临床论著

平山病患者与非平山病患者钩椎关节在 CT 上的形态学差异

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【摘要】目的:研究平山病患者和非平山病患者钩椎关节在 CT 上的形态学差异,提出平山病可能的发病机制。**方法**:选择 2006 年 10 月~2012 年 1 月我院骨科诊治的平山病患者 32 例作为病例组,均为男性,年龄 16~37 岁,平均 19.4±4.1 岁;发病年龄 14~27 岁,平均 16.8±2.5 岁;病程 1~120 个月,平均 31.7±23.7 个月。选取同期因急性颈痛于我院急诊就诊且颈椎 CT 正常的 32 例患者为对照组,亦均为男性,年龄 12~26 岁,平均 19.1±4.3 岁。两组年龄无统计学差异(P>0.05)。在 GE-PACS 系统上选取两组患者通过 C3~C7 横突孔中心的颈椎 CT 冠状截面图片,分别测量各节段左右两侧如下指标:①钩突基底宽,椎体上缘的延长线上钩突内外侧缘的间距;②钩突高,钩突尖至椎体上缘延长线的垂直距离;③钩突间距,双侧钩突尖间的直线距离;④钩突倾角,钩突与椎体上缘的夹角;⑤下终板倾角,被测量椎体下终板与同一椎体侧边的夹角。**结果**:平山病患者 C3~C7 同一节段左右两侧的钩突基底宽、钩突高、钩突间距、钩突倾角、下终板倾角均无显著性差异(P>0.05)。平山病患者 C3~C7 之间的钩突高及钩突间距有显著性差异(P<0.05),其中钩突高 C6 最高、C4 最低,其递减规律为 C6>C5>C7>C3>C4,同时钩突间距则表现为 C3~C7 逐渐增宽;钩突基底宽、钩突倾角、上椎体下终板倾角(除 C3 外)在 C3~C7 之间无显著性差异(P>0.05)。两组取左右两侧均值为相应节段的钩突基底宽、钩突高,并计算左右两侧钩突倾角总和、下终板倾角总和及相应节段的倾角总和之差(即钩突倾角总和-下终板倾角总和),再计算均值及标准差。平山病患者 C3~C7 的钩突基底宽、钩突间距以及钩突倾角总和与对照组比较均无显著性差异(P>0.05),而同一节段钩突高度和上位椎体下终板倾角总和均明显小于对照组(P<0.05),且倾角总和之差均显著大于对照组(P<0.05)。**结论**:平山病患者可能存在钩椎关节发育异常,表现为钩突的相关指标发育不平衡,同时具有较矮的钩突以及较小的下终板倾角,继而引发的颈椎不稳定在平山病的发生和发展过程中有重要意义。

【关键词】平山病;钩椎关节;钩突;发病机制
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【Abstract】 Objectives: To study the morphological difference of luscka joints between Hirayama disease patients and non-Hirayama disease patients on CT scan and to provide a new possible mechanism of Hirayama disease. **Methods:** 32 patients(all males) with a mean age of 19.4±4.1(range 16-37 years) and with Hirayama disease were treated in our hospital from October 2006 to January 2012, the mean course of disease was 31.7±23.7 months(range, 1-120 months). 32 patients(all males) with a mean of age was 19.1±4.3 (range, 12-26 years) suffering from acute neck pain and having no Hirayama disease were reviewed as control. Both groups showed no age related difference. From the cervical CT coronal plane reconstruction images which passing through the transverse foramen center of C3-C7 in GE-PACS system, the following data were measured in both sides: ①The width of the uncinate process base: the distance between inner and outer margin of the uncinate process at the upper edge of the vertebral body. ②The height of the uncinate process: the vertical distance from the top of the uncinate process to the upper edge of the vertebral body. ③The

