

一期翻修术治疗膝关节假体周围感染的疗效分析

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[摘要] 目的 探讨一期膝关节翻修术治疗膝关节假体周围感染的安全性及有效性。方法 选取 2015 年 1 月 ~ 2018 年 6 月厦门大学附属福州第二医院因膝关节假体周围感染接受一期膝关节翻修术的患者 28 例。收集患者的人口统计学资料、感染病原, 并回顾性分析患者术前及术后 KSS、HSS 与 OKS 评分及影像学资料, 评估膝关节假体周围感染接受一期膝关节翻修术的安全性及临床疗效。结果 28 例接受一期膝关节翻修术的患者, 男 14 例, 女 14 例, 平均年龄(65.3 ± 10.1)岁, 截止到末次随访, 除 1 例患者死亡(死于心肌梗死)失访外, 其余 27 例患者平均随访 25.7 个月(13 ~ 39 个月), 未发现假体松动及假体周围感染复发。患者术前 KSS 评分平均(34.19 ± 13.00)分, 末次随访时平均(76.37 ± 16.46)分; 术前 HSS 评分平均(36.03 ± 13.39)分, 末次随访时平均(71.24 ± 16.39)分; 术前 OKS 评分平均(16.62 ± 3.47)分, 末次随访时平均(27.43 ± 6.02)分, 差异有统计学意义($P < 0.05$)。结论 在选择合适适应证情况下, 膝关节置换术后假体周围感染的患者通过一期膝关节翻修术可以有效控制感染并重建膝关节功能。

[关键词] 膝关节; 假体周围感染; 一期翻修

[中图分类号] R687.4

[文献标识码] A

[文章编号] 2095-0616 (2019)24-07-06

Efficacy analysis of one-stage revision surgery in the treatment of periprosthetic knee infection

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[Abstract] Objective To investigate the safety and effectiveness of one-stage revision surgery of knee joint in the treatment of periprosthetic knee infection. **Methods** 28 patients undergoing one-stage revision surgery of knee joint for the treatment of periprosthetic knee infection at Fuzhou Second Affiliated Hospital of Xiamen University from January 2015 to June 2018 were selected. The patient's demographic data and infectious pathogens were collected, and the KSS, HSS and OKS scores as well as imaging data before and after surgery were analyzed retrospectively. The safety and clinical efficacy of one-stage revision surgery of knee joint in the treatment of periprosthetic knee infection were evaluated. **Results** Of the 28 patients undergoing one-stage revision surgery of knee joint, 14 were male and 14 were female, with an average age of (65.3 ± 10.1) years old. As of the last follow-up, the average follow-up time of the remaining 27 patients was 25.7 months (13-39 months), except for one patient who was lost of follow-up due to death (died of myocardial infarction), and no loosening of the prosthesis and recurrence of periprosthetic infection were found. The preoperative KSS score was (34.19 ± 13.00) points, and the average score at the last follow-up was (76.37 ± 16.46) points. The preoperative HSS score was (36.03 ± 13.39) points, and the average score at the last follow-up was (71.24 ± 16.39) points. The preoperative OKS score was (16.62 ± 3.47) points, and the average score at the last follow-up was (27.43 ± 6.02) points. The differences in the above results were statistically significant ($P < 0.05$). **Conclusion** In the case of selecting the appropriate indication, patients with periprosthetic infection after knee arthroplasty can effectively control the infection and reconstruct knee function through one-stage revision surgery of knee joint.

[Key words] Knee joint; Periprosthetic infection; One-stage revision

假体周围感染(periprosthetic joint infection, PJI)是全膝关节置换术(total knee arthroplasty, TKA)

[基金项目] 福建省自然科学基金项目(2017J01333)。

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最可怕的并发症之一,也是导致膝关节翻修最常见的原因之一^[1-2]。据报道,膝关节翻修术中PJI所占的比例高达47%^[3]。目前,假体周围感染的主要治疗方案为手术联合抗生素治疗^[4]。二期翻修术仍然

