

· 综述 ·

胫骨高位截骨临床结果相关影响因素的研究进展[△]

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摘要: 胫骨高位截骨 (high tibial osteotomy, HTO) 作为目前膝关节内侧间室骨性关节炎的一种经典的“保膝”治疗方案, 在广大高功能活动需求的年轻膝骨性关节炎 (knee osteoarthritis, KOA) 患者中扮演着重要角色。虽然 HTO 能有效改善临床症状, 恢复膝关节功能并延长使用寿命, 但术后临床效果及其影响因素仍具有不可预知性。研究并明确这些影响因素, 对于膝内侧间室骨性关节炎患者进行个体化治疗及提高术后临床疗效具有重要意义。本文将对影响 HTO 术后临床效果的相关因素进行综述, 以期对临床治疗有所帮助。

关键词: 胫骨高位截骨术, 膝关节骨性关节炎, 临床结果, 影响因素

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Abstract: High tibial osteotomy, a classic knee-preserving surgery for medial compartment osteoarthritis of the knee, plays an important role in young patients with knee osteoarthritis who need high-function activities. Although high tibial osteotomy can effectively improve clinical symptoms, restore knee function and prolong service life, the clinical results and the related factors still remain unpredictable. It is of great significance to study and clarify these influencing factors for individualized treatment of medial knee compartment osteoarthritis and to improve the postoperative clinical efficacy. This article will review the factors related to the clinical outcome of high tibial osteotomy, in order to help the decision making in clinical setting.

Key words: high tibial osteotomy, knee osteoarthritis, clinical results, influence factor

膝关节骨性关节炎 (knee osteoarthritis, KOA) 是以关节软骨磨损变性、关节边缘骨质增生以及关节间隙变窄为主要特征的退行性疾病。近年来, 随着人口老龄化的加剧, KOA 的发病率逐年增高, 严重影响患者的工作和生活, 已成为全世界公认的第四大致残性疾病之一^[1]。

胫骨高位截骨术 (high tibial osteotomy, HTO) 由 Jackson^[2] 于 1958 年报道并用于治疗 KOA, 其原理是通过截骨调整下肢力线缓解膝关节内侧单间室的高负荷状态, 从而减轻疼痛, 恢复功能并延长膝关节使用寿命, 避免或推迟膝关节置换。目前已有相当多的研究证明伴膝内翻畸形的 KOA 患者经 HTO 术矫正后, 膝内侧间室的高负荷状态可以得到有效卸载和平衡, 保证了较好的术后临床结果^[3]。然而 HTO 术后临床结果的改善在很大程度上是不能预知的, 在术前

尚不清楚临床结果可以改善到何种程度, 以及哪些因素影响了临床预后过程。研究并明确这些影响因素, 对于 KOA 进行个体化治疗和提高临床疗效具有重要意义。

1 患者个体因素

1.1 年龄及性别

有研究者对 2 815 例接受了膝关节软骨修复手术患者的基线数据和预后结果间的相关性进行了研究, 发现较大的年龄和女性性别与较差的手术预后相关^[4]。Lee 等^[5] 评估了年龄对膝内侧间室骨关节炎 HTO 术后生存率和并发症的影响, 结果表明老年患者 (>60 岁) HTO 术后生存率较低且围手术期并发症较多, 是 HTO 术后较差临床结果的预测因素之一。

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Filardo 等^[6]认为性别与 HTO 术后临床结果有关,其中女性性别是影响软骨治疗等临床结果预后的负面因素。Keenan 等^[7]也发现高龄和女性性别是 HTO 术后早期转化为全膝置换术的独立预测因素。然而 Goshima 等^[8]在评估了影响 HTO 临床结果的因素后发现,患者年龄与 HTO 术后的临床结果和影像学结果之间并不具有相关性, Kumagai 等^[9]也认为年龄和性别并不影响 HTO 术后软骨再生修复和临床结果。目前学者针对于年龄和性别是否与 HTO 术后软骨的再生修复水平相关尚无共识,未来还需要进行更高证据等级和更加深入的研究来确定。