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distance between two uncinate processes: the distance between the tips of the bilateral uncinate processes. ④ The inclination angle of the uncinate process: the angle between the uncinate process and the upper edge of the vertebral body. ⑤The inclination angle of the inferior endplate: the angle between the uncinate process: the vertical distance from the top of the uncinate process to the upper edge of the vertebral body. **Results:** There were no significant side-related differences on the width of the uncinate process base, the height of the uncinate process, the distance of the uncinate process, the inclination angle of the uncinate process and the inclination angle of the inferior endplate at the same segment from C3 to C7 in Hirayama disease patients(P>0.05). However, differences were found on the height of the uncinate process and the distance between two uncinate processes of C3-C7 (P<0.05), C6 and C4 had the highest and lowest height of the uncinate process as C6>C5>C7>C3>C4. The distance of the uncinate process gradually increased from C3 to C7. There were no significant differences on the width of the uncinate process base, the inclination angle of the uncinate process and the inclination angle of inferior endplate(except for C3) of C3-C7(P>0.05). Then, using the mean value of the left and right sides as the width of the base of uncinate process, the height of uncinate process, and calculating the sum of inclination angle of the uncinate process, the sum of inclination angle of inferior endplate of the upper vertebra and the difference between the sums (the sum of inclination angle of uncinate process - the sum of inclination angle of inferior endplate of the upper vertebra), then calculating the mean value and standard deviation. Compared with the non-Hirayama disease patients, there were no significant differences on the uncinate process base, the distance of the uncinate process and the sum of inclination angle of the uncinate process at the same segment of Hirayama disease patients (P>0.05), while the height of the uncinate process and the sum of inclination angle of uncinate process of Hirayama disease patients were significantly smaller than those of the control group, respectively(P<0.05), and the differences between the sums were larger than those of the control group (P<0.05). **Conclusions:** Hirayama disease patients may possess a dysplasia in the luscka joint, manifesting the nonuniform development of the uncinate indicators. Lower uncinate process and smaller inclination angle of inferior endplate of the upper vertebra are common, The consequential cervical instability may play a significantly important role in the pathogenesis and progress of Hirayama disease.

【**Key words**】Hirayama disease; Uncovertebral joint; Uncinate process; Pathogenesis

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平山病(Hirayama disease)又称青少年上肢远端肌萎缩症(juvenile muscular atrophy of distal upper extremity), 日本学者平山惠造于 1959 年首先描述了此病。目前平山病的发病机制尚不明确, 有研究发现平山病患者均存在颈椎节段性不稳定现象[1],其中小关节的形态异常可能是其原因之一[2]。钩椎关节是影响颈椎节段性稳定的重要因素之一, 但平山病患者的钩椎关节是否也存在异常尚无文献报告。本研究通过比较平山病和非平山病患者的钩椎关节在 CT 上的形态学差异, 以探究钩椎关节在平山病发病过程中的作用机理,试图提出新的可能的平山病发病机制。

1 资料与方法

1.1 一般资料

选择 2006 年 10 月~2012 年 1 月我院骨科诊治的平山病患者 32 例作为病例组, 均为男性,年龄 16~37 岁, 平均 19.4±4.1 岁; 发病年龄 14~27 岁, 平均 16.8±2.5 岁; 病程 1~120 个月, 平均 31.7±23.7 个月, 其中 1 例患者病程仅 1 个月,表现为右上肢肌肉萎缩无力伴精细活动不利, 所有患者均有不同程度的上肢远端肌肉萎缩或无力。对照组选取同期因急性颈痛于我院急诊就诊且颈椎 CT 正常的 32 例患者,亦均为男性,年龄 12~26 岁,平均 19.1±4.3 岁。两组年龄无统计学差异(P>0.05)。

1.2 影像学测量

所有测量均在我院的 GE-PACS (Picture Archiving & Communication Systems)上进行。两组患者均选取通过 C3~C7 横突孔中心的颈椎 CT 冠状截面图片, 分别测量各节段左右两侧如下指标(图 1):①钩突基底宽,在椎体上缘的延长线上钩突内外侧缘的间距;②钩突高,钩突尖至椎体上缘延长线的垂直距离;③钩突间距,双侧钩突尖之

图 1 在通过 C3~C7 横突孔中心的颈椎 CT 冠状截面上测量各节段以下指标：颈椎钩突基底宽(a)，椎体上缘的延长线上钩突内外侧缘的间距；钩突高(b)，钩突尖至椎体上缘延长线的垂直距离；钩突间距(c)，双侧钩突尖间的直线距离；钩突倾角(α)，钩突与椎体上缘的夹角；下终板倾角(β)，椎体下终板与椎体侧边的夹角

