

# 股骨头血供参数和平均坏死面积指数 与股骨头坏死 ARCO 分期的相关性分析

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**摘要 目的:**分析股骨头血供参数和平均坏死面积指数与股骨头坏死国际骨微循环研究学会 (Association Research Circulation Osseous, ARCO) 分期的相关性, 为量化评估股骨头血供和坏死程度提供参考。**方法:**纳入股骨头坏死患者 60 例 (65 髋), 其中 ARCO I 期 11 髋、II 期 23 髋、III 期 16 髋、IV 期 15 髋。于患者股骨头血管造影片上测量并计算跨股骨颈的旋股内侧动脉长度与股骨颈直径的比值、后上支持带动脉数量、后下支持带动脉数量等股骨头血供参数, 于股骨头轴位 MRI T1 加权像上测量并计算股骨头平均坏死面积指数。比较不同 ARCO 分期患髋的股骨头血供参数和平均坏死面积指数, 采用 Spearman 相关分析法分析股骨头血供参数和平均坏死面积指数与股骨头坏死 ARCO 分期的相关性。**结果:**不同 ARCO 分期患髋的跨股骨颈的旋股内侧动脉长度与股骨颈直径的比值、后上支持带动脉数量、后下支持带动脉数量及股骨头平均坏死面积指数的组间差异均有统计学意义 ( $H = 16.191, P = 0.001; H = 31.331, P = 0.000; H = 13.737, P = 0.003; H = 12.699, P = 0.005$ )。Spearman 相关分析显示, 跨股骨颈的旋股内侧动脉长度与股骨颈直径的比值、后上支持带动脉数量、后下支持带动脉数量与股骨头坏死 ARCO 分期均呈负相关 ( $r_s = -0.489, P = 0.000; r_s = -0.678, P = 0.000; r_s = -0.456, P = 0.000$ ), 股骨头平均坏死面积指数与股骨头坏死 ARCO 分期呈正相关 ( $r_s = 0.438, P = 0.000$ )。**结论:**股骨头血供参数与股骨头坏死 ARCO 分期呈负相关, 股骨头平均坏死面积指数与股骨头坏死 ARCO 分期呈正相关, 这些指标对于量化评估股骨头血供和坏死程度具有一定的参考价值。

**关键词** 股骨头坏死; 股骨头血供; 股骨头坏死面积; ARCO 分期

## Analysing the correlations of femoral head blood supply parameters and mean necrotic area index with ARCO stage of femoral head necrosis

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**ABSTRACT Objective:** To analyze the correlations of femoral head (FH) blood supply parameters and mean necrotic area index (MNAI) with Association Research Circulation Osseous (ARCO) stage of femoral head necrosis (FHN) so as to provide a reference for quantitatively assessing the blood supply and necrotic degree of FH. **Methods:** Sixty FHN patients (65 hips) were enrolled in the study, with 11 hips in ARCO stage I, 23 hips in stage II, 16 hips in stage III, and 15 hips in stage IV. The FH blood supply parameters, including the ratio of the length of medial femoral circumflex artery (MFCA) across the femoral neck to the diameter of femoral neck, the numbers of posterior superior retinacular artery (SRA) and posterior inferior retinacular artery (IRA), were measured on the angiogram of FH and then calculated. Additionally, the MNAI of FH was measured on the axial MRI T1-weighted image of the FH and then calculated. Furthermore, the FH blood supply parameters and MNAI of the affected hips in the different ARCO stages were compared, and the correlations of FH blood supply parameters and MNAI with the ARCO stage of FHN were analyzed by using Spearman's correlation analysis. **Results:** The differences were statistically significant in the ratio of the length of MFCA across the femoral neck to the diameter of femoral neck, the numbers of posterior SRA and IRA, MNAI among the hips in different ARCO stages ( $H = 16.191, P = 0.001; H = 31.331, P = 0.000; H = 13.737, P = 0.003; H =$

12.699,  $P=0.005$ ). The results of Spearman correlation analysis revealed that the ratio of the length of MFCA across the femoral neck to the diameter of femoral neck, the numbers of posterior SRA and IRA were all negatively correlated with the ARCO stage of FHN ( $r_s = -0.489$ ,  $P=0.000$ ;  $r_s = -0.678$ ,  $P=0.000$ ;  $r_s = -0.456$ ,  $P=0.000$ ); while, the MNAI of FH was positively correlated with the ARCO stage of FHN ( $r_s = 0.438$ ,  $P=0.000$ ). **Conclusion:** The FH blood supply parameters are negatively correlated with the ARCO stage of FHN; while, the MNAI is positively correlated with the ARCO stage of FHN. These indicators have a certain reference value for quantitatively assessing the blood supply and necrotic degree of FH.