是治疗假体周围感染的金标准,使用二期翻修术治疗假体周围感染的成功率在90%以上^[1,5-6]。然而,二期翻修术也有其自身的局限性,如多次手术可能增加对骨骼和周围软组织的损害、延长PJI的治疗周期及增加治疗费用^[7]。一期翻修术以治疗周期短、治疗费用低及临床效果与二期翻修术相当,已逐渐成为更有吸引力的替代方案^[2,8],在控制感染的临床疗效方面,一期翻修术的复发率为5%~25%,与二期翻修术的复发率9%~20%无显著差异^[1,9-11]。Haddad等^[5]对28例因膝关节置换术后慢性感染接受一期膝关节翻修术的患者进行研究,共随访3年,随访结果显示28例患者均未发生感染复发。

本研究中,在合理选择适应证的情况下,对膝关节假体周围感染的患者进行一期翻修术,通过回顾性分析,分析患者术前及术后KSS、HSS及OKS评分及影像学资料,探讨一期膝关节翻修术治疗膝关节假体周围感染的安全性及有效性。

1 资料与方法

1.1 一般资料

本研究经厦门大学附属福州市第二医院伦理委员会批准。选取2015年1月~2018年6月厦门大学附属福州第二医院因膝关节假体周围感染接受一期膝关节翻修术的28例患者(28膝)进行回顾性分析,其中男14例,女14例,年龄48~83岁,平均(65.3±10.1)岁。

1.2 纳入标准

(1)符合2018年假体周围感染国际共识中假体周围感染的诊断标准;(2)无明显骨质丢失及软组织缺损;(3)非免疫抑制性疾病且未发生败血症、贫血、癌症等慢性病;(4)术前分离单一低毒力病原体且已知敏感抗生素^[4]。

1.3 排除标准

(1)大量骨质丢失(如Anderson III型缺损);(2)软组织缺损严重,术后创口可能无法闭合;(3)合并免疫抑制性疾病;(4)术前分离多种病原体感染或多种耐药菌感染;(5)无法进行局部抗菌治疗^[4-5,7,11-14]。

1.4 手术方法及抗生素治疗方案

所有患者均采用全身麻醉,仰卧位,常规大腿根部行止血带,均行前正中手术入路。术中行需氧菌培养、厌氧菌培养、抗酸杆菌及真菌培养,培养时间至少1周,必要时延长至4周。为提高培养的阳性率,术前至少停止使用抗生素2周。术中彻底清创,依次使用双氧水、碘伏浸泡,浸泡时间每次3min。接着在脉冲冲洗枪辅助下以生理盐水彻底冲洗膝关节,缝合伤口。重新消毒铺巾,并使用新

的手术器械。根据术前病原微生物药敏试验结果,使用含敏感抗生素负载骨水泥进行新假体植入。植入假体后[典型病例使用NexGen LCCK假体(ZIMMER BIOMET, Warsaw, Indiana 46580, USA),生产批号11022776],将敏感抗生素置于膝关节腔,放置引流管,缝合伤口。所有手术均由操作熟练的关节外科医师完成,均为同一手术组。术后每2天取引流液行关节液常规培养及关节腔抗生素局部注射,保留引流管直至引流量<50mL/d或者关节液常规示多核细胞百分比≤60%或引流管保留≥7d。拔除引流管后鼓励患者进行功能锻炼,包括膝关节屈伸活动以及膝关节周围肌肉功能锻炼,并逐渐在助行器保护下行走。术后,继续根据细菌培养及药敏试验结果选择敏感抗生素治疗至少6周,静脉滴注配合关节腔注射2周后口服4~6周,直至炎症标志物(CRP, ESR, WBC)恢复到稳定标准(90%的病例标准化水平)。术后第3天、1、2、4周复查血常规、C反应蛋白、血沉及肝肾功能,以后每月复查一次。

1.5 随访和评估

在术后3、6个月、1年对患者进行随访,以后每年随访一次。每次随访时行膝关节正侧位X线片检查,采用美国膝关节协会膝评分(KSS评分)^[15]、美国特种外科医院膝关节评分(HSS评分)^[16]以及牛津大学膝关节评分(OKS评分)^[17]评估膝关节功能。评估和记录术前及末次随访膝关节KSS评分、HSS评分、OKS评分和影像学资料,以评估一期翻修术治疗膝关节假体周围感染的疗效。