Figure 1 From the cervical CT coronal plane reconstruction images which passing through the transverse foramen center of C3–C7 in GE–PACS system, the following datas were measured in both sides: The width of the base of uncinate process (a): the distance between inner and outer margin of the uncinate process at the upper edge of the vertebral body. The height of uncinate process (b): the vertical distance from top of the uncinate process to the upper edge of the vertebral body. The distance between uncinate processes(c): the distance between the tips of the bilateral uncinate process. The inclination angle of uncinate process (α): the angle between the uncinate process and the upper edge of the vertebral body. The inclination angle of inferior endplate(β): the angle between the endplate and the lateral border of vertebral body

间的直线距离；④钩突倾角，钩突内缘(钩椎关节的关节面) 延长线与椎体上缘延长线的夹角 (钝角)；⑤下终板倾角，被测量椎体下终板的延长线与同一椎体侧边(钩椎关节的关节面)延长线的夹角(钝角)。所有数据均精确到小数点后 1 位，为保证测量结果客观、准确，均由同一名医师测量，并测量两遍后取均值。

1.3 统计学处理

用 SPSS 17.0 统计软件进行数据分析。病例组和对照组之间进行同质性检验；用配对 *t* 检验分析病例组 C3~C7 椎体同一节段左右侧相关指标的一致性；取左右两侧的均值为 C3~C7 相应节段的钩突基底宽、钩突高，同时计算同一节段左右两侧钩突倾角总和、下终板倾角总和及相应节段的倾角总和之差 (即钩突倾角总和–下终板倾角总和)，并计算其均值及标准差，再运用均值单因素 *t* 检验分析两组间 C3~C7 相关指标的一致性。*P*<0.05 为有统计学意义。

2 结果

2.1 平山病患者 C3~C7 钩突基底宽、钩突高、钩突间距的测量结果

平山病患者 C3~C7 钩突基底宽、钩突高、钩突间距的测量结果见表 1，C3~C7 的钩突基底宽同一节段左右两侧之间和各节段左右两侧均值后相互之间均无显著性差异(*P*>0.05)。C3~C7 的钩突高同一节段左右侧之间无显著性差异 (*P*>0.05)，但 C3~C7 各节段左右侧均值后的钩突高度有显著性差异 (*P*<0.05)，其中 C6 最高、C4 最低，其递减规律为 C6>C5>C7>C3>C4。而 C3~C7 各节段钩突间距亦存在显著性差异 (*P*<0.01)，表现为 C3~C7 逐渐增宽。

2.2 平山病患者 C3~C7 钩突倾角和上位椎体下终板倾角的测量结果

平山病患者 C3~C7 钩突倾角和上位椎体下终板倾角的测量结果见表 2。C3~C7 的钩突倾角同一节段左右侧之间和各节段左右侧均值后钩突倾角相互之间均无显著性差异(*P*>0.05)。C3~C7 的上位椎体下终板倾角同一节段左右两侧之间无显著性差异(*P*>0.05)；左右两侧均值后 C3 上位椎体下终板倾角(即 C2 下终板倾角)明显大于其他节段 (*P*<0.01)，C4~C7 上位椎体下终板倾角相互之间并无显著性差异(*P*>0.05)。

2.3 病例组与对照组间 C3~C7 钩突基底宽、钩突高、钩突间距的比较

两组间 C3~C7 钩突基底宽、钩突高、钩突间距的比较见表 3。病例组和对照组的钩突基底宽在 C4、C7 有显著性差异(*P*<0.05)，余节段均无显著性差异(*P*>0.05)。同一节段对照组钩突高明显大于病例组，其中 C5 *P*<0.05，C3、C4、C6、C7 均 *P*<0.01。而病例组和对照组的钩突间距比较，C3 *P*<0.05，其他节段均无显著性差异(*P*>0.05)。

2.4 平山病组与对照组间 C3~C7 各个节段钩突倾角总和、上位椎体下终板倾角总和及倾角总和之差的比较

两组间 C3~C7 各节段钩突倾角总和、上位椎体下终板倾角总和及倾角总和之差的比较见表 4。病例组 C3~C7 同一节段的钩突倾角总和与对

表 1 平山病患者 C3~C 7 钩突宽度、钩突高度和左右钩突间距的测量结果 ($\bar{x}\pm s$, mm, n=32)

