

· 基础研究 ·

跟痛症相关的解剖学研究

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摘要 目的:探讨跟骨骨刺和小趾展神经走行的解剖学特点。**方法:**选取 589 具干燥完整的成人跟骨标本和 10 具以 10% 甲醛固定的下肢标本(范围包括小腿中段以下)。在跟骨标本上仔细观察是否存在骨刺,记录骨刺的形态、位置、数量,测量骨刺的长度和宽度,观察跖筋膜和趾短屈肌在跟骨的附着部位。从足背逐层解剖下肢标本,分离并观察小趾展神经走行及周围的结构。**结果:**589 具跟骨标本中,左侧跟骨 293 具、右侧跟骨 296 具。119 具跟骨骨刺位于跟骨结节内侧突前缘,部分跟骨骨刺还出现在跟骨结节内侧突后缘(2 具)、跟骨结节外侧突(14 具)、跟骨前结节和内外侧突之间(23 具),有的甚至出现在跟骨前结节足底长韧带附着处周围(8 具)。跟骨结节内侧突侧面存在一条骨嵴,将跟骨结节内侧突骨刺分为前后两部分;跟骨结节内侧突骨刺上表面光滑,下表面粗糙。119 具跟骨结节内侧突存在骨刺的标本中,左侧跟骨 62 具、右侧跟骨 57 具,两侧跟骨结节内侧突骨刺的发生率比较,差异无统计学意义($\chi^2=0.331, P=0.565$);两侧跟骨结节内侧突骨刺的长度比较,差异无统计学意义($Z=-0.396, P=0.692$);跟骨结节内侧突骨刺宽度(16.42 ± 5.26)mm,其中左侧跟骨结节内侧突骨刺宽度(15.72 ± 5.43)mm、右侧跟骨结节内侧突骨刺宽度(17.19 ± 5.02)mm,两侧跟骨结节内侧突骨刺宽度比较,差异无统计学意义($t=-1.533, P=0.128$)。589 具跟骨标本中,230 具跟腱止点处存在骨刺,其发生率高于跟骨结节内侧突骨刺的发生率($\chi^2=50.166, P=0.000$)。小趾展神经在跟骨底面的行程中伴有相关的动静脉,在跟骨底面内侧缘转折到跟骨结节外侧突之间走行的一段都被紧密的结缔组织和骨性结构包围。**结论:**跟骨骨刺为片状骨赘,且并非仅发生在跟骨结节内侧突;跟骨结节内侧突骨刺上下两个面接触的软组织不同,并不是都在跖筋膜里,而应该是上面与趾短屈肌接触,下面与跖筋膜接触;小趾展神经在跟骨底面内侧缘转折到跟骨结节外侧突之间走行的一段存在卡压的解剖学基础。

关键词 足跟痛;跟骨骨刺;筋膜炎;足底;解剖

An anatomical study associated with calcaneodynia

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ABSTRACT Objective: To explore the anatomical characteristics of calcaneal spurs and distribution of abductor digiti minimi nerve.

Methods: Five hundred and eighty-nine dry intact adult cadaveric calcaneus specimens and 10 lower limb specimens (below the mid-segment of cruris) fixed with 10% formaldehyde were selected. The calcaneus specimens were observed carefully and judged whether they had bone spurs. The shape, position and number of bone spurs were recorded, and their lengths and widths were measured. The attachment positions of plantar fascia and flexor digitorum brevis to calcaneus were observed. The lower limb specimens were dissected from dorsum pedis layer by layer, and the abductor digiti minimi nerve and its surrounding structures were isolated and observed. **Results:** The calcaneus specimens consisted of 293 left calcaneus and 296 right calcaneus. The calcaneus spurs were found at anterior border (119 cases) and posterior border (2 cases) of medial process of calcaneal tuberosity, lateral process of calcaneal tuberosity (14 cases) and anterior tubercle of calcaneus and between medial process and lateral process (23 cases), and some were even found around the adherent positions of long plantar ligament of anterior tubercle of calcaneus (8 cases). A bony crest was found on the plantar side of medial process of calcaneal tuberosity, and it divided the bone spurs on medial process of calcaneal tuberosity into anterior part and posterior part. The upper surface of bone spurs on medial process of calcaneal tuberosity was smooth, while the lower surface was rough. The 119 calcaneus, which had bone spurs on medial process of calcaneal tuberosity, consisted of 62 left calcaneus and 57 right calcaneus, and there was no statistical difference in the incidences of bone spurs on medial process of calcaneal tuberosity between the left calcaneus and the right calcaneus ($\chi^2=0.331, P=0.565$).