1.6 统计学处理

采用SPSS22.0软件进行统计学处理,计量资料以($\bar{x}\pm s$)表示,采用 t 检验, $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 细菌学结果及感染控制率

本组28例膝关节假体周围感染的患者术前细菌培养均为阳性,其中金黄色葡萄球菌6例,表皮葡萄球菌12例,肺炎克雷伯菌3例,链球菌4例,大肠埃希菌3例。术后所有患者至末次随访均未发现再次感染,感染控制率为100%。

2.2 膝关节功能评分及影像学结果

除1例患者死于心肌梗死失访外,其余27例患者一期膝关节翻修术后平均随访25.7个月(13~39个月),均未见感染复发。影像学检查结果提示,27例患者的假体均固定良好,未发现明显松动,典型病例影像资料见图1。所有经过一期膝

关节翻修术患者末次随访时 KSS 评分较术前均有明显提高,差异有统计学意义($P < 0.05$);末次随访时 HSS 评分较术前均有明显提高,差异有统计学意义($P < 0.05$);末次随访时 OKS 评分较术前均有明显提高,差异有统计学意义($P < 0.05$)。

表1 患者术前、术后KSS、HSS、OKS评分比较 ($\bar{x} \pm s$, 分)

| 时间 | KSS评分 | HSS评分 | OKS评分 |
|----------|---------------|---------------|--------------|
| 术前 | 34.19 ± 13.00 | 36.03 ± 13.39 | 16.62 ± 3.47 |
| 末次随访 | 76.37 ± 16.46 | 71.24 ± 16.39 | 27.43 ± 6.02 |
| <i>t</i> | -20.734 | -27.900 | -20.160 |
| <i>P</i> | <0.05 | <0.05 | <0.05 |



图1 患者男性,72岁,左膝关节置换术后2年发生假体周围感染
a:术前X线片;b:术后X线片,假体固定良好

3 讨论

膝关节假体周围感染是全膝关节置换术后严重的并发症之一。尽管发生率较低,但随着人口老龄化及全膝关节置换术患者基数的增大,PJI 仍然是一个巨大的挑战^[11,18]。膝关节假体周围感染的手术治疗方法包括保留假体的清创术、一期翻修术、二期翻修术、膝关节切除融合术等,截肢为终末的手术治疗方案^[19]。膝关节假体周围感染的治疗根本在于移除感染假体、暴露生物膜内病原菌^[20]。尽管在急性 PJI 的早期阶段,保留假体的清创术是

可行的,但一旦细菌学培养出明确的病原体就必须移除所有假体。采用一期翻修术还是二期翻修术治疗膝关节假体周围感染存在一定的争论^[21]。一期旷置联合二期翻修仍然是治疗膝关节假体周围感染的金标准,大量文献报道了二期翻修术对于治疗假体周围感染取得良好结果,感染清除率高达90%^[5,10,22-24]。但患者在二期翻修术中由于接受多次手术,感染、麻醉相关风险及发生耐药反应可能性增加,同时限制了患者在两次手术之间的日常活动。当患者行二期翻修术时,实际上部分患者在一期间隔物植入后未完成二期的假体植入^[22-24]。与二期翻修术相比,一期翻修术可以缩短住院时间,避免第二次手术相关的并发症,改善术后功能和疼痛,降低成本。然而,一期翻修术对最终感染控制情况及感染复发率仍存在争议。