1.2 体重指数

体重指数 (body mass index, BMI) 是 HTO 术后影响临床结果的重要预测因素。有研究表明,当 BMI>30 kg/m² 时 HTO 手术失败的风险提高 10 倍,术后并发症的发生率明显提高,同时与较差的临床结局相关,低体重患者 HTO 术后软骨再生修复水平明显高于超重患者^[10]。Niemeyer 等^[11]发现在正确的适应证下,尽管采用标准化的手术技术,但 BMI>30 kg/m² 者临床结果及预后较差。此外 Herbst 等^[12]研究并分析了肥胖对 HTO 术后 6 年临床结果的影响,发现超重患者和正常体重患者在短期的临床结果和生活质量方面并无显著差异,然而从长期随访结果来看,超重患者的临床结果比正常体重患者更差。目前的研究显示,低 BMI 是 HTO 术后临床结果的正向预测因子之一,因此在选择 HTO 患者时,应考虑到 BMI 对术后临床结果的影响,同时应对超重患者进行科学、系统的减重康复锻炼指导,以便提高临床疗效。

1.3 合并症

术前 KOA 患者存在的各种合并症也会对 HTO 术后的临床结果产生一定影响。Cotter 等^[13]研究了 HTO 术后与不良事件发生相关的危险因素,结果发现术前合并糖尿病、慢性阻塞性肺疾病的 KOA 患者术后发生不良事件的概率更大。Liu 等^[14]研究了 59 例 HTO 术后发生手术部位感染的危险因素,术前记录的危险因素包括性别、年龄、BMI、基础疾病、住院时间、矫正角度和手术时间,经单因素方差分析显示吸烟和糖尿病与术后手术部位感染呈正相关,多因素方差分析则显示吸烟和高龄与术后手术部位感染呈正相关,认为吸烟、糖尿病及高龄是 HTO 术后发生感染的危险因素。Yoon 等^[15]认为术前合并糖尿病、骨质疏松症及高脂血症的 KOA 患者经 HTO 治疗后的翻修率更高,此外有研究指出,术前维生素 D 也是影响 HTO 术后临床结果的因素之一,并建议将术前

血清维生素 D 检查作为 HTO 患者术前常规检查的一部分^[16]。因此在术前应对患者基本情况详尽评估,以达到最理想疗效。

2 术前因素

2.1 术前 K-L 分级

KOA 作为一种退行性疾病,在其早期阶段进行干预更为有效,然而大多数患者在初诊时其骨关节炎已发展到一定程度。Li 等^[17]通过一项回顾性研究,分析了经 HTO 治疗的 KOA 患者早期转为全膝关节置换术 (total knee arthroplasty, TKA) 的危险因素,结果表明 K-L 分级大于 II 级是与 HTO 术后临床结果相关的负向预测因素之一,是 HTO 患者早期转为 TKA 的独立危险因素。Takahara 等^[18]则认为术前 K-L 大于 III 级是 HTO 治疗失败和 KOA 继续进展的重要预测风险因素,Ekland 等^[19]发现在 HTO 术后 2 年随访时,术前 K-L 等级为 I 级和 II 级患者的临床结果评分显著优于 K-L 等级为 III 级和 IV 级的患者。此外 Lee 等^[20]研究发现,对于影像学上“骨对骨”(Ahlback 2 级)和存在关节间隙(Ahlback 0/1 级)的 KOA 患者,两者在 HTO 治疗后的临床结果上表现相当,无显著差异。因此选择患者时应严格把握 HTO 适应证,从而提高临床疗效,避免 HTO 相关并发症的出现。

2.2 术前膝关节评分

膝关节术前的各种评分代表着膝关节的功能状态,能够对 HTO 术后的临床结果产生一定程度的影响。Lakra 等^[21]认为术前视觉模拟评分 (visual analogue scale, VAS) 是 TKA 术后 2 年内功能改善相关的独立危险因素。Li 等^[17]同样认为术前 VAS 评分与术后较差的临床结果相关,并认为术前 VAS>5 分的患者是 HTO 术后转化为 TKA 的高风险人群。Sasaki 等^[22]在一项 HTO 术后生存率的 15 年随访研究中发现,术前低日本骨科协会评分 (Japanese orthopaedic association, JOA) 是 HTO 术后临床结果的危险因素。Ishimatsu 等^[23]发现术前高的西安大略和麦克马斯特大学骨关节炎指数 (Western Ontario and McMaster Universities Osteoarthritis Index, WOMAC) 通常与 HTO 术后较差的临床结果相关。

