

成人非创伤性股骨头坏死骨密度定量分析

冯强强, 王玲, 程晓光, 郭晓忠

(北京积水潭医院, 北京 100035)

摘要 目的:探讨成人非创伤性股骨头坏死患者骨密度的特征。**方法:**收集 2015 年 6 月至 2017 年 6 月在北京积水潭医院行 CT 检查诊断为非创伤性股骨头坏死的患者(坏死组)。共 31 例 48 髋, 男 36 髋、女 12 髋, 年龄(47.42 ± 15.29)岁, ARCO 分期 II 期 21 髋、III 期 27 髋。均无骨盆或髋关节外伤及手术史, 未进行过药物干预。同时选取 2015 年 6 月至 2017 年 6 月因单侧髋关节骨折在北京积水潭医院行髋关节 CT 检查的患者(非坏死组)。共 52 例 52 髋, 男 38 髋、女 14 髋, 年龄(47.42 ± 15.29)岁, 对侧股骨均无异常。采用非同步定量 CT 测定坏死组股骨头坏死区、坏死周围区域、股骨颈、大转子、转子间的骨密度, 测定非坏死组非骨折侧股骨头中心、股骨头边缘、股骨颈、大转子、转子间的骨密度, 并对测得的数据做统计分析。**结果:**坏死组坏死区骨密度大于非坏死组股骨头中心骨密度[(348.44 ± 78.77)mg · cm⁻³, (284.05 ± 45.88)mg · cm⁻³, $t = 4.942, P = 0.000$]; 坏死组坏死周围区域骨密度大于非坏死组股骨头边缘骨密度[(218.59 ± 47.82)mg · cm⁻³, (141.37 ± 31.93)mg · cm⁻³, $t = 9.419, P = 0.000$]; 2 组股骨颈、大转子、转子间骨密度比较, 组间差异均无统计学意义[(98.63 ± 58.43)mg · cm⁻³, (81.14 ± 63.78)mg · cm⁻³, $t = 1.426, P = 0.157$; (45.38 ± 37.15)mg · cm⁻³, (52.55 ± 31.23)mg · cm⁻³, $t = -1.048, P = 0.297$; (48.14 ± 34.07)mg · cm⁻³, (45.37 ± 42.60)mg · cm⁻³, $t = 0.357, P = 0.722$]。坏死组 ARCO II 期坏死周围区域骨密度大于非坏死组股骨头边缘骨密度[(228.97 ± 49.64)mg · cm⁻³, (141.37 ± 31.93)mg · cm⁻³, $t = 7.486, P = 0.000$]; 坏死组 ARCO II 期坏死区、股骨颈、大转子、转子间骨密度与非坏死组比较, 组间差异均无统计学意义[(307.31 ± 64.15)mg · cm⁻³, (284.05 ± 45.88)mg · cm⁻³, $t = 1.513, P = 0.141$; (100.71 ± 45.88)mg · cm⁻³, (81.14 ± 63.78)mg · cm⁻³, $t = 1.277, P = 0.206$; (65.39 ± 26.72)mg · cm⁻³, (52.55 ± 31.23)mg · cm⁻³, $t = 1.653, P = 0.103$; (59.97 ± 31.76)mg · cm⁻³, (45.37 ± 42.60)mg · cm⁻³, $t = 1.417, P = 0.161$]。坏死组 ARCO III 期坏死区骨密度大于非坏死组股骨头中心骨密度[(380.42 ± 74.99)mg · cm⁻³, (284.05 ± 45.88)mg · cm⁻³, $t = 6.110, P = 0.000$]; 坏死组 ARCO III 期坏死周围区域骨密度大于非坏死组股骨头边缘骨密度[(210.52 ± 45.64)mg · cm⁻³, (141.37 ± 31.93)mg · cm⁻³, $t = 7.853, P = 0.000$]; 坏死组 ARCO III 期大转子骨密度小于非坏死组[(29.81 ± 37.03)mg · cm⁻³, (52.55 ± 31.23)mg · cm⁻³, $t = -2.879, P = 0.005$]; 坏死组 ARCO III 期股骨颈、转子间骨密度与非坏死组比较, 组间差异均无统计学意义[(97.01 ± 67.43)mg · cm⁻³, (81.14 ± 63.78)mg · cm⁻³, $t = 1.029, P = 0.307$; (38.94 ± 33.49)mg · cm⁻³, (45.37 ± 42.60)mg · cm⁻³, $t = -0.682, P = 0.497$]。ARCO II 期坏死区骨密度小于 ARCO III 期($t = -3.565, P = 0.001$), 大转子、转子间骨密度均大于 ARCO III 期($t = 3.771, P = 0.001$; $t = 2.208, P = 0.032$); ARCO II 期坏死周围区域、股骨颈骨密度与 ARCO III 期比较, 差异均无统计学意义($t = 1.337, P = 0.188$; $t = 0.225, P = 0.823$)。**结论:**股骨头坏死区和坏死周围区域骨密度较正常股骨头增高。