Table 1 Measurement of the width of the base of uncinate process, the height of uncinate process and the distance between two uncinate processes from C3–C7 in Hirayama disease patients

	钩突基底宽 The width of the base of uncinate process			钩突高 The height of uncinate process			钩突间距 The distance between two uncinate processes
	左侧 Left	右侧 Right	左右两侧均值 Mean of both sides	左侧 Left	右侧 Right	左右两侧均值 Mean of both sides	
C3	6.99±1.09	6.88±1.29①	6.94±1.09	3.88±1.08	3.71±1.25①	3.80±1.11	20.54±1.48
C4	6.50±1.07	6.28±1.18①	6.37±1.01	3.51±1.05	3.76±1.04①	3.64±0.95	22.07±1.57
C5	6.82±1.83	6.56±0.81①	6.69±0.73	4.29±0.83	4.12±0.72①	4.21±0.66②③	23.29±1.27
C6	6.95±0.66	6.80±0.80①	6.88±0.62	4.35±1.13	4.39±0.88①	4.37±0.94②③	25.04±1.31②③
C7	6.53±1.04	6.78±0.87①	6.66±0.80	3.89±1.56	4.01±1.11①	3.95±1.07	26.28±1.61②③

注：①与同节段左侧比较 P>0.05；②与同一指标 C3 比较 P<0.05；③与同一指标 C4 比较 P<0.05

Note: ①Compared with the left side of same index of the same segment, P>0.05; ②Compared with C3 of same index, P<0.05; ③Compared with C4 of same index, P<0.05

表 2 平山病患者 C3~C7 钩突倾角和上位椎体下终板倾角的测量结果 ($\bar{x}\pm s$, °, n=32)

Table 2 Measurement of the inclination angle of uncinate process and inclination angle of inferior endplate from C3–C7

	钩突倾角 The inclination angle of uncinate process			上位椎体下终板倾角 The inclination angle of inferior endplate of the upper vertebra		
	左侧 Left	右侧 Right	左右两侧均值 Mean of both sides	左侧 Left	右侧 Right	左右两侧均值 Mean of both sides
C3	134.85±9.81	135.44±10.99①	135.14±9.50	121.61±11.51	117.05±16.47①	119.33±11.93②
C4	138.96±8.08	135.45±9.99①	137.20±7.74	103.73±5.31	103.35±5.95①	103.54±4.10
C5	135.18±7.20	134.99±6.27①	135.09±5.91	104.93±5.14	104.25±4.31①	105.09±3.90
C6	136.24±7.45	135.51±5.16①	135.88±5.72	105.15±4.97	104.83±3.79①	104.99±3.33
C7	138.78±8.98	139.99±6.88①	139.18±7.35	104.43±5.25	105.57±5.38①	105.00±4.81

注：①与同节段左侧比较 P>0.05；②与 C4~C7 比较 P<0.01

Note: ①Compared with the left side of same index of the same segment, P>0.05; ②There is significant difference between the inclination angle of inferior endplate of the upper vertebra of C3 and those of C4–C7(P<0.01)

表 3 病例组与对照组间 C3~C7 钩突基底宽、钩突高、钩突间距的比较 ($\bar{x}\pm s$, mm, n=32)

Table 3 Comparison of the width of uncinate process, the height of uncinate process and distance between uncinate processes from C3–C7 in the case group and the control group

	钩突基底宽 The width of uncinate process		钩突高 The height of uncinate process		钩突间距 The distance between uncinate processes	
	病例组 Case group	对照组 Control group	病例组 Case group	对照组 Control group	病例组 Case group	对照组 Control group
C3	6.94±1.19	6.88±1.10	3.79±1.16	4.36±1.05②	20.54±1.48	21.54±1.69①
C4	6.39±1.12	6.84±0.89①	3.64±1.04	4.37±0.77②	22.07±1.57	22.59±1.43
C5	6.69±0.82	6.80±0.87	4.20±0.77	4.54±0.93①	23.29±1.27	23.59±1.51
C6	6.88±0.73	6.79±0.65	4.37±1.01	4.85±1.03②	25.04±1.31	24.93±1.37
C7	6.65±0.96	7.03±0.81①	3.95±1.13	4.65±1.16②	26.28±1.61	26.08±1.87