**Keywords** femoral head necrosis; femoral head blood supply; femoral head necrotic area; ARCO classification

股骨头坏死是一种进行性破坏疾病,其病理过程为股骨头血供受损或中断,引起骨髓坏死和骨细胞死亡,随后发生坏死区域周围修复硬化,进而导致股骨头结构改变,出现股骨头塌陷<sup>[1-3]</sup>。准确判断股骨头的血供和坏死情况,对于股骨头坏死治疗方案的选择具有重要意义。目前,临床上多根据股骨头坏死的分期和分型制定治疗方案、判断预后和评价疗效等。然而,临床上常用的分期和分型均缺少针对股骨头血供和坏死情况的量化指标<sup>[4-8]</sup>。为此,我们提出了股骨头血供参数和平均坏死面积指数,分析了股骨头血供参数和平均坏死面积指数与股骨头坏死国际骨微循环研究学会(Association Research Circulation Osseous, ARCO)分期的相关性,以期为临床上量化评估股骨头血供与坏死程度提供参考。

## 1 临床资料

### 1.1 一般资料

选取 2022 年 6 月至 2024 年 2 月在河南省洛阳正骨医院(河南省骨科医院)住院治疗的股骨头坏死患者为研究对象。试验方案经河南省洛阳正骨医院(河南省骨科医院)医学伦理委员会审查通过,伦理批件号:KY2023-017-01。

### 1.2 纳入标准

①符合股骨头坏死诊断标准<sup>[9]</sup>;②年龄 $\geq 18$ 岁;③患者治疗前行髋关节 MRI 检查与股骨头血管造影术;④病例资料完整。

### 1.3 排除标准

①创伤性股骨头坏死者;②有髋部手术史者。

## 2 方法

### 2.1 分组方法

根据 ARCO 分期标准<sup>[10]</sup>将患髋分为 I 期、II 期、III 期、IV 期。

### 2.2 数据测量方法

**2.2.1 股骨头血供参数** 在股骨头血管造影图中,过股骨颈与大转子交界处做垂直于股骨颈纵轴的垂线,与股骨颈上下缘相交于 C 点和 A 点,线段 AC 即为股骨颈直径;于股骨颈上找到旋股内侧动脉的终点,过该点做 AC 的垂线,并相交于 B 点,线段 AB 即为跨股骨颈的旋股内侧动脉的相对长度,计算线段 AB 和 AC 的比值,即为跨股骨颈的旋股内侧动脉长度与股骨颈直径的比值(L),见图 1(1)。过股骨头和股骨颈交界处上顶点做水平线为线 I,股骨头和股骨颈交界线为线 II,计算达到线 I 的血管数量,即为后上支持带动脉数量(M),计算达到线 II 但未达到线 I 的血管数量,即为后下支持带动脉数量(N),见图 1(2)。