关键词 股骨头坏死; 骨密度; 定量 CT

Quantitative analysis of bone density of adults with non – traumatic femur head necrosis

FENG Qiangqiang, WANG Ling, CHENG Xiaoguang, GUO Xiaozhong

Beijing Jishuitan Hospital, Beijing 100035, China

ABSTRACT Objective: To explore the characteristics of bone density of adults with non – traumatic femur head necrosis (FHN).

Methods: Thirty – one patients who were diagnosed as non – traumatic FHN (necrotic group) by computerized tomography (CT) examination in Beijing Jishuitan Hospital from June 2015 to June 2017 were collected. The patients (48 hips) consisted of males (36 hips) and females (12 hips), and ranged in age of 47.42 ± 15.29 years, and the FHN belonged to ARCO phase II (21 hips) and ARCO phase III (27 hips). None of these patients had a history of trauma and surgery of pelvis or hip and received any drug intervention. Meanwhile, fifty – two patients who received hip CT examination for unilateral hip fracture (non – necrotic group) in Beijing Jishuitan Hospital from June 2015 to June 2017 were selected. The patients (52 hips) consisted of males (38 hips) and females (14 hips), and ranged in age of 47.42 ± 15.29 years, and no abnormality was found in contralateral femur. The bone density of FHN area, FHN surrounding area, femoral neck, greater trochanter and

intertrochanteric area of necrotic group and the bone density of center of femoral head, edge of femoral head, femoral neck, greater trochanter and intertrochanteric area of non-fractured side of non-necrotic group were determined by using non-synchronous quantitative CT, and then the measured data were statistically analyzed. **Results:** The bone density of FHN area of necrotic group was higher than that of center of femoral head of non-necrotic group (348.44 ± 78.77 vs 284.05 ± 45.88 mg/cm³, $t = 4.942$, $P = 0.000$). The bone density of FHN surrounding area of necrotic group was higher than that of edge of femoral head of non-necrotic group (218.59 ± 47.82 vs 141.37 ± 31.93 mg/cm³, $t = 9.419$, $P = 0.000$). There was no statistical difference in the bone density of femoral neck, greater trochanter and intertrochanteric area between the 2 groups (98.63 ± 58.43 vs 81.14 ± 63.78 mg/cm³, $t = 1.426$, $P = 0.157$; 45.38 ± 37.15 vs 52.55 ± 31.23 mg/cm³, $t = -1.048$, $P = 0.297$; 48.14 ± 34.07 vs 45.37 ± 42.60 mg/cm³, $t = 0.357$, $P = 0.722$). The bone density of FHN surrounding area (ARCO phase II) of necrotic group was higher than that of edge of femoral head of non-necrotic group (228.97 ± 49.64 vs 141.37 ± 31.93 mg/cm³, $t = 7.486$, $P = 0.000$). There was no statistical difference in the bone density of FHN (ARCO phase II) area, femoral neck, greater trochanter and intertrochanteric area between necrotic group and non-necrotic group (307.31 ± 64.15 vs 284.05 ± 45.88 mg/cm³, $t = 1.513$, $P = 0.141$; 100.71 ± 45.88 vs 81.14 ± 63.78 mg/cm³, $t = 1.277$, $P = 0.206$; 65.39 ± 26.72 vs 52.55 ± 31.23 mg/cm³, $t = 1.653$, $P = 0.103$; 59.97 ± 31.76 vs 45.37 ± 42.60 mg/cm³, $t = 1.417$, $P = 0.161$). The bone density of FHN area (ARCO phase III) of necrotic group was higher than that of center of femoral head of non-necrotic group (380.42 ± 74.99 vs 284.05 ± 45.88 mg/cm³, $t = 6.110$, $P = 0.000$). The bone density of FHN (ARCO phase III) surrounding area of necrotic group was higher than that of edge of femoral head of non-necrotic group (210.52 ± 45.64 vs 141.37 ± 31.93 mg/cm³, $t = 7.853$, $P = 0.000$). The bone density of greater trochanter was lower in necrotic group (ARCO phase III) compared to non-necrotic group (29.81 ± 37.03 vs 52.55 ± 31.23 mg/cm³, $t = -2.879$, $P = 0.005$). There was no statistical difference in the bone density of femoral neck and intertrochanteric area between necrotic group (ARCO phase III) and non-necrotic group (97.01 ± 67.43 vs 81.14 ± 63.78 mg/cm³, $t = 1.029$, $P = 0.307$; 38.94 ± 33.49 vs 45.37 ± 42.60 mg/cm³, $t = -0.682$, $P = 0.497$). The bone density of FHN area was lower and the bone densities of greater trochanter and intertrochanteric area were higher in ARCO phase II compared to ARCO phase III ($t = -3.565$, $P = 0.001$; $t = 3.771$, $P = 0.001$; $t = 2.208$, $P = 0.032$). There was no statistical difference in the bone density of FHN surrounding area and femoral neck between ARCO phase II and ARCO phase III ($t = 1.337$, $P = 0.188$; $t = 0.225$, $P = 0.823$). **Conclusion:** The bone densities are higher in FHN area and FHN surrounding area compared to normal femoral head.

