·临床研究·

青少年强直性脊柱炎早期年龄、身高、体重、体重指数与腰椎骨量、骨密度的相关性初步分析

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【摘要】 **目的** 研究青少年强直性脊柱炎(Ankylosing spondylitis, AS)早期年龄、身高、体重、体重指数(BMI)与腰椎骨矿含量(L_{1-4} BMC、L_{2-4} BMC)、腰椎面积骨密度(L_{1-4} BMD、L_{2-4}BMD)、腰椎体积表观骨密度(L_{1-4} BMAD、L_{2-4} BMAD)之间的相关性,旨在初步探讨我国青少年AS早期骨量、骨密度的重要相关因素及评价指标。**方法** 选择男性青少年AS早期患者31例,统计AS患者年龄(y)、身高(cm)、体重(kg)、BMI(kg/m^2)、病程(mon)及ESR (mm/h)等变量,应用DPX-IQ双能X线骨密度仪(DEXA)检测L_{1-4}BMC、L_{2-4}BMC、L_{1-4}BMD和L_{2-4}BMD,计算L_{1-4}BMAD和L_{2-4} BMAD(BMAD = BMC/面积$^{3/2}$, g/cm^3);采用相关和回归分析研究多因素相关性。**结果** 年龄、身高、体重、BMI、病程、ESR、L_{1-4}BMC、L_{2-4}BMC、L_{1-4}BMD、L_{2-4}BMD、L_{1-4}BMAD和L_{2-4}BMAD的变量值分别为(17.56 ± 2.01)y、(168.52 ± 8.59) cm、(56.13 ± 12.72) kg、(19.65 ± 3.42) kg/m^2、(19.61 ± 12.39)mon、(21.71 ± 10.04) mm/h、(52.16 ± 12.17) g、(41.29 ± 9.59) g、(0.971 ± 0.139) g/cm^2、(0.984 ± 0.142)g/cm^2、(0.1332 ± 0.0146) g/m^3和(0.1527 ± 0.0173) g/m^3。双因素相关分析初步证实AS早期ESR增高(51.61% AS患者ESR≥20 mm/h)且与腰椎骨量、骨密度呈负相关(r = -0.509 ~ -0.424、P = 0.003 ~ 0.018)。多因素回归分析表明仅体重因素进入L_{1-4} BMD(R = -0.657, P = 0.000)、L_{2-4}BMD (R = 0.620, P = 0.000)、L_{1-4}BMAD(R = 0.551, P = 0.001)和L_{2-4} BMAD(R = 0.510, P = 0.003)回归疗程;另一方面,身高因素成为L_{1-4}BMC(R = 0.676, P = 0.000)和L_{2-4} BMC(R = 0.673, P = 0.000)主要相关因素而被纳入其回归方程。**结论** 身高和体重即成为青少年AS早期骨量及骨密度的重要相关因素。此时期重视发挥二因素对腰椎骨矿含量和骨密度的正相关作用,将对于减缓青少年AS早期骨量丢失及AS相关性骨质疏松症有积极意义。

【关键词】 青少年;强直性脊柱炎;骨密度;身高;骨质疏松症;体重

Effects of age, height, weight and BMI on lumbar spinal bone mineral contents and densities in Chinese adolescents with early ankylosing spondylitis *MA Xing, HU Yunyu, WU Xiaoming, et al. Institute of Orthopaedic Surgery of PLA & Department of Orthopaedics, Xijing Hospital, Fourth Military Medical University, Xi'an* 710032, China

【**Abstract**】 **Objective** To study the possible effects of age, height, weight and body mass index (BMI) on lumbar spinal bone mineral contents (L_{1-4}BMC, L_{2-4}BMC), areal bone mineral densities (L_{1-4}BMD, L_{2-4}BMD), and volumetric bone mineral apparent densities (L_{1-4}BMAD, L_{2-4}BMAD) of Chinese adolescents with early ankylosing spondylitis (AS). **Methods** Thirty-one male Chinese adolescent outpatients with early AS were included. Age (y), height (cm), total body weight (kg), body mass index (BMI, kg/m^2), disease duration (mon), and erythrocyte sedimentation rate (ESR, mm/h) of AS patients were recorded. L_{1-4}BMD, L_{2-4}BMC, L_{1-4}BMD, and L_{2-4} BMD were evaluated by dual-energy X-ray absorptiometry (DEXA) using Lunar DPX-IQ device. L_{1-4} BMAD and L_{2-4} BMAD (BMAD = BMC/Area$^{3/2}$, g/cm^3) were subsequently calculated. Correlation and multiple regression analyses were performed. **Results** The values of age, height, weight, BMI, disease duration, ESR, L_{1-4}BMC, L_{2-4}BMC, L_{1-4}BMD, L_{2-4}BMD, L_{1-4}BMAD, and L_{2-4}BMAD were 17.56 ± 2.01y, 168.52 ± 8.59 cm, 56.13 ± 12.72 kg,