因此本研究中,在合理选择适应证的情况下采用一期翻修方案治疗膝关节假体周围感染,术后随访28例患者均无感染复发,感染控制率达100%。优良的感染控制率高于之前的文献报道。2018年,Yaghmour及其团队对3645例一期膝关节翻修术进行系统分析,再感染率范围为0~38%,平均值为15.42%^[25]。在Massin等^[26]对285例患者(其中108例患者行一期翻修及177例患者行二期翻修)的多中心回顾性对照研究显示:一期翻修感染复发率为23.15%,二期翻修感染复发率为31.07%,认为一期翻修在减轻患者负担、改善患者术后膝关节功能的同时不增加感染复发的风险。在另一篇文献中,Romano及其团队分别报道了二期翻修术(38项研究)和一期翻修术(6项研究)的平均感染根除率分别为89.8%和81.8%,提示二期翻修术的感染率可能较高^[27]。与标准的二期翻修术相比,关于一期膝翻修术的有效性的比较研究较少。通过之前文献报道,笔者发现在一期翻修术中有较高感染根除率的研究中,合理选择一期翻修术的适应证显得尤其的重要。故本研究选择在术前细菌培养分离单一病原体且已知敏感抗生素的患者,排除MRSA和MRSE等难以控制的感染病原微生物、合并免疫抑制性疾病、骨缺损及软组织损伤严重的患者^[13-14]。术中在冲洗前从不同区域采集多份组织标本行细菌培养、基因二代测序及病理学检测,以提高培养的阳性率,从而术后能更精确进行抗感染治疗。术中行彻底清创,包括物理清创,即切除所有感染及可疑感染的组织、滑膜及窦道。术中过氧化氢溶液及碘伏溶液浸泡,以及脉冲枪辅助冲洗可以起到化学清创的作用^[28,31]。彻底清创后,合理

的抗生素治疗方案对根除感染至关重要^[30]。术中
含抗生素骨水泥、术中敏感抗生素关节腔置入、术
后关节腔局部抗生素注射、术后静脉及口服抗生素
是抗生素治疗方案的四重奏。关节腔抗生素应用
不仅在局部可以达到一个较高的治疗浓度,同时也
不会增加假体的第三方磨损。在本研究中,术后 2
周静脉滴注配合关节腔注射抗生素后改口服 4 ~ 6
周,抗生素治疗时间达 6 ~ 8 周,这与 2018 年假体
周围感染国际共识相符^[31-32]。

膝关节假体周围感染的治疗目的不仅在于
根除感染,同时也需要重建膝关节功能。Jietal
等^[33]采用一期翻修治疗膝关节假体周围感染长
达 5 年随访的回顾性研究显示,术后 HSS 从术前
平均 46 分(38 ~ 57 分)显著增加至术后平均 78
分(73 ~ 84 分)。Tibrewal 等^[12]在对 50 例患者
长达平均 10 年的随访结果显示 OKS 评分从术前
平均 14.5 分(6 ~ 25 分)提升至术后平均 34.5 分
(26 ~ 38 分)。Haddad 等^[5]在对 28 例患者回顾性
对照研究显示,一期翻修组术后 KSS 评分从术前平
均 32 分(18 ~ 65 分)显著提升至术后平均 88 分
(38 ~ 97 分),明显高于二期翻修组 KSS 术后评分
76 分(29 ~ 93 分)。而 Nagra 等^[34]报道的研究的
亚组分析表明,通过合理的患者选择和手术治疗,
一期膝关节翻修术治疗 PJI 与较低的复发率和较
好的功能结果相关。本组病例中通过一期膝关节
翻修术治疗膝关节假体周围感染,术后 KSS、HSS、
OKS 评分较术前均明显提高,影像学表现假体位
固定良好,与文献报道基本相符。这些结果可能表
明行一期翻修术后膝关节功能更快重建与恢复的
潜在优势。

本研究存在一定的不足之处。第一,本组患者
随访时间较短,不足以确定患者感染的根除情况,
仍存在感染复发的风险。因此,仍有必要对这批患
者进行进一步的随访。第二,膝关节置换术后的感
染控制可能受到许多风险因素的影响,包括年龄、
性别、手术时间、症状持续时间、患者合并症以及
感染病原^[26]。由于患者数量较少,研究人群的异质
性(原始手术类型、既往手术次数和手术类型)以及
本研究的观察性质,无法进行多变量分析以进一步
研究这些风险因素对感染控制结果的影响。第三,
尽管本研究中所有患者均未发生感染复发,但本研
究中患者数量较小,需要更大样本来验证研究结果。