Keywords femur head necrosis; bone density; quantitative computerized tomography

成人股骨头坏死可以分为创伤性和非创伤性 2 大类^[1]。在我国,非创伤性股骨头坏死的主要发生原因因为应用皮质类固醇及酗酒,发生率占有非创伤性股骨头坏死的 90%^[2]。非创伤性股骨头坏死虽然备受国内外学者关注,但罕有以定量 CT 研究股骨头坏死骨密度的相关报道。本研究对成人非创伤性股骨头坏死 ARCO II、III 期患者骨密度进行了定量分析,现总结报告如下。

1 资料与方法

1.1 研究对象收集 收集 2015 年 6 月至 2017 年 6 月在北京积水潭医院行 CT 检查诊断为非创伤性股骨头坏死的患者(坏死组)。共 31 例 48 髋,男 36 髋、女 12 髋,年龄(47.42 ± 15.29)岁,ARCO 分期 II 期 21 髋、III 期 27 髋。均无骨盆或髋关节外伤及手术史,未进行过药物干预。同时选取 2015 年 6 月至 2017 年 6 月因单侧髋关节骨折在北京积水潭医院行髋关节 CT

检查的患者(非坏死组)。共 52 例 52 髋,男 38 髋、女 14 髋,年龄(47.42 ± 15.29)岁,对侧股骨均无异常。试验方案经医院医学伦理委员会审查通过。

1.2 骨密度测定 均采用东芝 320 排 CT 机和东芝 80 排 CT 机进行螺旋扫描,扫描参数:120 kV, 100 mAs,视野 400 mm,扫描床高 120 cm,使用标准体部重建为层厚 1 mm 的薄层容积数据。扫描了 4 型非同步校准模型进行质量保证校准,每 4 周校准 1 次。所得图像转移到定量 CT 工作站,并使用 Mindways 定量 CTpro5.10 软件(Mindways Software 公司)进行分析。坏死组测定股骨头坏死区(坏死中心区域)、坏死周围区域(硬化带外侧区域)、股骨颈、大转子、转子间的骨密度,非坏死组测定非骨折侧股骨头中心、股骨头边缘、股骨颈、大转子、转子间的骨密度。坏死组坏死周围区域的骨密度为坏死区前缘和外侧缘骨密度的平均值,非坏死组股骨头边缘的骨密度为股骨头前缘和外侧缘骨密度的平均值。见图 1。