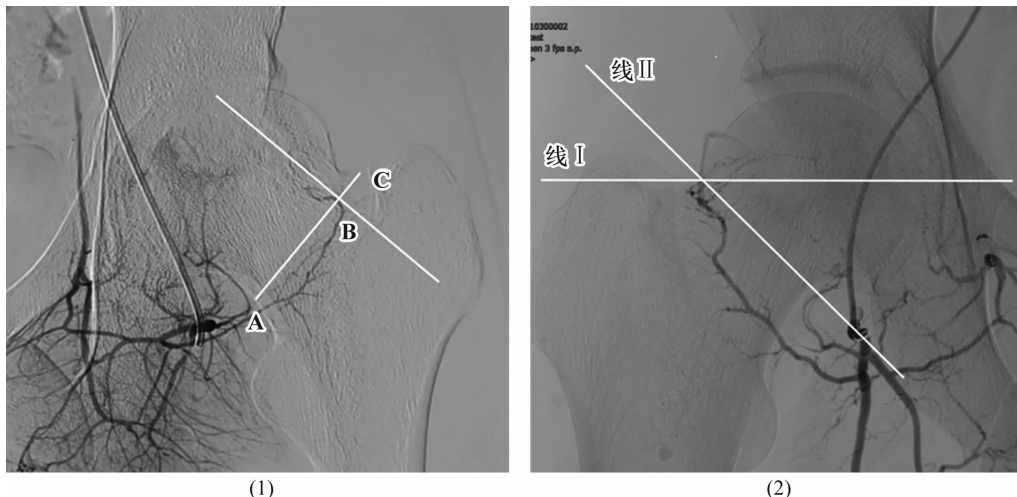


图 1 股骨头血供参数测量示意图

**2.2.2 股骨头平均坏死面积指数** 在股骨头轴位 MRI T1 加权像上,以股骨颈纵轴和过股骨头中心的股骨颈纵轴的垂线将股骨头划分为 4 个区域(图 2)。统计所有层面股骨头有坏死区域的数量及 MRI 层数,计算股骨头平均坏死面积指数。股骨头平均坏死面积指数 = 有坏死区域的数量  $\times 2.5$  / MRI 层数。

### 2.3 数据统计方法

采用 SPSS24.0 统计软件对所得数据进行统计学分析。不同 ARCO 分期患髋的跨股骨颈的旋股内侧动脉长度与股骨颈直径的比值、后上支持带动脉数量、后下支持带动脉数量及股骨头平均坏死面积指数的组间整体比较均采用 Kruskal-Wallis 检验,相关性分析均采用 Spearman 相关分析。检验水准  $\alpha = 0.05$ 。

## 3 结果

共纳入股骨头坏死患者 60 例(65 髋),不同 ARCO 分期患髋的跨股骨颈的旋股内侧动脉长度与股骨颈直径的比值、后上支持带动脉数量、后下支持带动脉数量及股骨头平均坏死面积指数的组间差异均有统计学意义(表 1)。Spearman 相关分析显示,跨股骨颈的旋股内侧动脉长度与股骨颈直径的比值、后上支持带动脉数量、后下支持带动脉数量与股骨头坏死 ARCO 分期均呈负相关( $r_s = -0.489, P = 0.000; r_s =$

$-0.678, P = 0.000; r_s = -0.456, P = 0.000$ ),股骨头平均坏死面积指数与股骨头坏死 ARCO 分期呈正相关( $r_s = 0.438, P = 0.000$ )。

## 4 讨论

股骨头坏死分期和分型是临床制定治疗方案的重要参考,但这些分期和分型均缺少量化指标。对于经验不足的临床医生,依据现有的股骨头坏死分期和分型进行诊疗可能会导致病情误判,进而延误治疗<sup>[11-13]</sup>。因此,提出评价股骨头血供和坏死的量化指标,对于临床诊断股骨头坏死病情具有重要意义。

股骨头的血供情况是临床判断股骨头坏死病情和制定治疗方案的重要指标。Wang 等<sup>[14]</sup>通过分析股骨头坏死患者股骨头血管造影结果,提出了包括静脉瘀滞期、动脉缺血期、动脉闭塞期的股骨头坏死血运分期,并建议在不同时期采取不同的治疗方案;认为在静脉瘀滞期可采用髓芯减压术治疗,在动脉缺血期可采用带血管的自体骨移植治疗,在动脉闭塞期可采用关节置换术治疗。股骨头的血供大部分来源于旋股内侧动脉和旋股外侧动脉,其中旋股内侧动脉的分支后上支持带动脉在股骨头和股骨颈上交界处进入股骨头,提供了股骨头外侧 60% ~ 75% 的血供,后下支持带动脉沿着股骨头软骨的下边缘穿过股骨头,

