·骨伤论坛·

儿童肱骨髁上骨折移位程度与 Baumann 角关系的分析研究

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【摘要】 **目的**: 应用 Excel 软件对小儿肱骨髁上骨折的桡尺侧移位值和 Baumann 角进行数值拟合分析, 得出相关数据曲线, 以期用于指导临床小儿肱骨髁上骨折治疗。**方法**: 收集 2010 年 7 月至 2011 年 7 月间就诊的小儿肱骨髁上骨折病例 56 例(年龄 3~14 岁; 男 34 例, 女 22 例; 桡偏型 15 例, 尺偏型 41 例)。采用数据测量工具 MB-Ruler, 测量各病例 X 线片骨折的移位值及 Baumann 角, 将数值录入于 Excel, 分别对 56 组骨折的移位值和 Baumann 角, 以及 15 组桡偏型、41 组尺偏型数值行拟合分析, 并对所得数据曲线进行分析。**结果**: 用 2 种方式进行拟合所得出结果相近, 即尺偏切线斜率>桡偏切线斜率; 当桡偏系数<-0.18, 尺偏系数>0.50 时, Baumann 角有反向改变的趋势, 即 Baumann 角变化范围在 65.70°~96.77°; 当尺偏系数≥0.15 时, Baumann 角≥82°。**结论**: 小儿肱骨髁上骨折尺偏移位对 Baumann 角的影响大于桡偏移位, 当尺偏系数≥0.15 时应注重纠正, 预防肘内翻发生。

【关键词】 儿童;　肱骨骨折;　Baumann 角
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Relationship between the degree of displacement and the Baumann angle in pediatric supracondylar humeral fractures

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ABSTRACT　**Objective**: To analyze the relationship between the degree of displacement and Baumann angle in pediatric supracondylar humeral fractures by using Excel, and to guide treatment for humeral fractures of children. **Methods**: From July 2010 to July 2011, 56 children with humeral supracondylar fractures were collected (34 boys and 22 girls, 15 patients with radial deviation and 41 patients with ulnar deviation, ranging in age from 3 to 14 years). The data of the patients about fracture displacement and the Baumann angle measured by MB-Ruler were input in Excel and then were analyzed to obtain data fitting curve. **Results**: There were close results between two methods, and the tangent of the radial deviation was more than tangent of ulnar deviation, which indicated that the influence of ulnar deviation was stronger than that of the radial deviation in pediatric supracondylar humeral fractures, so the correction should be paid attention to in clinic. When the radial deviation coefficient was less than -0.18 and ulnar deviation coefficient was more than 0.50, the Baumann angle would change to the reverse trend, so the angle range of Baumann in clinic should be between 65.70 and 96.77 degree. When the ulnar deviation factor was more than 0.15 (including 0.15) and Baumann angle more than 82 degrees (including 82 degree), cubitus varus deformity occurred inevitably, so the practices and surgical reduction should be focused on in clinic. **Conclusion**: According to data curves analysis results, the influence of ulnar deviation is stronger than that of the radial deviation in pediatric supracondylar humeral fractures. When the ulnar deviation factor is more than 0.15 (including 0.15), correction should be focused on in order to prevent cubitus varus deformity.

KEYWORDS　Child;　Humeral fractures;　Baumann angle
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肱骨髁上骨折以小儿多见, 治疗后肘内翻畸形的发生率较高。Excel 软件在数据拟合上有简便易行、数据精确等优点[1]。本研究采用 Excel 软件对 56 例小儿肱骨髁上骨折断端偏向距与 Baumann 角等数值进行拟合及分析, 以期为指导小儿肱骨髁上骨折临床治疗规范化提供依据。

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1　临床资料

收集 2010 年 7 月至 2011 年 7 月富阳中医骨伤医院, 符合《中医病症诊断疗效标准》中关于"肱骨髁上骨折的诊断标准"的病例 70 例(年龄 3~14 岁), 删除 10 例有明显旋转畸形和压缩畸形的病例, 另 4 例因断端不接触, 无法证实其相关性, 亦删除。最后得到符合入组标准, 保存完整的 X 线片的 56 例, 其中男 34 例, 女 22 例; 右侧 35 例, 左侧 21 例; 桡偏型