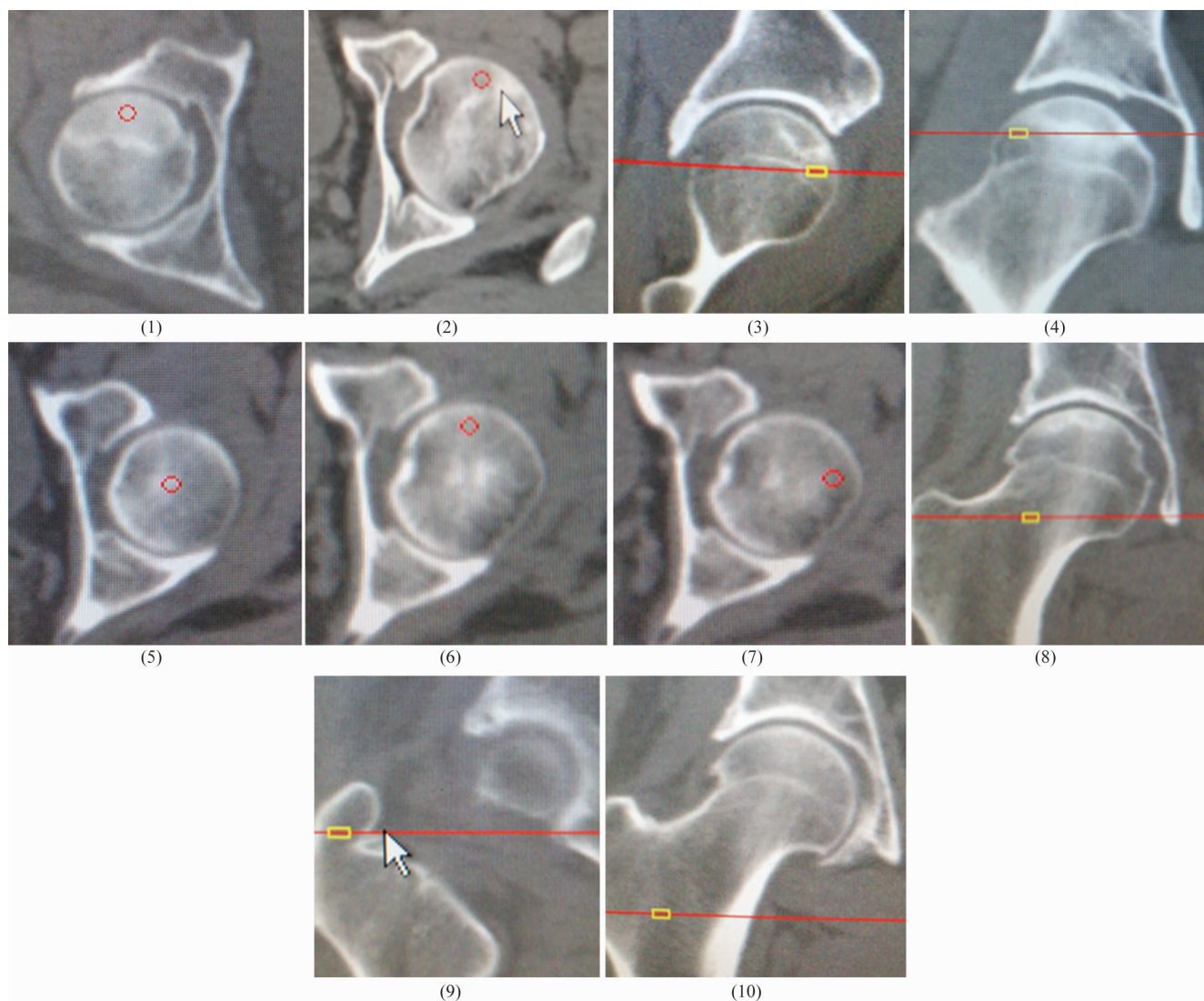


图 1 股骨骨密度定量 CT 测量

(1) 为股骨头轴位图像,在红色圆圈内测量坏死区的骨密度;(2)(3)分别为股骨头轴位和矢状位图像,在红色圆圈和黄色方框内测量坏死周围区域(前缘)的骨密度;(4)为股骨头冠状位图像,在黄色方框内测量坏死周围区域(外侧缘)的骨密度;(5)(6)(7)均为股骨头轴位图像,在红色圆圈内测量正常股骨头中心、前缘和外侧缘的骨密度;(8)(9)(10)均为股骨近端冠状位图像,在黄色方框内测量股骨颈、大转子和转子间的骨密度