总的来说,细菌培养、彻底清创以及合理选择
抗生素是治疗膝关节假体周围感染的根本。在合
理选择适应证情况下,一期翻修术可以有效治疗膝

关节假体周围感染并重建膝关节功能。

[参考文献]

- [1] Kunutsor SK, Whitehouse MR, Blom AW, et al. Patient-Related Risk Factors for Periprosthetic Joint Infection after Total Joint Arthroplasty: A Systematic Review and Meta-Analysis[J]. *PLoS One*, 2016, 11 (3): e01508661-e1508718.
- [2] Rowan FE, Donaldson MJ, Pietrzak JR, et al. The Role of One-Stage Exchange for Prosthetic Joint Infection[J]. *Current Reviews in Musculoskeletal Medicine*, 2018, 11 (3): 370-379.
- [3] Chuan KK, Irene Z, Saiprassad R. Periprosthetic Joint Infection Is the Main Cause of Failure for Modern Knee Arthroplasty: An Analysis of 11,134 Knees[J]. *Clin Orthop Relat Res*, 2017, 475: 2194-2201.
- [4] Cury Rde P, Cinagawa EH, Camargo OP, et al. Treatment Of Infection after Total Knee Arthroplasty[J]. *Acta Ortopedica Brasileira*, 2015, 23 (5): 239-243.
- [5] Haddad FS, Sukeik M, Alazzawi S. Is single-stage revision according to a strict protocol effective in treatment of chronic knee arthroplasty infections[J]. *Clinical Orthopaedics and Related Research*, 2015, 473 (1): 8-14.
- [6] Marang-van de, Mheen PJ, Bragan Turner E, et al. Variation in Prosthetic Joint Infection and treatment strategies during 4.5 years of follow-up after primary joint arthroplasty using administrative data of 41397 patients across Australian, European and United States hospitals[J]. *BMC Musculoskeletal Disorders*, 2017, 18 (1): 2071-2078.
- [7] Vanhegan IS, Morgan-Jones R, Barrett DS, et al. Developing a strategy to treat established infection in total knee replacement: a review of the latest evidence and clinical practice[J]. *The Journal of Bone and Joint Surgery British Volume*, 2012, 94 (7): 875-881.
- [8] Belden K, Cao L, Chen J, et al. Hip and Knee Section, Fungal Periprosthetic Joint Infection, Diagnosis and Treatment: Proceedings of International Consensus on Orthopedic Infections[J]. *The Journal of Arthroplasty*, 2019, 34 (2S): S387-S391.
- [9] Castellani L, Daneman N, Mubareka S, et al. Factors Associated with Choice and Success of One-Versus Two-Stage Revision Arthroplasty for Infected Hip and Knee Prostheses[J]. *HSS J*, 2017, 13 (3): 224-231.
- [10] Li H, Ni M, Li X, et al. Two-stage revisions for culture-negative infected total knee arthroplasties: A five-year outcome in comparison with one-stage and two-stage