2.3 术前软骨损伤程度

传统上膝关节外侧间室软骨存在损伤被认为是 HTO 的禁忌证之一,然而近些年来有部分研究者认为术前膝关节外侧间室软骨损伤并不会对术后临床结

果产生不利影响。Hohloch等^[24]评估了术前膝关节外侧间室无症状的正常软骨、单一软骨损伤和多发对吻软骨损伤对HTO术后临床结果的影响,结果表明对于外侧间室软骨正常和软骨单一损伤的患者,术后疼痛程度明显降低,临床结果良好,而对于多发对吻软骨损伤的患者,术后疼痛程度较术前无明显改善。Moon等^[25]研究发现对于术前膝关节外侧间室国际软骨修复协会(International Cartilage Repair Society, ICRS)软骨损伤等级为2级和3级的患者而言,都不会影响HTO术后的手术结果。此外Niemeyer等^[26]通过研究发现,对于HTO术后的临床结果而言,术前膝关节内侧间室严重的软骨损伤并不会对其产生影响,同时术前膝关节外侧间室部分软骨厚度的缺失也同时可以接受,然而Jin等^[27]则认为术前膝关节内侧间室软骨损伤ICRS等级>4级和外侧间室软骨损伤ICRS等级>2级为HTO手术失败的重要风险因素。

3 术中因素

3.1 截骨方式

虽然HTO手术截骨方式多样,但其术后临床结果及并发症发生率却不尽相同。刘效仿等^[28]对张英泽院士提出的胫骨近端HTO(张氏HTO)和台湾花世源教授提出的胫骨近端HTO(花氏HTO)治疗内侧间室KOA的临床疗效进行了对比研究,结果发现两种截骨方式的早期临床疗效相当,均能有效缓解疼痛,改善膝关节功能。He等^[29]在一项HTO治疗KOA的系统回顾研究中发现,与外侧闭合楔形HTO相比,内侧开放楔形HTO在长期存活率和较低的骨折发生风险方面具有一定的优势,同样Nerhus等^[30]也发现两种截骨方式的术后临床结果之间无明显差异,但是外侧闭合楔形HTO术后胫骨和腓骨愈合不良及需再次手术的发生率较高。刘娜等^[31]则比较了胫骨结节上截骨和结节下截骨治疗KOA的疗效,结果发现胫骨结节下截骨对髌骨高度几乎无影响,临床疗效也更好。

3.2 内固定方式

随着近年来材料技术及膝关节生物力学研究的深入,学者们针对HTO手术提出了各种不同的固定方式。Kyung等^[32]在双平面开放楔形HTO治疗膝关节内侧间室骨关节炎时对比了Aescula钢板和TomoFix钢板两种不同内固定方式的临床结果,研究结果显示两种内固定方式的术后膝关节评分均较术前有明显改

善,且两者并无明显差异,然而相较于Aescula钢板固定,TomoFix钢板固定具有更好的放射学结果和低并发症发生率。Raja等^[33]利用有限元分析技术评估了Puudu钢板和TomoFix钢板在HTO中的生物力学特性,结果发现TomoFix钢板较Puudu钢板具有更好的抗压缩性、抗扭转性和稳定性,而这可能是临床结果差异性的来源。杨梦其等^[34]研究了HTO联合Taylor外固定架和内固定钢板治疗伴膝内翻畸形的KOA患者,结果发现Taylor外固定架治疗组手术时间、术中出血量和术后膝关节评分均显著优于内固定钢板治疗组患者,展现出较好的临床结果。

4 术后因素

4.1 术后下肢力线

下肢力线对膝关节应力负荷的分布有很大影响,被认为是KOA进展的关键因素。Jung等^[35]为159名KOA患者行HTO手术2年后,对关节软骨行二次关节镜评估,发现矫正外翻角度在0°~6°的患者膝关节软骨再生修复水平明显高于矫正不足的患者。Tawy等^[36]研究了下肢力线对HTO术后临床结果的影响,发现虽然患者术后并未达到外翻3°~6°的“理想矫正”,但临床结果较术前均明显改善,认为“理想矫正”可能比3°~6°更灵活。此外有研究者发现,当矫正角度过大,WBL超过62°时,髌股关节软骨和股骨滑车软骨更趋向于恶化,术后膝前疼痛明显增加,半月板也发生进行性退变^[37]。