There was no statistical difference in the length of bone spurs on medial process of calcaneal tuberosity between the left calcaneus and the right calcaneus ($Z = -0.396, P = 0.692$). The width of bone spurs on medial process of calcaneal tuberosity was 16.42 ± 5.26 mm, and there was no statistical difference in the width of bone spurs on medial process of calcaneal tuberosity between the left calcaneus and the right calcaneus (15.72 ± 5.43 vs 17.19 ± 5.02 mm, $t = -1.533, P = 0.128$). The bone spurs were found at the ending point of tendo calcaneus in 230 out of 589 calcaneus specimens, and its incidence of bone spurs was higher than that of medial process of calcaneal tuberosity ($\chi^2 = 50.166, P = 0.000$). The abductor digiti minimi nerve was accompanied by related arteries and veins on the undersurface of calcaneus and it was surrounded by dense connective tissues and bony structures in the process of running from medial border of undersurface of calcaneus to lateral process of the calcaneus tuberosity. **Conclusion:** The calcaneus spur is flaky osteophytes, and it is not only found on the medial process of calcaneal tuberosity. The upper surface and lower surface of bone spur on medial process of calcaneal tuberosity touch different soft tissues, and not always metatarsal fascia. Instead, the upper surface is in contact with flexor digitorum brevis, and the lower surface is in contact with metatarsal fascia. The entrapment syndromes has the anatomical basis for abductor digiti minimi nerve in the process of running from medial border of undersurface of calcaneus to lateral process of calcaneus tuberosity.

Keywords heel pain; heel spur; fasciitis; plantar; dissection

跟痛症是骨科的常见病,属于痹证范畴,多因肝肾亏虚,筋骨失养,复感风寒湿邪或慢性损伤,伤及筋骨所致,按疼痛可分为跟骨下疼痛和足跟后疼痛^[1-3]。由于缺乏相关的解剖学研究,跟痛症的病因存在较多的争议和误解^[4-7]。为此,我们对与跟痛症发病相关的跟骨骨刺和小趾展神经进行了解剖学研究,现总结报告如下。

1 材料与方法

1.1 实验材料及设备 589 具干燥完整的成人跟骨标本,性别、年龄不详,10 具 10% 甲醛固定的下肢标本(范围包括小腿中段以下),均由南方医科大学解剖教研室提供;游标卡尺(精度 0.02 mm,无锡凯保鼎工具有限公司);尼康 D610 单反相机;Photoshop6.0 软件(Adobe Systems 公司)。

1.2 实验观察 仔细观察跟骨标本上是否存在骨刺,记录骨刺的形态、位置、数量,测量骨刺的长度和宽度,观察跖筋膜和趾短屈肌在跟骨的附着部位。由于跟骨骨刺有的仅有略微突出、有的起点范围较大,难以准确测量其长度,故将跟骨骨刺的长度分为 3 度:1 度为骨刺略微突出;2 度为骨刺突出较明显,骨刺与跟骨底面可见成角;3 度为骨刺与跟骨底面成角,且长度 >4 mm[图 1(1)]。从足背逐层解剖下肢标本,分离并观察小趾展神经走行及周围的结构。

