

# 闭合复位石膏外固定术治疗发育性髋关节发育不良的相关研究进展

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## 摘 要

发育性髋关节发育不良(developmental dysplasia of the hip, DDH)作为最常见的儿童髋关节先天畸形, 对儿童髋关节功能具有重大影响。闭合复位作为一种常用的治疗方法, 在发育性髋关节发育不良的治疗过程中起到了重要作用。同心圆复位以及髋臼的发育潜能是闭合复位能够成功进行的前提条件。闭合复位的传统方法已广为接受, 但仍有许多学者在不同方面提出改进。而关于闭合复位的适用范围, 目前仍有许多争议。故本文对闭合复位治疗发育性髋关节发育不良研究进展进行综述。

## 关键词

发育性髋关节发育不良, 闭合复位, 保守治疗

# Research Progress of Closed Reduction and Hip Spica Casting in the Treatment of Developmental Dysplasia of the Hip

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## Abstract

Developmental dysplasia of the hip (DDH) is the most common congenital deformity of the hip

joint in children, which has a significant impact on the function of the hip joint. As a commonly used treatment method, closed reduction plays an important role in the treatment of developmental dysplasia of the hip. Concentric reduction and the development potential of the acetabulum are prerequisites for successful closed reduction. The traditional process of closed reduction is widely accepted, but there are still some researchers who propose improvements in different aspects. There are still many controversies about the indications of closed reduction. Therefore, this article reviews the research progress of closed reduction in the treatment of developmental dysplasia of the hip.

## Keywords

Developmental Dysplasia of the Hip, Closed Reduction, Conservative Treatment

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## 1. 引言

发育性髋关节发育不良(developmental dysplasia of the hip, DDH)是最常见的髋关节先天畸形。其主要表现为髋臼与股骨头的异常发育以及两者之间解剖关系的异常。包括髋臼发育不良、髋关节半脱位以及全脱位[1]。其发生率在 0.1‰到 6.6‰之间[2]。女性较男性发病率更高,比例约为 5.8:1 [3]。目前 DDH 的治疗效果随着年龄增加而减弱,晚发的 DDH 通常预后较差。目前学术界的主流观点在于早期进行筛查,并尽早干预[4]。目前 DDH 的治疗主要依据年龄进行划分,依据患儿年龄不同可以采取 Pavlik 吊带、闭合复位石膏固定、切开复位骨盆截骨术等多种治疗方式[4]。闭合复位石膏固定术作为一种常用的治疗方法,具有创伤小、并发症发生率低等优点,在 DDH 的治疗过程中被广泛应用。闭合复位治疗 DDH 的历史悠久,最早可追溯到 1895 年,但至今关于这种治疗方法,仍有许多问题存在争议。本文现就闭合复位治疗 DDH 的相关研究进展进行介绍。

## 2. 髋关节的发育过程

髋关节的发育自胚胎期开始,至 35 岁左右 Y 形软骨完全闭合,可以划分为 3 个阶段:第一阶段为胚胎第 5 周到 12 周,此阶段主要是髋臼及股骨头软骨雏形逐步形成。第二阶段从胎儿第 12 周持续到 7~8 岁,主要发生的是髋臼及股骨头的初级骨化。第三阶段从 7~8 岁髋臼次级骨化中心出现开始,至 35 岁 Y 型软骨完全闭合结束,主要发生的过程为髋关节的次级骨化[5]。髋臼形态从出生后逐渐加深,形态由浅斜逐渐趋于球形,至 13 岁之后形态基本不会再发生改变[6] [7],因而针对 DDH 的治疗时间窗多在此时间之前,对于青春期及成年后的 DDH,多采取姑息治疗措施。

髋关节的发育以软骨内成骨为主,除了依赖于 Y 型软骨的增殖骨化之外,也明显受到髋臼与股骨头之间的相互作用影响。Harrison [8]等人的文献指出,对于切除股骨头或髋关节脱位的大鼠,其髋臼发育明显浅斜,证明髋臼以及股骨头之间的相互应力作用对于髋臼发育至关重要。Archer 以及 Zusik 等人的文章也报道了机械应力对于髋臼发育以及软骨内成骨作用[9] [10]。DDH 的发病左侧明显多于右侧,原因可能是多数胎儿的胎方位为枕左前位,左髋关节位于母体背侧,受到母体脊柱的限制,髋关节外展受限,无法产生有效的刺激,进而影响髋关节发育[11]。除此之外,臀位产、高体重儿、羊水过少、襁褓方法等