1.3 数据统计 采用 SPSS19.0 软件进行数据统计分析。坏死组与非坏死组、ARCO II 期与非坏死组、ARCO III 期与非坏死组、ARCO II 期与 ARCO III 期股骨不同部位骨密度的组间(或期间)比较均采用 t 检验。检验水准 $\alpha = 0.05$ 。

2 结果

坏死组坏死区骨密度大于非坏死组股骨头中心骨密度;坏死组坏死周围区域骨密度大于非坏死组股骨头边缘骨密度;2 组股骨颈、大转子、转子间骨密度比较,组间差异均无统计学意义。见表 1。

坏死组 ARCO II 期坏死周围区域骨密度大于非坏死组股骨头边缘骨密度;坏死组 ARCO II 期坏死

区、股骨颈、大转子、转子间骨密度与非坏死组比较,组间差异均无统计学意义。见表 2。

坏死组 ARCO III 期坏死区骨密度大于非坏死组股骨头中心骨密度;坏死组 ARCO III 期坏死周围区域骨密度大于非坏死组股骨头边缘骨密度;坏死组 ARCO III 期大转子骨密度小于非坏死组;坏死组 ARCO III 期股骨颈、转子间骨密度与非坏死组比较,组间差异均无统计学意义。见表 3。

ARCO II 期坏死区骨密度小于 ARCO III 期,大转子、转子间骨密度均大于 ARCO III 期;ARCO II 期坏死周围区域、股骨颈骨密度与 ARCO III 期比较,差异均无统计学意义。见表 4。

表 1 2 组患者股骨不同部位骨密度 $\bar{x} \pm s, \text{mg} \cdot \text{cm}^{-3}$

组别	样本量 (髌)	坏死区 / 股骨头中心	坏死周围区域 / 股骨头边缘 ¹⁾	股骨颈	大转子	转子间
坏死组	48	348.44 ± 78.77	218.59 ± 47.82	98.63 ± 58.43	45.38 ± 37.15	48.14 ± 34.07
非坏死组	52	284.05 ± 45.88	141.37 ± 31.93	81.14 ± 63.78	52.55 ± 31.23	45.37 ± 42.60
<i>t</i> 值		4.942	9.419	1.426	-1.048	0.357
<i>P</i> 值		0.000	0.000	0.157	0.297	0.722

1) 坏死组坏死周围区域的骨密度为坏死区前缘和外侧缘骨密度的平均值,非坏死组股骨头边缘的骨密度为股骨头前缘和外侧缘骨密度的平均值

表 2 坏死组 ARCO II 期患者与非坏死组患者股骨不同部位骨密度 $\bar{x} \pm s, \text{mg} \cdot \text{cm}^{-3}$

组别	样本量 (髌)	坏死区 / 股骨头中心	坏死周围区域 / 股骨头边缘 ¹⁾	股骨颈	大转子	转子间
坏死组 ARCO II 期	21	307.31 ± 64.15	228.97 ± 49.64	100.71 ± 45.88	65.39 ± 26.72	59.97 ± 31.76
非坏死组	52	284.05 ± 45.88	141.37 ± 31.93	81.14 ± 63.78	52.55 ± 31.23	45.37 ± 42.60
<i>t</i> 值		1.513	7.486	1.277	1.653	1.417
<i>P</i> 值		0.141	0.000	0.206	0.103	0.161

1) 坏死组坏死周围区域的骨密度为坏死区前缘和外侧缘骨密度的平均值,非坏死组股骨头边缘的骨密度为股骨头前缘和外侧缘骨密度的平均值

表 3 坏死组 ARCO III 期患者与非坏死组患者股骨不同部位骨密度 $\bar{x} \pm s, \text{mg} \cdot \text{cm}^{-3}$

组别	样本量 (髌)	坏死区 / 股骨头中心	坏死周围区域 / 股骨头边缘 ¹⁾	股骨颈	大转子	转子间
坏死组 ARCO III 期	27	380.42 ± 74.99	210.52 ± 45.64	97.01 ± 67.43	29.81 ± 37.03	38.94 ± 33.49
非坏死组	52	284.05 ± 45.88	141.37 ± 31.93	81.14 ± 63.78	52.55 ± 31.23	45.37 ± 42.60
<i>t</i> 值		6.110	7.853	1.029	-2.879	-0.682
<i>P</i> 值		0.000	0.000	0.307	0.005	0.497