- revisions for culture-positive cases[J].*J Orthop Sci*, 2017, 22 (2): 306-312.
- [11] Jenny JY, Barbe B, Gaudias J, et al. High infection control rate and function after routine one-stage exchange for chronically infected TKA[J]. *Clinical Orthopaedics and Related Research*, 2013, 471 (1): 238-243.
- [12] Tibrewal S, Malagelada F, Jeyaseelan L, et al. Single-stage revision for the infected total knee replacement: results from a single centre[J]. *Bone Joint J*, 2014, 96-B (6): 759-764.
- [13] Klatte TO, Kendoff D, Kamath AF, et al. Single-stage revision for fungal peri-prosthetic joint infection: a single-centre experience[J]. *Bone Joint J*, 2014, 96-B (4): 492-496.
- [14] Segawa H, Tsukayama DT, Kyle RF, et al. Infection after total knee arthroplasty. A retrospective study of the treatment of eighty-one infections[J]. *The Journal of Bone and Joint Surgery American Volume*, 1999, 81 (10): 1434-1445.
- [15] Scuderi GR, Bourne RB, Noble PC, et al. The new Knee Society Knee Scoring System[J]. *Clinical Orthopaedics and Related Research*, 2012, 470 (1): 3-19.
- [16] Gonzalez Della Valle A, Sharrock N, Barlow M, et al. The modern, hybrid total hip arthroplasty for primary osteoarthritis at the Hospital for Special Surgery[J]. *Bone Joint J*, 2016, 98-B (1 Suppl A): 54-59.
- [17] Dawson J, Fitzpatrick R, Murray D, et al. Questionnaire on the perceptions of patients about total knee replacement[J]. *The Journal of Bone and Joint Surgery British Volume*, 1998, 80 (1): 63-69.
- [18] Osmon DR, Berbari EF, Berendt AR, et al. Diagnosis and management of prosthetic joint infection: clinical practice guidelines by the Infectious Diseases Society of America[J]. *Clin Infect Dis*, 2013, 56 (1): e1-e25.
- [19] Berbari EF, Kanj SS, Kowalski TJ, et al. 2015 Infectious Diseases Society of America (IDSA) Clinical Practice Guidelines for the Diagnosis and Treatment of Native Vertebral Osteomyelitis in Adults[J]. *Clin Infect Dis*, 2015, 61 (6): e26-46.
- [20] 曹力, 纪保超. 髋膝关节置换术后假体周围感染焦点问题 [J]. *中华关节外科杂志(电子版)*, 2016, 10 (4): 360-363.
- [21] Srivastava K, Bozic KJ, Silverton C, et al. Reconsidering Strategies for Managing Chronic Periprosthetic Joint Infection in Total Knee Arthroplasty: Using Decision Analytics to Find the Optimal Strategy Between One-Stage and Two-Stage Total Knee Revision[J]. *The Journal of Bone and Joint Surgery American Volume*, 2019, 101 (1): 14-24.
- [22] 朱晗晓, 蔡迅梓, 严世贵. 关节置换术后深部感染的诊断和治疗 [J]. *中华关节外科杂志(电子版)*, 2011, 5 (3): 379-385.
- [23] Gomez MM, Tan TL, Manrique J, et al. The Fate of Spacers in the Treatment of Periprosthetic Joint Infection[J]. *The Journal of Bone and Joint Surgery American Volume*, 2015, 97 (18): 1495-1502.
- [24] Negus JJ, Gifford PB, Haddad FS. Single-Stage Revision Arthroplasty for Infection—An Underutilized Treatment Strategy[J]. *The Journal of Arthroplasty*, 2017, 32 (7): 2051-2055.
- [25] Yagmour KM, Chisari E, Khan WS. Single-Stage Revision Surgery in Infected Total Knee Arthroplasty: A PRISMA Systematic Review[J]. *J Clin Med*, 2019, 8 (2): E1741-E1813.
- [26] Massin P, Delory T, Lhotellier L, et al. Infection recurrence factors in one- and two-stage total knee prosthesis exchanges[J]. *Knee Surg Sports Traumatol Arthrosc*, 2016, 24 (10): 3131-3139.
- [27] Romano CL, Gala L, Logoluso N, et al. Two-stage revision of septic knee prosthesis with articulating knee spacers yields better infection eradication rate than one-stage or two-stage revision with static spacers[J]. *Knee Surg Sports Traumatol Arthrosc*, 2012, 20 (12): 2445-2453.
- [28] Peel TN, Cheng AC, Choong PF, et al. Early onset prosthetic hip and knee joint infection: treatment and outcomes in Victoria, Australia[J]. *J Hosp Infect*, 2012, 82 (4): 248-253.
- [29] 曹力. 清创保留假体治疗人工关节置换术后假体周围感染 [J]. *临床外科杂志*, 2019, 27 (4): 283-286.
- [30] Argenson JN, Arndt M, Babis G, et al. Hip and Knee Section, Treatment, Debridement and Retention of Implant: Proceedings of International Consensus on Orthopedic Infections[J]. *The Journal of Arthroplasty*, 2019, 34 (2S): S399-S419.
- [31] Roy ME, Peppers MP, Whiteside LA, et al. Vancomycin concentration in synovial fluid: direct injection into the knee vs. intravenous infusion[J]. *The Journal of Arthroplasty*, 2014, 29 (3): 564-568.