1.3 数据统计 采用 SPSS23.0 软件进行数据统计分析。两侧跟骨结节内侧突骨刺的发生率及跟腱止点骨刺和跟骨结节内侧突骨刺发生率的组间比较均采用 χ^2 检验,两侧跟骨结节内侧突骨刺长度的比较采用秩和检验。检验水准 $\alpha = 0.05$ 。

2 结果

589 具跟骨标本中,左侧跟骨 293 具、右侧跟骨 296 具。119 具跟骨骨刺位于跟骨结节内侧突前缘,部分跟骨骨刺还出现在跟骨结节内侧突后缘(2 具)[图 1(2)]、跟骨结节外侧突(14 具)、跟骨前结节和内外侧突之间(23 具)[图 1(3)],有的甚至出现在跟骨前结节足底长韧带附着处周围(8 具)。跟骨结节内侧突跖侧面存在一条骨嵴,将跟骨结节内侧突骨刺分为前后两部分[图 1(4)];跟骨结节内侧突骨刺上表面光滑,下表面粗糙[图 1(5)]。119 具跟骨结节内侧突存在骨刺的标本中,左侧跟骨 62 具、右侧跟骨 57 具,两侧跟骨结节内侧突骨刺的发生率比较,差异无统计学意义($\chi^2 = 0.331, P = 0.565$);两侧跟骨结节内侧突骨刺的长度比较,差异无统计学意义($Z = -0.396, P = 0.692$),见表 1;跟骨结节内侧突骨刺宽度(16.42 ± 5.26) mm,其中左侧跟骨结节内侧突骨刺宽度(15.72 ± 5.43) mm、右侧跟骨结节内侧突骨刺宽度(17.19 ± 5.02) mm,两侧跟骨结节内侧突骨刺宽度比较,差异无统计学意义($t = -1.533, P = 0.128$)。589 具跟骨标本中,230 具跟腱止点处存在骨刺,其发生率高于跟骨结节内侧突骨刺的发生率($\chi^2 = 50.166, P = 0.000$)。

