来所采取的载抗生素硫酸钙技术，有利于延长抗生素释放周期^[15]。对于病原菌培养阴性或药敏结果未得出的患者，建议静脉滴注万古霉素及喹诺酮类，随后继续口服利福平及喹诺酮类治疗^[16]。

初次全膝关节置换术后 3 个月内的感染，采用保留假体清创可取得较好的早期疗效，初次置换术后 4~6 个月内的感染，保留假体清创失败率较高。术前明确诊断、术中清创彻底、术后针对性敏感抗

生素的足量使用均对感染的控制起着关键作用。

参考文献

- [1] Sloan M, Lee GC. Is conversion TKA a primary or revision? Clinical course and complication risks approximating revision TKA rather than primary TKA [J]. *J Arthroplasty*, 2021, 36 (8) : 2685–2690. DOI: 10.1016/j.arth.2021.03.034.
- [2] 中华医学会骨科学分会关节外科学组,《中国 PJI 诊断和治疗指南》编写委员会. 中国人工关节感染诊断与治疗指南 [J]. *中华外科杂志*, 2021, 59 (6) : 430–442. DOI: 10.3760/cma.j.cn112139–20210309–00120.
Workgroup on the Guidelines for the Diagnosis and Treatment of Prosthetic Joint Infection; Joint Surgery Committee of the Chinese Orthopaedic Association. Guidelines for the diagnosis and treatment of prosthetic joint infection [J]. *Chin J Surg*, 2021, 59 (6) : 430–442. DOI: 10.3760/cma.j.cn112139–20210309–00120.
- [3] Kunutsor SK, Beswick AD, Whitehouse MR, et al. Debridement, antibiotics and implant retention for periprosthetic joint infections: A systematic review and meta-analysis of treatment outcomes [J]. *J Infect*, 2018, 77 (6) : 479–488. DOI: 10.1016/j.jinf.2018.08.017.
- [4] 徐一宏, 徐卫东. 急性假体周围感染清创方法及抗生素策略 [J]. *中华骨与关节外科杂志*, 2018, 11 (6) : 475–480. DOI: 10.3969/j.issn.2095–9958.2018.06.017.
Xu YH, Xu WD. Debridement and antibiotics treatment for acute periprosthetic joint infection [J]. *Chin J Bone Joint Surg*, 2018, 11 (6) : 475–480. DOI: 10.3969/j.issn.2095–9958.2018.06.017.
- [5] Wildeman P, Tevell S, Eriksson C, et al. Genomic characterization and outcome of prosthetic joint infections caused by *Staphylococcus aureus* [J]. *Sci Rep*, 2020, 10 (1) : 5938. DOI: 10.1038/s41598–020–62751–z.
- [6] Lamret F, Colin M, Mongaret C, et al. Antibiotic tolerance of *Staphylococcus aureus* biofilm in periprosthetic joint infections and antibiofilm strategies [J]. *Antibiotics (Basel)*, 2020, 9 (9) : 547. DOI: 10.3390/antibiotics9090547.
- [7] Bashyal RK, Mathew M, Bowen E, et al. A novel irrigant to eliminate planktonic bacteria and eradicate biofilm superstructure with persistent effect during total hip arthroplasty [J]. *J Arthroplasty*, 2022, 37 (7S) : S647–S652. DOI: 10.1016/j.arth.2022.01.045.
- [8] Visperas A, Santana D, Klika AK, et al. Current treatments for biofilm-associated periprosthetic joint infection and new potential strategies [J]. *J Orthop Res*, 2022, 40 (7) : 1477–1491. DOI: 10.1002/jor.25345.
- [9] Ottesen CS, Troelsen A, Sandholdt H, et al. Acceptable success rate in patients with periprosthetic knee joint infection treated with debridement, antibiotics, and implant retention [J]. *J Arthroplasty*, 2019, 34 (2) : 365–368. DOI: 10.1016/j.arth.2018.09.088.
- [10] Street TL, Sanderson ND, Atkins BL, et al. Molecular diagnosis of orthopedic-device-related infection directly from sonication fluid by metagenomic sequencing [J]. *J Clin Microbiol*, 2017, 55 (8) : 2334–2347. DOI: 10.1128/jcm.00462–17.
- [11] Fang X, Cai Y, Shi T, et al. Detecting the presence of bacteria in low-volume preoperative aspirated synovial fluid by metagenomic next-generation sequencing [J]. *Int J Infect Dis*, 2020, 99: 108–116. DOI: 10.1016/j.ijid.2020.07.039.
- [12] Tan J, Liu Y, Ehnert S, et al. The effectiveness of metagenomic next-generation sequencing in the diagnosis of prosthetic joint infection: a systematic review and Meta-analysis [J]. *Front Cell Infect Microbiol*, 2022, 12: 875822. DOI: 10.3389/fcimb.2022.875822.
- [13] He R, Wang Q, Wang J, et al. Better choice of the type of specimen used for untargeted metagenomic sequencing in the diagnosis of periprosthetic joint infections [J]. *Bone Joint J*, 2021, 103–B (5) : 923–930. DOI: 10.1302/0301–620X.103B5.BJJ–2020–0745.R1.
- [14] 李韬, 高琪乐, 刘少华, 等. 宏基因组测序在骨关节感染诊断中的应用前景 [J]. *中国矫形外科杂志*, 2022, 30 (10) : 898–901. DOI: 10.3977/j.issn.1005–8478.2022.10.07.
Li T, Gao QL, Liu SH, et al. The application prospects of metagenomic next-generation sequencing in the diagnosis of osteoarticular infections [J]. *Orthop J Chin*, 2022, 30 (10) : 898–901. DOI: 10.3977/j.issn.1005–8478.2022.10.07.
- [15] 任远中, 王昌耀, 姜雅萍, 等. 关节镜联合万古霉素硫酸钙治疗膝关节感染 [J]. *中国矫形外科杂志*, 2020, 28 (17) : 1543–1547. DOI: 10.3977/j.issn.1005–8478.2020.17.02.
Ren YZ, Wang CY, Jiang YP, et al. Arthroscopic debridement combined with implantation of vancomycin–calcium sulfate for septic knee arthritis [J]. *Orthop J Chin*, 2020, 28 (17) : 1543–1547. DOI: 10.3977/j.issn.1005–8478.2020.17.02.
- [16] 程翔, 梁玉龙, 邵宏翊, 等. 假体周围感染病原菌及耐药性分析 [J]. *中国矫形外科杂志*, 2020, 28 (11) : 870–875. DOI: 10.3977/j.issn.1005–8478.2020.11.02.
Cheng X, Liang YL, Shao HY, et al. An analysis on pathogens and their drug resistance in periprosthetic joint infection [J]. *Orthop J Chin*, 2020, 28 (11) : 870–875. DOI: 10.3977/j.issn.1005–8478.2020.11.02.

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