15 例,尺偏型 41 例;全部为伸直型骨折。

2　方法

2.1　数据测量　使用 MB-Ruler 软件,分别测量患儿 X 线正位片上断端远侧与近侧两边界的偏差值,记录为 a 值和 b 值(尺偏为正,桡偏为负);然后对断端两侧正位片上长度进行测量,记录为 c 值和 d 值;计算移位系数,移位系数=(a+b)/(c+d)。使用 MB-Ruler 软件,分别测定各患肢 Baumann 角,将各数值录入 Excel 表格中进行数据处理和统计分析。

2.2　创建经验公式　为保证结果的精确性,采用两种方式拟合曲线:方法一,对测取的所有移位系数和 Baumann 角进行拟合;方法二,分别筛选出桡偏和尺偏的系数及相应的 Baumann 角,独立进行拟合。

Excel 拟合曲线的方法:选中移位系数及 Baumann 角数值,点击菜单“插入”-“图表”,选取“XY 散点图”,完成 XY 图形。用右键点击 XY 图形上的 XY 曲线,出现对话框,选“加上趋势线”,出现“趋势线”对话框。“趋势线”对话框中的曲线“类型”,有“线性”、“对数”、“多项式”、“升幂”、“指数”、“移动”等 6 种可供选择。根据观察,选取 1 种适合的线型;再点击“选项”,选中“显示公式”和“显示 r 平方值”;然后点“确定”,XY 图形上就会自动加上选定的曲线公式(经验公式)和决定系数 r^2 值。

2.3　数据处理及分析　曲线配合的拟合度优劣以相关系数表示,代表经验公式对原始数据拟合的程度。相关系数 r 值:0.8~1.0 为非常强的相关,0.6~0.8 为强相关,0.4~0.6 为中度相关,0.2~0.4 为弱相关,0.0~0.2 为无关。对曲线公式求导即可得到曲线的切线斜率公式,代入桡偏和尺偏绝对值等大的移位系数,对比两侧的切线斜率大小,即为两侧 Baumann 角变化速率大小。

3　结果

选取 56 组数据得出散点图,根据散点图的变化趋势,选择多项式曲线模型进行拟合,得经验公式 $y = 31.204x^4 - 207.76x^3 + 86.519x^2 + 54.352x + 71.397$,决定系数 $r^2 = 0.890\ 6$,$r = 0.95$,呈非常强相关(图 1)。可得出曲线最高点 y(0.50)=96.77°,最低点 y(−0.18)=65.70°;x≥0.15 时,y≥82°。对曲线求导得出切率 $y` = 124.816x^3 - 623.27x^2 + 173.038x + 54.352$。则 y`(−0.1)=30.69,y`(0.1)=65.55,y`(0)=54.352,尺偏的变化率大于桡偏造成的变化率。

单独对尺偏的数据进行拟合后得出经验公式 $y1 = -81.148x^2 + 94.117x + 69.141$,决定系数 $r^2 = 0.805\ 8$,则相关系数 $r = 0.92$,呈非常强相关性(图 2)。单独对桡偏的数据进行拟合后得出经验公式 $y2 = 284.16x^2 + 106.38x + 75.099$,决定系数 $r^2 = 0.717\ 2$,则相关系数 $r = 0.85$,也呈强相关(图 3),拟合度良好。分别得出最高点 y1(0.580)=96.43°,最低点 y2(−0.187)=65.15°,并且 x≥0.15 时,y1≥82°。对两式求导得 $y1` = -162.29x + 94.117$,$y2` = 568.32x + 106.38$。当 |x1|=|x2|>0.03 时,有 y1`(x1)>y2(x2),由此同样证实了尺偏的变化率大于桡偏造成的变化率。