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19.65 ± 3.42 kg/m², 19.61 ± 12.39 mon, 21.71 ± 10.04 mm/h, 52.16 ± 12.17 g, 41.29 ± 9.59 g, 0.971 ± 0.139 g/cm², 0.984 ± 0.142g/cm², 0.1332 ± 0.0146 g/m³, and 0.1527 ± 0.0173 g/m³ respectively. In AS patients, raised ESR (51.61% of patients had ESR≥20 mm/h) was negatively correlated with lumbar spinal bone mineral contents and densities (r = -0.509 ~ -0.424, P = 0.003 ~ 0.018). Multiple regression analysis further identified that olny the factor of weight had predominant influences on L_{1-4}BMD (R = 0.657, P = 0.000), L_{2-4}BMD (R = 0.620, P = 0.000), L_{1-4}BMAD (R = 0.551, P = 0.001) and L_{2-4}BMAD (R = 0.510, P = 0.003), and the factor of height had positively determinant effects on both L_{1-4}BMC (R = 0.676, P = 0.000) and L_{2-4}BMC (R = 0.673, P = 0.000). **Conclusion** Positive and protective effects of height and weight on lumbar spinal bone mass and densities contribute favorably to early prevention of AS-associated spinal bone loss and osteoporosis.

【**Key words**】 Adolescence; Ankylosing spondylitis; Bone mineral dentisy; Height; Osteoporosis; Weight

青少年时期是人体生长发育的第二个高峰期，对骨骼成长及峰值骨量获取具有极其的重要意义[1,2]。然而，此时期好发的强直性脊柱炎（Ankylosing spondylitis，AS）将对青少年骨关节造成严重损害。其中AS相关性骨质疏松症（Osteoporosis，OP）是一种威胁青少年生长发育及健康成长的严重炎症性、免疫性的脊柱及关节疾患，病程进展将导致和遗留严重骨骼畸形及多器官损害。AS相关性骨质疏松症作为AS严重并发症之一，已日益受到关注[3-5]。但是，青少年尤其是我国青少年AS早期骨量变化特点尚无确切研究。本研究通过分析31例青少年AS早期患者的年龄、身高、体重、体重指数（BMI）与腰椎骨矿含量（L_{1-4} BMC、L_{2-4}BMC）、腰椎面积骨密度（L_{1-4} BMD、L_{2-4}BMD）、腰椎体积表观骨密度（L_{1-4} BMAD、L_{2-4} BMAD）的相关性，旨在初步探讨适合我国青少年AS早期骨量、骨密度研究的相关因素和评价指标。

材料和方法

1. 研究对象：自2000年1月至2003年10月，择取男性青少年AS早期患者31例。AS患者均符合下列入选标准：（1）AS纽约诊断标准[6]；（2）血清HLA-B27(+)[7,8]；（3）无明显脊柱侧弯、增生、韧带骨化或竹节样改变，无烟酒嗜好，否认其它血清阴性关节炎，否认服用激素、巴比妥类和其他影响骨代谢等药物，除外特殊补钙治疗、超常体力活动、先天性骨骼畸形、严重肝、肾疾病、糖尿病、骨肿瘤、佝偻病、骨软化症等。

2. 临床和影像分析指标：基本临床资料包括：年龄（y）、身高（cm）、体重（kg）、BMI（kg/m²）和病程（月）。采用近期（≤2月内）影像学资料，按照纽约标准评估骶髂关节炎，早期骶髂关节炎诊断采用CT扫描。