注：①与病例组同节段比较 P<0.05；②与病例组同节段比较 P<0.01

Note: ①Compared with case group of same index of the same segment, P<0.05; ②Compared with case group of the height of uncinate process, P<0.01

照组比较无显著性差异(P>0.05)。病例组中 C3~C6 同一节段的上位椎体下终板倾角总和明显小于对照组(P<0.001)、但是 C7 无显著性差异(P>0.05)。C3~C7 同一节段的倾角总和之差病例组明显大于对照组,其中 C3~C6 P<0.001、C7 P<0.05。

3 讨论

平山病多见于亚洲人群,起病隐匿,好发于青少年男性,15~17 岁为其发病高峰,临床表现呈非对称性上肢远端肌肉萎缩无力,常伴有寒冷麻痹、伸指束颤,一般无感觉及锥体束受累,病情一般在 5~6 年内发展至上肢肌肉严重萎缩而致残后停止进展[3~5]。但目前平山病的发病机制尚不明确,主要包括发育不平衡学说、脊髓动力学说、静脉压迫学说、遗传机制学说及免疫机制学说等[6~16]。有研究发现平山病患者均存在颈椎节段性不稳定现象,考虑这种不稳定性可能是导致平山病的原因之一[1],而影响颈椎稳定性的钩椎关节对平山病的发生和发展是否具有重要意义尚无文献报告。

钩椎关节是 C3~C7 所特有的关节,由位于椎体上缘两侧外后侧隆起的钩突与上位椎体下缘斜坡咬合而成,1858 年德国学者 Hubert Von Luschka 首先提出钩椎关节的存在,故又称为 Luschka 关节[17]。钩椎关节与椎间盘及两侧关节突关节一起构成颈椎的椎间关节,共同维持颈椎的稳定。钩椎关节兼具滑膜关节及软骨关节的性质,但 5 岁以下的儿童尚无钩椎关节,随着颈椎的发育和功能的完善,钩椎关节逐渐形成,因此钩椎关节的形成也是形态对功能适应的过程。颈椎的受力由上而下逐渐增大,形态学观察表明,钩突在上位颈椎位于椎体的外侧面,而在下位颈椎则变为后外侧,其作用是限制颈椎后伸以及侧弯,且钩突的外倾角与钩突基底宽均逐渐增大[18,19]。Clausen 等[20]认为钩椎关节对下位颈椎的联合运动起主要作用,钩突有效地减少了颈椎的联合运动和基本运动,特别是轴向旋转和向外侧屈的承载。研究发现,正常颈椎功能单位施加轴向载荷时,钩椎关节所承受的压应力随着载荷的增加而递增,且其主要的生物力学功能大部分由其后部分提供[21,22]。Chen 等[23]的研究进一步指出钩椎关节使颈椎的伸屈活动更加稳定。由此可见,钩椎关节作为维持颈椎稳定性、承载颈椎压力及导向伸屈运动的重要解剖结构,但目前尚无文献报道其与平山病的发生发展是否存在相关性。

本研究结果显示,平山病患者左、右侧钩椎关节的钩突基底宽度、钩突高度、钩突倾角以及上位椎体下终板倾角均无统计学差异(P>0.05),说明平山病患者的左右两侧钩椎关节的发育是均衡的。但上述各指标在节段之间比较却差异较大,其中钩突基底宽、钩突倾角以及上位椎体下终板倾角(除 C3 外)各节段之间既无显著性差异(P>0.05)又无递增或递减规律,其测量值均相对稳定,而 C3 上位椎体下终板倾角明显大于其他段是因枢椎的特殊解剖结构所致。而钩突高度及钩

表 4 平山病组与对照组间 C3~C7 钩突倾角总和、上位椎体下终板倾角总和及倾角总和之差的比较 ($\bar{x}\pm s$, °, n=32)

Table 4 Comparison of the sum of inclination angle of uncinate process, the sum of inclination angle of inferior endplate of the upper vertebra and the difference between the sums