4　讨论

不论从极值还是切率来看,尺偏位移对 Baumann 角的影响远大于桡偏,这一结果与临床上小儿肱骨髁上骨折并发症以肘内翻畸形高发而外翻畸形罕见相符。肱骨髁上骨折导致的肘内翻,发生原因与很多因素有关,基本有 2 类:一类是“一次形成学说”,即肘内翻畸形是由于骨折整复不良造成的畸形愈合;另一类为“二次发生学说”,即由于肱骨外上髁及肱骨小头骨骼受刺激使外髁生长速度增加而致。

“一次形成学说”已被广大学者认可。刘飞等[2]

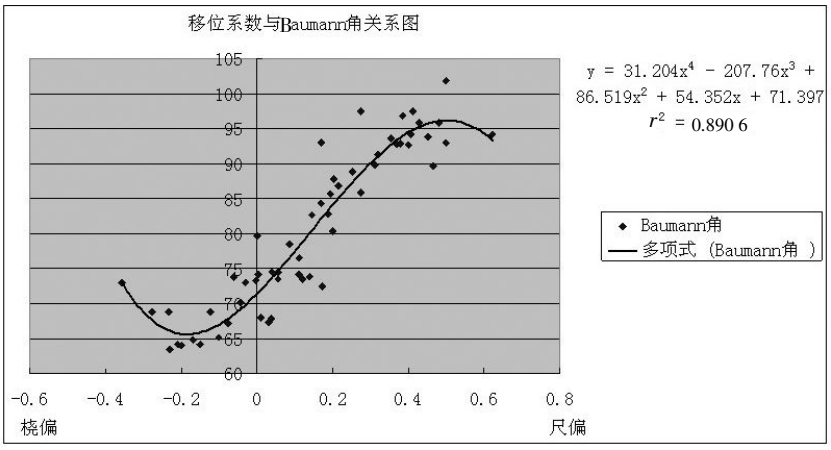

图 1　移位系数与 Baumann 角关系。图中 x 正值为尺偏,负值为桡偏,可得:①无偏移时,Baumann 角约为 71°。②尺偏时,Baumann 角增大;尺偏系数达 0.50 时,Baumann 角达最大值 96.77°,Baumann 角呈减小趋势。③桡偏时,Baumann 角减小;当桡偏系数达−0.18 时,Baumann 角达最小值 65.70°,且呈反向增大趋势。④当移位系数达 0.15 时,Baumann 角达 82°,易发生肘内翻畸形

Fig.1　Relationship between deviation coefficient and Baumann angle. The figure showed (about x, the positive number meant ulnar deviation, the negative meant radial deviation): ①When no offset existed, the Baumann angle was about 71 degree. ② When ulnar deviation occurred the Baumann angle increased; when ulnar deviation coefficient reached 0.50, the Baumann angle got the maximum 96.77 degree, then the Baumann angle turned to decrease. ③When radial deviation occurred, the Baumann angle decreased; when the radial deviation was about −0.18, the Baumann angle got the minimum 65.70 degree, then reverse to the increasing trend. ④When the deviation coefficient reached 0.15, the Baumann angle got 82 degree, varus deformity most likely happened

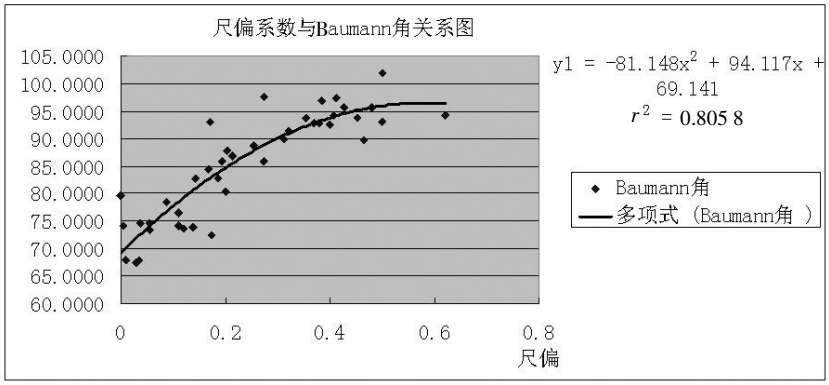

图 2　尺偏系数与 Baumann 角关系。图中筛选了尺偏型的移位系数及相应的 Baumann 角值，得出与全部数据拟合类似的结果，即尺偏时，Baumann 角增大；尺偏系数达 0.580 时，Baumann 角达最大值 96.43°，然后 Baumann 角呈减小趋势；当移位系数达 0.15 时，Baumann 角达 82°，易发生肘内翻畸形