3. 实验室检查：检测AS患者血清HLA-B27及血红细胞沉降率（ESR，mm/h）。

4. DEXA：受检者取仰卧屈髋屈膝位，采用Lunar DPX-IQ双能X线骨密度测量仪（DEXA）测定L_{1-4} BMC、L_{2-4}BMC、L_{1-4}BMD和L_{2-4}BMD，计算L_{1-4}BMAD和L_{2-4} BMAD（BMAD = BMC/面积$^{3/2}$，g/cm³）。变异系数（CV）1%，每日开机后用厂家提供的体模进行仪器检测质量校验。

5. 统计学处理：

（1）年龄、身高、体重、BMI、病程、ESR、L_{1-4}BMC、L_{2-4}BMC、L_{1-4} BMD、L_{2-4}BMD、L_{1-4}BMAD及L_{2-4}BMAD正态性检验。变量值用均数±标准差表示。

（2）AS组内简单双因素以及多因素相关分析，P<0.01差异有显著性。

应用SPSS10.0统计软件建立数据库并进行相关和回归分析。

结 果

1. 变量值及结果经正态性检验各变量均符合正态分布。青少年AS早期患者ESR增高（21.71±10.04）mm/h，其中51.61%（16/31）患者ESR≥20 mm/h，见表1。

表1 AS患者变量值统计结果

变量	n	$\bar{x} \pm s$	Z	$P^{K\text{-}S}$
年龄（y）	31	17.56 ± 2.01	0.701	0.709
身高（cm）	31	168.52 ± 8.59	0.854	0.459
体重（kg）	31	56.13 ± 12.72	1.076	0.198
BMI（kg/m²）	31	19.65 ± 3.42	0.658	0.779
病程（mon）	31	19.61 ± 12.39	0.898	0.395
ESR（mm/h^{1st}	31	21.71 ± 10.04	0.965	0.309
L_{1-4}BMC（g）	31	52.16 ± 12.17	0.541	0.931
L_{2-4}BMC（g）	31	41.29 ± 9.59	0.557	0.916
L_{1-4}BMD（g/cm²）	31	0.971 ± 0.139	0.494	0.968
L_{2-4}BMD（g/cm²）	31	0.984 ± 0.142	0.531	0.941
L_{1-4}BMAD（g/cm³）	31	0.1332 ± 0.0146	0.777	0.582
L_{2-4}BMAD（g/cm³）	31	0.1527 ± 0.0173	0.946	0.332

注：$P^{K\text{-}S}$：K-S（Kolmogorov-Smirnov）适配度检验P值；Z：K-SZ值

2. 简单双因素相关分析初步证实了腰椎骨量、

骨密度之间具有良好的正相关性。其中，L_{1-4}BMC 与 L_{1-4}BMD（$r=0.939$，$P=0.000$）、L_{1-4}BMAD（$r=0.740$，$P=0.000$）均显著正相关；L_{1-4}BMD 与 L_{1-4}BMAD（$r=0.925$，$P=0.000$）显著正相关。此外，L_{2-4}BMC 与 L_{2-4}BMD（$R=0.938$，$P=0.000$）、L_{2-4}BMAD（$r=0.742$，$P=0.000$）均显著正相关，且 L_{2-4}BMD 与 L_{2-4}BMAD（$r=0.929$，$P=0.000$）亦显著正相关。体重则与身高（$r=0.608$，$P=0.000$）以及 BMI（$r=0.892$，$P=0.000$）显著正相关。另一方面，ESR 增高（21.71±10.04mm/h，51.61% AS 患者 ESR≥20mm/h）且与 L_{1-4}BMC、L_{2-4}BMC、L_{1-4}BMD、L_{2-4}BMD、L_{1-4}BMAD 及 L_{2-4}BMAD（$r=0.497$，$P=0.006$；$r=0.484$，$P=0.006$，$r=-0.509$；$P=0.003$；$r=-0.492$，$P=0.005$；$r=-0.455$，$P=0.010$ 和 $r=-0.424$，$P=0.018$）均呈负相关。

3. 多因素相关回归分析进一步证实，在众多因素中身高（$R=0.608$，$P=0.000$）和 BMI（$R=0.350$，$P=0.009$）进入 L_{1-4}BMC 回归方程（$R=0.759$，$Radj^2=0.545$，$P=0.000$）。身高因素不仅是 L_{1-4}BMC（$R=0.676$，$Radj^2=0.439$，$P=0.000$）主要相关因素而且是唯一被纳入 L_{2-4}BMC（$R=0.673$，$Radj^2=0.434$，$P=0.000$）回归方程的变量因素。体重则是唯一被纳入 L_{1-4}BMD（$R=0.657$，$Radj^2=0.412$，$P=0.000$）、L_{2-4}BMD（$R=0.620$，$Radj^2=0.363$，$P=0.000$）、L_{1-4}BMAD（$R=0.551$，$Radj^2=0.280$，$P=0.001$）以及 L_{2-4}BMAD（$R=0.510$，$Radj^2=0.235$，$P=0.003$）回归方程的显著正相关因素，见表2。