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- relationship between longitudinal and radial function in left, right, and total heart pumping in human[J]. *Am J Physiol Heart Circ Physiol*, 2007, 293 (1): H636-H644.
- [12] Torrent G, Ballester M, Buckberg GD, et al. Spatial orientation of the ventricular muscle band: physiologic contribution and surgical implications[J]. *J Thorac Cardiovasc Surg*, 2001, 122 (2): 389-392.
- [13] Chow PC, Liang XC, Cheung EW, et al. New two-dimensional global longitudinal strain and strain rate imaging for assessment of systemic right ventricular function[J]. *Heart*, 2008, 94 (7): 855-859.
- [14] Meluzín J, Spinarová L, Bakala J, et al. Pulsed Doppler tissue imaging of the velocity of tricuspid annular systolic motion; a new, rapid, and non-invasive method of evaluating right ventricular systolic function[J]. *Eur Heart J*, 2001, 22 (4): 340-348.
- [15] 魏丽群, 李越. 组织多普勒成像测量三尖瓣环等容收缩期峰值速度在评价肺高压患者右心功能中的应用[J]. *中华医学超声杂志(电子版)*, 2014, 11 (3): 8-12.
- [16] Lang RM, Badano LP, Mor-Avi V, et al. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the EuroDean Association of Cardiovascular Imaging[J]. *J Am Soc Echocardiogr*, 2015, 28 (1): 1-39.
- [17] 刘琨, 邓又斌, 孙杰, 等. 超声二维斑点追踪成像技术评价缩窄性心包炎患者术后心脏功能的改变[J]. *中国超声医学杂志*, 2014, 30 (1): 26-29.
- [18] 王丁, 邓又斌, 黄润青. 等. 超声三维斑点追踪技术定量评价不同部位心肌梗死患者心功能的研究[J]. *中国超声医学杂志*, 2013, 29 (7): 610-614.
- [19] 李玉曼, 谢明星, 吕清, 等. 斑点追踪显像评价肺动脉高压患者右心室整体纵向功能的临床研究[J]. *中华超声影像学杂志*, 2009, 18: 206-210.
- [20] Urheim S, Cauduro S, Frantz R, et al. Relation of tissue displacement and strain to invasively determined right ventricular stroke volume[J]. *Am J Cardiol*, 2005, 96: 1173-1178.
- [21] MacGregor AJ, Dhillon VB, Binder A, et al. Fasting lipids and anticardiolipin antibodies As risk factors for vascular disease in SLE[J]. *Ann Rheum Dis*, 1992, 51 (2): 152-155.
- [22] Cervera R, Font J, Pare C, et al. Cardiac disease in SLE: propect-live study of 70 Patients[J]. *Ann Rheum Dis*, 1992, 51 (2): 156-159.
- [23] Drew P, Asherson RA, Zuk RJ, et al. Aortic occlusion in SLE associated with antiphospholipid antibodies[J]. *Ann Rheum Dis*, 1987, 46 (8): 612-616.

(收稿日期: 2019-10-30)

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- [32] Edelstein AI, Weiner JA, Cook RW, et al. Intra-Articular Vancomycin Powder Eliminates Methicillin-Resistant *S. aureus* in a Rat Model of a Contaminated Intra-Articular Implant[J]. *The Journal of Bone and Joint Surgery American Volume*, 2017, 99 (3): 232-238.
- [33] Ji B, Zhang X, Xu B, et al. Single-Stage Revision for Chronic Fungal Periprosthetic Joint Infection: An Average of 5 Years of Follow-Up[J]. *The Journal of Arthroplasty*, 2017, 32 (8): 2523-2530.
- [34] Nagra NS, Hamilton TW, Ganatra S, et al. One-stage versus two-stage exchange arthroplasty for infected total knee arthroplasty: a systematic review[J]. *Knee Surg Sports Traumatol Arthrosc*, 2016, 24 (10): 3106-3114.

(收稿日期: 2019-09-09)