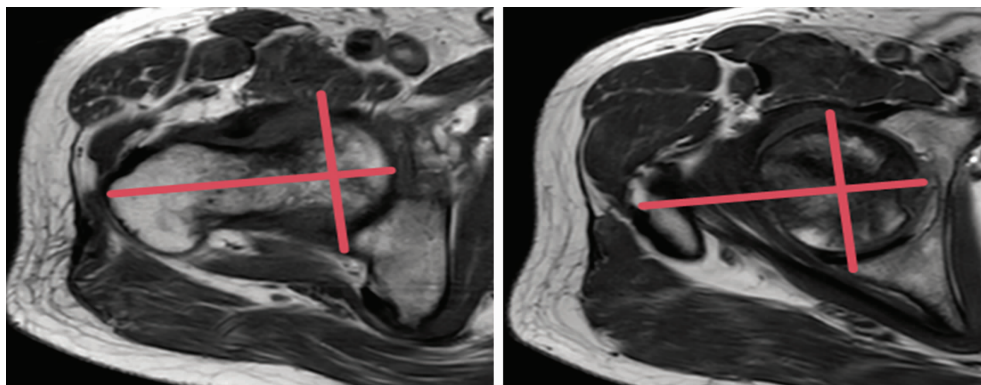


图 2 不同 MRI 层面股骨头区域划分示意图

表 1 不同 ARCO 分期患髋股骨头的血供参数和平均坏死面积指数

ARCO <sup>1)</sup> 分期	样本量/ 髋	股骨头血供参数			股骨头平均坏死面积 指数(M, Q)
		L <sup>2)</sup> (M, Q)	M <sup>3)</sup> / [(M, Q), 根]	N <sup>4)</sup> / [(M, Q), 根]	
I 期	11	0.98, 0.06	3, 1	2, 2	3.44, 4.01
II 期	23	0.95, 0.09	2, 1	2, 2	3.67, 2.84
III 期	16	0.88, 0.16	1, 1	1, 1	5.63, 3.23
IV 期	15	0.83, 0.48	0, 1	0, 2	7.62, 4.54
H 值		16.191	31.331	13.737	12.699
P 值		0.001	0.000	0.003	0.005

注:1)国际骨微循环研究学会;2)跨股骨颈的旋股内侧动脉长度与股骨颈直径的比值;3)后上支持带动脉数量;4)后下支持带动脉数量。

提供了股骨头内侧 25% ~ 50% 的血供<sup>[15-16]</sup>。Zheng 等<sup>[17]</sup>研究发现,保留股骨头的部分外侧血供(后上支持带动脉)能够延迟股骨头塌陷,这与良好的外侧血供能够维持股骨头外形完整有关。本研究结果显示,ARCOⅢ期后上支持带动脉数量和后下支持带动脉数量的中位数均为 1,而股骨头塌陷多发生在 ARCOⅢ期,提示当股骨头后上支持带动脉数量和后下支持带动脉数量均小于 2 根时,股骨头塌陷的发生风险会显著增加。

股骨头坏死面积是评估股骨头坏死发展阶段的重要指标。Steinberg 分期中根据骨坏死面积占比将每个分期又分为 3 个亚组<sup>[18]</sup>;《股骨头坏死临床诊疗规范(2015 年版)》中提出的股骨头坏死中国分型也将股骨头坏死面积作为重要的评估指标之一<sup>[9]</sup>。然而,这些分期和分型中均未提出定量测定股骨头坏死面积的具体方法。我们前期通过分析股骨头坏死患者的 MRI 资料,提出了股骨头平均坏死面积指数,该指标在一定程度上能够定量反映股骨头坏死的程度<sup>[19]</sup>。股骨头平均坏死面积指数先将股骨头等分为 4 个区域,并对 MRI 所有层面有坏死的区域进行统计分析,准确性较高;而通过赋值的方式获得平均坏死面积指数,操作便捷、结果明了。袁强等<sup>[20]</sup>研究发现,股骨头平均坏死面积指数与股骨头塌陷进展具有相关性。本研究结果显示,股骨头平均坏死面积指数与 ARCO 分期呈正相关,提示股骨头平均坏死面积指数具有一定的临床参考价值。

本研究结果表明,股骨头血供参数与股骨头坏死 ARCO 分期呈负相关,股骨头平均坏死面积指数与股骨头坏死 ARCO 分期呈正相关,这些指标对于量化评估股骨头血供和坏死程度具有一定的参考价值。但本研究样本量较小,且为单中心、回顾性研究,所得结论仍需要开展更多高质量的临床研究进一步验证。

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