Fig.2　Relationship between ulnar deviation coefficient and Baumann angle. In the figure, ulnar deviation coefficient and the corresponding Baumann angle were filtered. The similar results was gotten as above: when ulnar deviation occurred, the Baumann angle increased; when the ulnar deviation reached about 0.580, Baumann angle reached to the minimum 96.43 degree, then the Baumann angle turned to increase; and when the ulnar deviation was 0.15, the Baumann angle was 82 degree, and varus deformity most likely happened

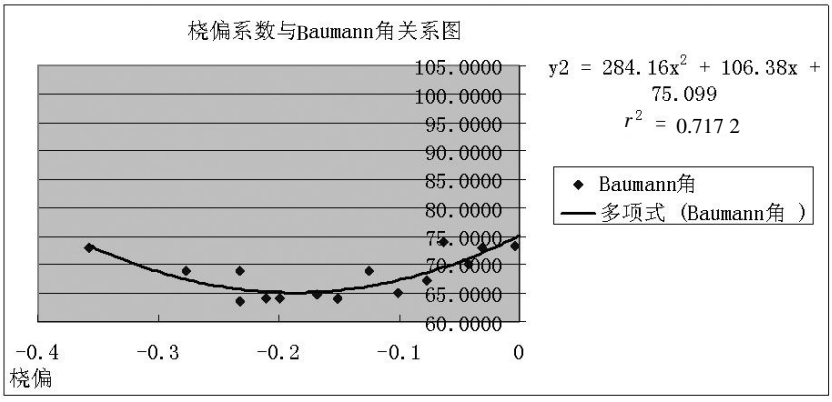

图 3　桡偏系数与 Baumann 角关系。图中筛选了桡偏型的位移系数及 Baumann 角值，得出与全部数据拟合类似的结果，当桡偏时，Baumann 角逐渐减小；当桡偏系数达-0.187 时，Baumann 角达最小值 65.15°，且呈反向增大趋势

Fig.3　Relationship between radial deviation coefficient and Baumann angle. In the figure, radial deviation coefficient and the corresponding Baumann angle were filtered. The similar results was gotten as above: when radial deviation occurred, the Baumann angle decreased; when radial deviation reached about -0.187, the Baumann angle decreased to the minimum 65.15 degree, then the Baumann angle turned to increase

建立儿童肱骨远端有限元模型，并模拟肱骨轴向受力状态下应力分布，得出肱骨在轴向载荷状态下应力集中主要位于髁上区，且尺侧应力集中现象较桡侧明显。而 Bub 等[3]认为，肱骨髁上骨折时旋转中心及轨迹的破坏是造成尺偏病例居多的原因。刘军等[4]认为，肱骨髁上骨折时复位骨折远端内侧移位整复不准确，固定不牢，前臂重力或过早持重等原因皆会导致肘内翻。

“二次形成学说”尚未被广泛认可。例如 Skaggs 等[5]认为出现成角畸形的罪魁祸首并不在骨骺损伤，小儿肱骨髁上骨折对骨骺发育的影响很小，而通过最初复位后的状态可以直接预测到后期的内翻畸形。张德洲等[6]对 100 例肘内翻患儿进行统计分析，认为骨折后导致骨骺发育异常为造成肘内翻畸形的主要成因。但不论骨骺损伤是否为主要原因，复位后断端的偏向对肘内翻发生的影响是明确的。

本研究在证实小儿肱骨髁上骨折并发症以肘内翻畸形高发而外翻畸形罕见的基础上，进一步得出临床小儿肱骨髁上骨折 Baumann 角的变化范围在 65.70°~96.77°之间，当 Baumann 角>82°时，应注重纠正肘内翻畸形，对临床小儿肱骨髁上骨折治疗有一定指导意义。

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