	钩突倾角总和 The sum of inclination angle of uncinate process		上位椎体下终板倾角总和 The sum of inclination angle of inferior endplate of the upper vertebra		倾角总和之差① The difference between the sums	
	病例组 Case group	对照组 Control group	病例组 Case group	对照组 Control group	病例组 Case group	对照组 Control group
C3	270.29±18.99	260.73±19.07②	238.66±23.87	263.30±19.55③	31.63±32.20	−2.58±24.00③
C4	274.41±15.47	266.54±10.52②	207.08±8.21	222.05±8.67③	67.33±15.63	44.49±14.24③
C5	270.17±11.81	269.49±11.84②	210.18±7.80	219.52±9.44③	59.99±12.03	49.97±16.02③
C6	271.75±11.44	268.60±11.30②	209.98±6.66	217.08±9.87③	61.78±12.79	51.52±15.22③
C7	278.36±14.79	270.94±14.60②	209.99±9.63	213.69±6.32②	68.37±19.20	57.26±16.94④

注:①倾角总和之差=钩突倾角总和−上位椎体下终板倾角总和;②与病例组同节段比较 P>0.05;③与病例组同节段比较 P<0.001;④与病例组同节段比较 P<0.05

Note: ①The difference between the sums=The sum of inclination angle of uncinate process−The sum of inclination angle of inferior endplate of the upper vertebra; ②Compared with case group of same index of the same segment, P>0.05; ③Compared with case group of same index of the same segment, P<0.001; ④Compared with case group of the difference between the sums, P<0.05

突间距在各节段之间却存在统计学差异（$P<0.05$），其中钩突高度从上到下大致呈逐渐增大趋势，并在椎序方面则呈“尖峰状”，其峰值为 C6；而钩突间距从上到下呈逐渐增大变化，与 Oh 等[24]发现的变化规律（C3~C7 钩突间距为 15.18~20.28mm）是一致的。平山病患者这种钩突基底宽、钩突倾角以及上位椎体下终板倾角（除 C3 外）等指标从上到下相对均衡，而钩突高及钩突间距则逐渐增大的变化规律，与王星等[25]对正常人的观察结果不符，提示平山病患者这种不均衡的钩椎关节发育可能导致钩椎关节在承受压力时不能满足其由上而下逐渐增大的生物力学要求，而致使导致平山病患者在发育过程中逐渐出现下颈椎不稳定现象。

本研究中，同时选取因急性颈痛于我院急诊就诊且颈椎 CT 正常的 32 例非平山病患者作为对照组，就诊原因均为急性外伤，故可初步认为对照组的钩椎关节属于正常对照。本研究中，考虑到双侧钩突与上位椎体之间的“钳夹式”咬合关系，故选用双侧倾角总和、上位椎体下终板倾角总和作为比较对象，符合钩椎关节解剖情况。通过表 3、表 4 可知，两组的钩突基底宽仅 C4、C7 存在统计学差异（$P<0.05$），钩突间距（除 C3 外）及钩突倾角各节段均无统计学意义（$P>0.05$）；然而，两组的钩突高度、上位椎体下终板倾角总和以及倾角总和之差均存在显著性差异（$P<0.05$），其中平山病患者的钩突高度、上位椎体下终板倾角总和（C3~C6）明显小于对照组，而倾角总和之差显著大于对照组，提示平山病患者的钩突相对于非平山病患者较矮，同时上位椎体下终板倾角总和亦相对较小，使得钩突与上位椎体下缘不能较好地吻合，既不能充分实现钩突导向颈椎伸屈运动以及限制侧弯、旋转的作用，又因钩椎关节咬合较差导致颈椎的活动度增加、稳定性降低，这种长期的下颈椎功能性不稳导致相应节段的脊髓受到持续的动态压迫和刺激，继而出现变性和萎缩，引起临床症状。

综上所述，平山病患者可能存在钩椎关节发育异常，表现为钩突基底宽、钩突高、钩突间距、钩突倾角等相关指标之间的发育不均衡，同时相对于非平山病患者具有较矮的钩突以及较小的下终板倾角，继而引发的颈椎不稳定，在平山病的发生和发展过程中可能具有重要意义。

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消息

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