危险因素也可能是通过改变髋臼与股骨头之间的位置关系，进而影响生物力学结构而发挥作用的。

髋臼的发育及塑型能力在治疗的过程中起到关键作用，随着年龄增长，髋臼的塑型能力逐渐下降，因而目前主流观点仍然建议依据年龄来决定治疗方式。Brougham 等人[12]的研究纳入了 53 人，60 髋，得出的结论是髋臼发育在患儿平均 5 岁时停止。而其他学者也在治疗 DDH 的过程中得出相似的结论[13] [14] [15]：即髋臼发育和塑型能力可维持到闭合复位术后 3 年，此时患儿年龄一般在 4 岁左右。

基于以上机制，我们可以得出闭合复位治疗 DDH 的原理：即通过复位与固定来纠正异常的头臼解剖关系，为髋臼发育提供合适的生物力学应力刺激，利用幼儿期患儿较强的髋臼发育潜能，促进髋臼发育，改善髋臼形态，进而纠正结构异常。这一同心圆复位原理，在 DDH 的治疗过程中得到广泛应用，成为了治疗 DDH 的基本原则之一。

### 3. 闭合复位的方法

术前牵引一度被认为可以降低术后股骨头坏死的风险[16]，但是也有研究并不支持这一点[17]。Sucato [18]等人的研究表明，对于小于 3 岁的 DDH 患儿，牵引并不能显著改善闭合复位的成功率以及股骨头坏死的发生率。而且牵引通常在屈髋位进行，并不能有效牵拉髂腰肌以及内收肌[19]。而且由于牵引时间耗时较长，护理不便，目前很多专家已经不再把牵引作为闭合复位术前的必须步骤。

经典的闭合复位人类位石膏固定术操作流程已经使用多年，且广泛受到认可。闭合复位通常需要在手术室中进行，患儿需要充分麻醉，平卧于手术台上，手术医生在操作时应动作轻柔，避免暴力复位，首先予以牵拉患肢，而后逐步使患儿屈髋屈膝外展，并在大转子水平处向前挤压，以辅助复位。理想情况下，应保证髋关节能够解剖复位，术中运用关节造影可以明确复位情况。安全角是指髋关节的最大外展位置与内收至刚好脱位时两者之间的角度范围，若感觉复位困难，可切断内收肌以增加安全角，此操作同时可以降低股骨头坏死的发生率[20]。复位成功后大致维持髋关节屈曲 90~100 度，外展 45°~50°。同时避免过度外展以及内旋髋关节，若髋关节必须在过度外展及内旋时方可保持稳定，应及时放弃闭合复位。

闭合复位成功后，需维持上述体位进行人类位石膏固定。石膏固定的时间与更换频次存在多种观点，但都缺乏高质量的证据支持。目前最广为接受的固定时间为 3 个月左右，在 6 周时可以予以更换一次石膏[21]。3 月后根据情况改为支具固定，支具固定的时间目前尚无定论[22]。石膏固定可以选用传统石膏或者高分子石膏，高分子石膏具有强度大、重量轻、X 光透光性好的优点，但具体的石膏种类选择取决于操作者的个人喜好，并无明显优劣之分。严格[23]等人采取改良半硬化高分子石膏绷带进行固定，具有重量轻，透气性好，拆卸方便的特点，拆除时无需石膏锯，从而避免锯伤患儿的风险。

动态石膏固定也是一种常用的固定方法，与传统人类位石膏相比，动态石膏不固定髋关节，利用硬质横杆维持髋关节屈曲外展位，使得髋关节可以进行一定程度的屈伸活动。有文献报道，此种石膏固定方法的效果及并发症发生率与传统人类位石膏相比差异不大[24]。