1) 坏死组坏死周围区域的骨密度为坏死区前缘和外侧缘骨密度的平均值,非坏死组股骨头边缘的骨密度为股骨头前缘和外侧缘骨密度的平均值

表 4 坏死组 ARCO II 期患者和 ARCO III 期患者股骨不同部位骨密度 $\bar{x} \pm s, \text{mg} \cdot \text{cm}^{-3}$

组别	样本量 (髌)	坏死区	坏死周围区域 ¹⁾	股骨颈	大转子	转子间
坏死组 ARCO II 期	21	307.31 ± 64.15	228.97 ± 49.64	100.71 ± 45.88	65.39 ± 26.72	59.97 ± 31.76
坏死组 ARCO III 期	27	380.42 ± 74.99	210.52 ± 45.64	97.01 ± 67.43	29.81 ± 37.03	38.94 ± 33.49
<i>t</i> 值		-3.565	1.337	0.225	3.771	2.208
<i>P</i> 值		0.001	0.188	0.823	0.001	0.032

1) 坏死周围区域的骨密度为坏死区前缘和外侧缘骨密度的平均值

3 讨 论

股骨头发生坏死,骨细胞死亡,随后通过血管再分布进行修复,纤维肉芽组织从股骨头基底或股骨颈沿骨小梁间隙向死骨蔓延,在坏死骨小梁表面形成新骨^[3-7]。病变组织成分多样,结构杂乱,存在变性、坏死、修复、增生、炎症反应等多种病理改变^[8]。在发生多种病理改变的同时,骨密度也会发生变化。因此本研究对股骨头坏死的骨密度变化进行了探究。

目前测量骨密度的仪器主要有双能 X 线骨密度、同步定量 CT,最近又出现了非同步定量 CT^[9]。Wang 等^[10]的研究显示,同步定量 CT 和非同步定量 CT 的

测定结果高度一致。本研究对 48 髌坏死股骨头和 52 髌正常股骨头采用非同步定量 CT 进行了定量骨密度测量。结果显示,股骨头坏死区域骨密度均较正常股骨头骨密度增高,其中 ARCO III 期坏死区域的骨密度高于 ARCO II 期,ARCO II、III 期坏死周围区域的骨密度均高于正常股骨头边缘的骨密度,但 ARCO II、III 期坏死周围区域的骨密度比较,差异无统计学意义。蔡自强等^[11-12]应用双能 X 线骨密度仪对股骨头坏死病例进行骨密度测量,结果显示股骨头坏死后骨密度降低。其结果与本研究不同,可能是由于股骨头坏死后后的囊变对骨密度值存在较大影响。周斌等^[13]应用

双能 X 线骨密度仪对股骨头缺血坏死的病例进行股骨头局部骨密度测量,结果显示股骨头坏死局部骨密度明显增高,并且股骨头局部骨密度随着病变加重而增高,这与本研究结果相似。

ARCO I、II 期股骨头坏死可行下肢牵引及药物等非手术治疗,也可行保留关节的手术治疗,如髓芯减压术和带或不带血液循环的骨移植术、截骨术等;ARCO III 期股骨头坏死可采用带血液循环的自体或非自体骨移植术治疗;ARCO IV 期应选择人工关节置换术治疗^[14-15]。康斌等^[16]认为,股骨头松质骨骨密度能够很好地反映股骨头的生物力学性质及骨小梁形态、结构的变化趋势,并且可以预判股骨头塌陷风险。Mann 等^[17]认为,术前应用定量 CT 评估股骨头骨密度,可为髓内钉固定提供一定的指导。