表2 多因素回归分析结果（$n=31$）

项目	L_{1-4}BMC		L_{2-4}BMC		L_{1-4}BMD		L_{2-4}BMD		L_{1-4}BMAD		L_{2-4}BMAD	
	β	P	β	P	β	P	β	P	β	P	β	P
年龄	-		-		-		-		-		-	
身高	0.608	0.000	0.673	0.000	-		-		-		-	
体重	-		-		0.657	0.000	0.620	0.000	0.551	0.001	0.510	0.003
BMI	0.350	0.009	-		-		-		-		-	
病程	-		-		-		-		-		-	
ESR	-		-		-		-		-		-	
R	0.759		0.673		0.657		0.620		0.551		0.510	
R^2	0.575		0.452		0.431		0.384		0.304		0.260	
$Radj^2$	0.545		0.434		0.412		0.363		0.280		0.235	
P	0.000		0.000		0.000		0.000		0.000		0.003	

注：β：变量的标准系数；R：相关系数；R^2：决定系数；$Radj^2$：调整决定系数；P：显著性 P 值；-：无显著性，该变量未进入回归方程

讨 论

强直性脊柱炎（Ankylosing spondylitis，AS）以其发病早、易导致和遗留严重骨骼畸形，而成为威胁青少年生长发育的一种严重脊柱及关节疾患。AS 相关性骨质疏松症（Osteoporosis，OP）不仅是骨骼系统严重并发症之一，还是脊柱畸形、压缩性骨折以及容易合并脊髓损伤的重要危险因素[4,9-11]。目前有关急性期炎性反应指标如 ESR 与 AS 相关性的研究屡见不鲜。近来有研究提示急性炎性反应指标不仅与 AS 活动性有关，而且 ESR 增高可能预示着骨吸收增强。本研究不仅发现该组青少年 AS 早期患者 ESR 显著增高，31 例患者中有 16 例（51.61%）ESR≥20 mm/h[12]、11 例（35.48%）ESR≥25 mm/h[13]；而且明确证实了增高的 ESR 与腰椎骨矿含量、骨密度显著负相关性（$r=-0.509\sim-0.424$，$P=0.003\sim0.018$），进而为上述论点提供了重要直接依据[12,14,15]。

另一方面，年龄、身高、体重和体重指数（BMI）是青少年成长发育密切相关的个体化特征基本要系，深入研究该要素与骨量和骨密度的相关性，将有助于早期、全面、正确评估青少年 AS 骨量、骨强度变化特点及远期骨质疏松危险性[4]。

虽然 AS 早期骨密度下降可能是疾病本身炎症所引起的[12,14,15]，但是本研究证实，在众多因素中仅有体重因素被严格纳入 L_{1-4}BMD（$R=0.657$，$Radj^2=0.412$，$P=0.000$），L_{2-4}BMD（$R=0.620$，$Radj^2=0.363$，$P=0.000$）、L_{1-4}BMAD（$R=0.551$，$Radj^2=0.280$，$P=0.001$）和 L_{2-4}BMAD（$R=0.510$，$Radj^2=0.235$，$P=0.003$）回归方程，即体重决定 24%～41% 腰椎密度的变化。另一方面，身高作为 L_{1-4}BMD（身高 $R=0.676$，$Radj^2=0.439$，$P=0.000$）和 L_{2-4}BMC

($R = 0.673$, $Radj^2 = 0.434$, $P = 0.000$)的关键相关因素,决定了44%腰椎骨矿量的变化。身高和体重即对青少年AS早期骨矿含量和骨密度有着极其重要的正相关意义。进而提示,如果能在积极治疗AS的同时,正确开展康复训练及促进青少年成长发育,将有利于发挥身高和体重对骨矿含量和骨密度的正相关作用,对于维持和增加骨量和骨密度、改善骨强度、降低AS相关性骨质疏松及骨折危险性都大有裨益。

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