除了传统闭合复位之外，也有一些学者提出使用持续牵引的方法进行闭合复位[25] [26] [27] [28]，复位成功率高而且股骨头坏死发生率低。以 Petit-Morel [25]法为例，此方法是一种术前牵引、人类位石膏固定、骨盆截骨术相结合的贯序治疗方法。第一步为持续牵引，对患儿在双下肢伸直位实施牵引，并逐渐增加负重，每周随访髋关节 X 片明确股骨头位置，待股骨头的骨化中心接近 Hilgenreiner 线时，逐渐进行外展、内旋的牵引，使股骨近端骨骺对准 Y 形软骨，而后逐渐减轻负重使股骨头落入髋臼。第二步为人类位石膏固定，固定方式与时间与目前的主流方案一致。第三步，对于随访至 5~6 岁，仍存在残余发育不良的患儿，则行骨盆截骨术。但此类方法需要长时间卧床牵引，治疗时间长，对患儿的身心健康以及家庭的经济能力均有不小的影响，目前并未被广泛采用。

#### 4. 并发症及远期预后

残余髋臼发育不良是指 DDH 患儿在复位良好且股骨头生长正常的情况下, 髋臼发育依然无法正常发育, 是闭合复位术后常见的并发症之一。关于残余发育不良并无统一的诊断标准, 有文献选取年龄与髋臼指数(AI)作为评价标准[29] [30], 但也有学者认为应该同时参考术前 IHDI 分级, 也有学者直接运用 Severin 评分来诊断残余发育不良[31]。但对于诊断明确的残余发育不良, 均需要手术进行干预。对于采取手术的指征和时机, 不同文献有不同的观点。Li [29]等人的研究认为闭合复位术后 1 年时 AI 大于  $28^{\circ}$ , 或术后 2~4 年时 AI 大于  $25^{\circ}$ , 就应该进行手术干预。Shin 等人则认为, 患儿 3 岁时, 若 AI 大于  $32^{\circ}$  且中心边缘角(CEA)小于  $14^{\circ}$ , 则应该进行手术干预。Mansour [32]认为, 髋臼发育潜能目前被低估, 仅仅依据髋臼指数评估髋臼发育潜能往往会导致过度诊疗, 因而建议利用 MRI 对盂唇发育进行评估, 结合软组织发育情况综合判断髋臼是否存在残余发育不良。对于手术时机的把握, 应遵循以下流程: 1) 术后 2 年时, 若患儿 AI 大于  $25^{\circ}$ , MRI 提示盂唇发育异常, 立即进行手术治疗; 2) 若患儿在术后 2 年时的 AI 大于  $25^{\circ}$ , 盂唇发育正常, 可以予以密切随访至 5~8 岁, 期间若发现 AI 与相应年龄段不相符, 则手术干预; 3) 若术后 2 年时 AI 小于  $25^{\circ}$ , 则进行观察随访至患儿 5 岁左右, 若此时 AI 仍正常, 则继续观察随访, 若异常, 则进行 MRI 检查评估盂唇发育情况, 对于盂唇发育异常的患儿, 及时采取手术治疗。

股骨头缺血性坏死(avascular necrosis, AVN)是 DDH 治疗过程中最常见, 也是最严重的并发症, 会严重影响患儿髋关节功能和寿命。目前认为, 股骨头坏死均为医源性[33], 不进行治疗的 DDH 均不会出现股骨头坏死。股骨头坏死发生的原因之一可能为治疗过程中的机械压迫。目前已知闭合复位时的过度外展会增加股骨头坏死的风险[34], 而复位过程中的暴力操作也可能导致股骨头坏死[35]。另一种观点认为, 股骨头坏死原因是股骨头血供的破坏。在部分文献中报道, 闭合复位的 AVN 发生率低于切开复位[36], 而另一项 meta 分析则指出, 切开复位是股骨头坏死的危险因素[37], 这可能与切开复位破坏了关节囊周围结构, 进而影响股骨头血供有关。另有文献报道, 利用 MRI 灌注成像监测闭合复位后股骨头血供, 结果提示, MRI 灌注成像正常的患儿中无人发生股骨头坏死, 因而提示股骨头血供受阻可能是造成 AVN 的原因之一。对于年龄是否是 AVN 的危险因素, 目前仍有争议, 支持[38] [39] [40]与反对[14] [36] [41]的文献均有报道。另一个危险因素是股骨头骨化核的出现, 既往有文献报道称, 股骨头骨化核出现之前进行闭合复位, 会增加 AVN 风险[42], 但后来许多研究并不支持这一观点[41] [43], 考虑到年龄增加会增加髋臼发育不良等并发症的发生率, 目前多数学者认为对闭合复位应尽早实施, 无需等待骨化核出现。除此之外, 有报道称, 病情的严重程度(IHDI 或 Tonnis 分级)可能与 AVN 的发生有关[39] [44]。研究 DDH 治疗过程中股骨头坏死的危险因素的文献有很多, 某些危险因素总能找到结论相反的报道。笔者认为, 对于 AVN 危险因素的探寻, 不能只关注统计学结果, 应该更多地关注 DDH 发生发展和治疗过程中的病理解剖和病理生理机制, 进而探究行之有效的减少 AVN 发生的方法。