本研究的结果提示,股骨头坏死区和坏死周围区域骨密度较正常股骨头增高。

4 参考文献

- [1] 张崇耀,李峻辉,宁亚功. 股骨头坏死发病机制探讨[J]. 中华临床医师杂志(电子版),2011,5(6):1705-1707.
- [2] 刘铁钢,陈卫衡. 非创伤性股骨头坏死的流行病学研究[J]. 当代医学,2008,14(20):64-65.
- [3] ANN DOROTHY, KING, et al. Magnetic resonance imaging staging of nasopharyngeal carcinoma in the head and neck [J]. World J Radiol, 2010, 91(5):159-165.
- [4] WENBAO, WANG, JEFFREY, et al. Longitudinal evaluation of time related femoral neck narrowing after metal-on-metal hip resurfacing [J]. World J Orthop, 2013, 80(2):75-79.
- [5] ZAINO CJ, LEALI A, FETTO JF. Bone density and mechanical properties in femoral bone of swim loaded aged mice [J]. Clin Orthop Relat Res, 2010, 468(1):276-282.
- [6] VANDE BERG BC, LECOUVET FE, KOUTAISOFF S, et al. Bone marrow edema of the femoral head and transient osteoporosis of the hip [J]. Eur J Radiol, 2008, 67(1):68-77.
- [7] 赵凤朝,李子荣,张念非. 不同病因股骨头坏死的病理改变[J]. 实用骨科杂志,2005,11(3):210-213.
- [8] 郑云,贾乐,董都选,等. 股骨头坏死 20 例组织病理学观察[J]. 诊断病理学杂志,2016,23(2):100-102.
- [9] BROWN JK, TIMM W, BODEEN G, et al. Asynchronously Calibrated Quantitative Bone Densitometry [J]. J Clin Densitom, 2017, 20(2):216-225.
- [10] WANG L, SU Y, WANG Q, et al. Validation of asynchronous quantitative bone densitometry of the spine: Accuracy, short-term reproducibility, and a comparison with conventional quantitative computed tomography [J]. Sci Rep, 2017, 7(1):6284.
- [11] 蔡自强,闫培华,魏相磊,等. 骨密度测量评价股骨头无菌坏死的应用研究[J]. 中华关节外科杂志(电子版),2008,2(5):528-531.
- [12] 周志强. 骨密度测量在股骨头无菌坏死患者中的应用[J]. 临床研究,2016,24(1):119-120.
- [13] 周斌,孙革,韩冬梅,等. 成人股骨头缺血性坏死[J]. 风湿病与关节炎,2013,31(1):75-78.
- [14] 赵德伟,胡永成. 成人股骨头缺血性坏死[J]. 风湿病与关节炎,2013,36(1):75-78.
- [15] JOINT SURGERY GROUP OF THE ORTHOPAEDIC BRANCH OF THE CHINESE MEDICAL ASSOCIATION. Guideline for diagnostic and treatment of osteonecrosis of the femoral head [J]. Orthop Surg, 2015, 7(3):200-207.
- [16] 康斌,唐诗添,杨衡,等. 骨密度在股骨头缺血坏死后塌陷预测中的应用[J]. 实用骨科杂志,2009,1(1):30-32.
- [17] MANN J, HOLDSTOCK G, HARMAN M, et al. Current concepts on osteonecrosis of the femoral head [J]. World J Orthop, 2015, 13(8):590-601.

(收稿日期:2017-12-26 本文编辑:李晓乐)

(上接第 24 页)

- [15] 鲁常胜,蒋涛,鲁婷玮,等. 经皮椎体后凸成形术椎管内骨水泥渗漏的诊断及预防[J]. 临床骨科杂志,2017,20(1):30-33.
- [16] 耿家金,赵平,牛和明,等. 分次灌注骨水泥技术治疗骨质疏松性椎体压缩骨折疗效观察[J]. 中国骨与关节损伤杂志,2013,28(3):225-227.
- [17] 王远政,田晓滨,李波,等. 高粘度骨水泥与低粘度骨水泥经皮椎体成形术治疗严重骨质疏松性椎体压缩性骨折的前瞻性比较研究[J]. 中华创伤骨科杂志,2017,19(1):54-60.
- [18] 郑毓嵩,张勇,林金丁,等. 椎体成形术骨水泥渗漏的相关危险因素分析[J]. 中华创伤杂志,2015,31(4):312-316.
- [19] TAYLOR RS, TAYLOR RJ, FRITZELL P. Balloon kyphoplasty and vertebroplasty for vertebral compression fractures—A comparative systematic review of efficacy and safety [J]. Spine (Phila Pa 1976), 2006, 31(23):2747-2755.
- [20] 陈建德,樊晓琦,夏炳江,凌义龙. 球囊扩张部位对椎体后凸成形术治疗骨质疏松性椎体压缩骨折疗效及安全性的影响[J]. 中医正骨,2017,29(2):11-16.

(收稿日期:2018-03-15 本文编辑:时红磊)