近年来,有学者提出了基于个体因素的个性化HTO下肢力线矫正方案。Hohloch等^[38]指出,对于膝关节K-L分级0~2级的内侧间室的孤立性软骨损伤,下肢力线控制在50%~55%;对于K-L为3级的晚期KOA,下肢力线应>55%,然而需要注意的是,下肢力线>60%的过度矫正并不会改善膝关节临床功能结局。目前针对理想的下肢力线尚无公认的结果,而这也是导致手术疗效差异的来源,这些问题需要未来更加深入的研究予以解决。

4.2 术后胫骨近端内侧角和关节线倾角

胫骨近端内侧角(medial proximal tibial angle, MPTA)是描述膝关节外胫骨近端内翻程度的角度,在HTO手术中扮演重要作用。Kubota等^[39]通过研究发现,MPTA是HTO手术计算截骨矫正角度的重要参考指标,基于MPTA的精确矫正可以获得更好的临床效果。Akamatsu等^[40]对接受了HTO手术的患者进行了回顾性研究,并根据术后的MPTA是否>

95°分为两组, 结果发现术后 MPTA>95°的患者在术后膝关节功能评分等方面要差于 MPTA<95°的患者。然而 Goshima 等^[41]认为 HTO 术后由于髌关节和踝关节的代偿性改变, 一定程度的过度矫正 (MPTA≥95°) 并不会影响 HTO 术后临床结果。

关节线倾角 (joint line obliquity, JLO) 是地面水平线与胫骨平台内外侧髁连线所形成的角, 是导致 HTO 术后非解剖性关节线倾斜的关键因素。Goto 等^[42]研究了 HTO 术后膝关节冠状面各种矫正参数对术后长期临床结果的影响, 结果发现在众多矫正参数中, 术后 JLO 残留与 HTO 术后长期临床结果恶化呈独立相关。Song 等^[43]则认为当 HTO 术后 JLO≥6°时, 会对术后的影像学结果产生影响; 当 JLO≥4°时, HTO 术后临床结果则会变差, 然而 Rosso 等^[44]则发现在 HTO 术后随访 10 年时, 术后 JLO 的增加并不会对临床结果产生影响。

4.3 术后功能锻炼

功能锻炼也是影响 HTO 术后临床结果的重要因素, 在术后增强膝关节稳定性、促进膝关节功能恢复、改善术后疼痛方面扮演着重要作用。刘爱峰等^[45]对 HTO 术后的康复功能锻炼进行了系统综述, 认为 HTO 术后积极进行股四头肌锻炼、膝关节活动度锻炼和一定程度的有氧运动对 HTO 术后的临床结果均有积极影响。Kean 等^[46]认为 HTO 术后通常需要一段时间的保护性负重, 而这可能会导致肌肉力量的严重不足, 影响临床结果。他们发现如果在术前 12 周对股四头肌和腘绳肌进行针对性的锻炼, 在 HTO 术后便可具有比术前未进行针对性锻炼患者更加优良的膝关节功能评分和临床结果。

综上所述, KOA 患者在行 HTO 手术治疗后, 其临床结果及 KOA 的病程进展仍具有不确定性。目前已有相当多的研究者对 HTO 术后的 KOA 患者进行长期随访, 并对 HTO 术后可能影响临床结果的因素进行探讨, 但对于一些影响因素, 不同研究者间的结论并不相同, 仍然具有争议性。此外软骨修复作为 KOA 治疗的核心问题, 目前相关研究并不深入, 软骨修复对于 HTO 术后临床结果的影响仍未可知, 因此除了关注 HTO 术后的临床结果外, 还应继续加强对 KOA 疾病和软骨再生修复机制的研究, 同时严格把握 HTO 的适应证并明确各种因素对临床结果的影响, 对于 KOA 患者的治疗和术后康复将是至关重要的。相信随着未来更多基础研究的进一步深入, 将会为 HTO 这一经典的“保膝”治疗方法提供更多有力的理论基础, 造福更多的 KOA 患者。

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