DDH 在患儿成年后常常演变为骨关节炎, 正规治疗可以改善髋臼形态, 纠正异常的生物力学结构, 进而延长髋关节寿命, 然而即便经过正规治疗, 骨关节炎仍然是大多数 DDH 患儿的最终结局。目前在关于接受闭合复位后的 DDH 患儿远期预后的文献中, 随访时间最长的是 Terjesen [45]进行的研究, 共纳入 60 人(74 髋), 平均随访时间 58 年, 接受本次随访调查时患儿的年龄在 55~60 岁之间。32 髋(43%)的患者诊断为髋关节骨关节炎, 其中 24 髋(31%)在 31~58 岁(平均 48.1 岁)时接受了髋关节置换术。这一结果明显高于正常人群中 OA 的发病率。

#### 5. 闭合复位的适用范围

关于闭合复位的争议目前主要围绕其适用范围内而展开。随着患儿年龄增大, 髋臼发育及塑型潜能不断降低, 闭合复位的治疗效果会逐渐变差。Zhang [44]等人进行了一项回顾性研究, 依据患儿接受闭合

复位时的年龄将患儿分为3组, I组年龄小于12月, II组年龄在12~18月之间, III组年龄大于18月。通过比较相关影像学指标来反应治疗效果以及并发症的发生率, 最终发现对于大于18月患儿, 术后出现髋臼残余发育不良的风险明显偏高。证明年龄越大, 闭合复位对于髋臼形态的纠正效果越差。毫无疑问, DDH 越早治疗效果越好, 但是对于错过最佳治疗时机的大年龄患儿应该采取何种治疗方式, 目前仍有不同的看法。主流观点认为闭合复位适用于6~18月。这一观点最初由 Salter [46]提出并逐渐被接受, Salter 指出, 随着患儿髋臼发育潜能降低, 18月以上的 DDH 进行闭合复位存在残余畸形的风险增加, 因而主张对于18月以上患儿进行切开复位。许多学者则更为激进, 认为闭合复位仅适用于12月以下患儿[20]。然而, Schoenecker [47]的研究则表明, 对大于18月的患儿, 尤其是18~21月的患儿, 进行闭合复位, 能够取得相对理想的效果。其他学者的文章也提出了相同的见解, 即闭合复位对于18月以上患儿仍然有效[14] [48]。许多学者认为, 对于闭合复位术后出现的髋臼残余发育不良, 可以通过再次行关节囊外的骨盆截骨术加以纠正, 此时手术的难度明显降低, 成功率明显提高, 因而支持对大年龄患儿进行闭合复位, 即便不能完全纠正髋臼发育异常, 也可以改善髋臼形态, 进一步降低切开手术的难度[29] [30] [49]。

## 6. 总结

发育性髋关节脱位的治疗目前仍存在许多需要探索的地方, 闭合复位作为一种经典且常用的方法, 具有创伤小、操作简便、价格低廉等优点。现阶段的争议主要在于适用范围的选取以及如何降低 AVN 等并发症的发病率。当前学术界关于 DDH 的相关研究证据等级普遍不高, 样本量普遍较低, 仍需要进行更多的研究来为临床工作提供更多的指导, 提升治疗效果。

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