表 1 两侧跟骨结节内侧突骨刺长度比较 具

侧别	样本量	1 度	2 度	3 度
左侧	62	45	13	4
右侧	57	44	7	6
合计	119	89	20	10

从下肢标本解剖结果来看,小趾展神经在屈肌支持带深面,自内踝尖后方由足底外侧神经发出,然后走行在跟骨内外侧突前面、足底长韧带下面、跖筋膜

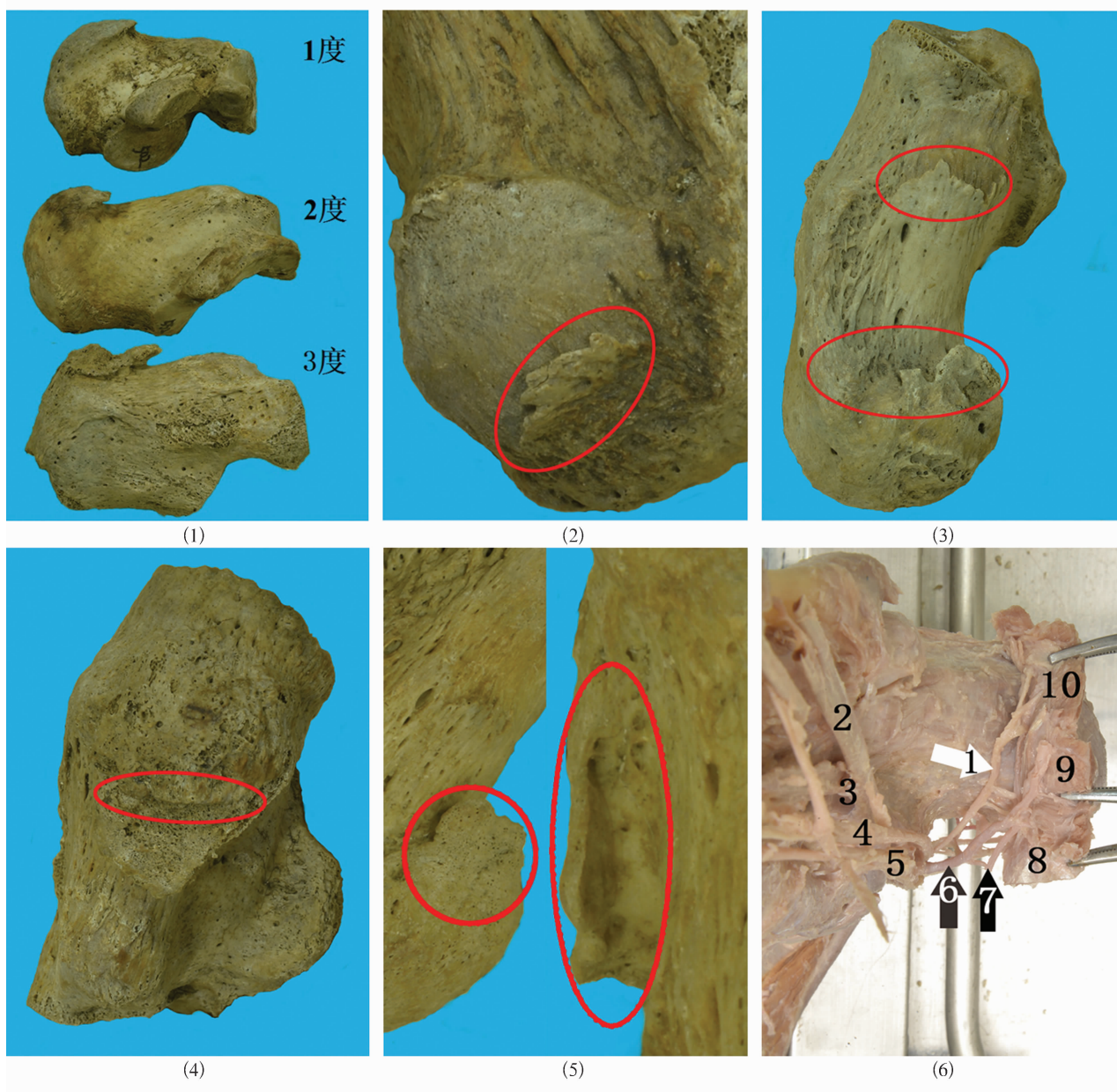
和趾短屈肌附着点深面,由内向外斜行至小趾展肌。小趾展神经在跟骨底面的行程中伴有相关的动静脉,在跟骨底面内侧缘转折到跟骨结节外侧突之间走行的一段都被紧密的结缔组织和骨性结构包围[图 1(6)]。

3 讨论

跟骨骨刺在跟骨 X 线侧位片上表现为鸟嘴状的尖刺,其存在与跟痛症是否有关,目前尚无直接的证据。Lareau 等^[2]随机观察了 1000 例患者的足部 X 线片,跟骨骨刺的发生率为 13.2%,但仅有 39% 的跟骨

骨刺患者存在跟痛症。跟痛症与跟骨骨刺的大小、方向及形状也无明显相关性^[3,8]。从我们对跟骨结节内侧突骨刺的观察和根部宽度的测量结果来看,跟骨结节内侧突骨刺为片状而非尖刺状。

临床中所说的跟骨骨刺大多指出现在跟骨结节内侧突前缘的骨刺。但本研究中发现,部分跟骨骨刺还可出现在跟骨结节内侧突后缘、跟骨结节外侧突、跟骨前结节和内外侧突之间,有的甚至出现在跟骨前结节足底长韧带附着处周围。这可能与跟骨结节内



(1) 跟骨骨刺长度分度; (2) 跟骨结节内侧突后缘的骨刺; (3) 跟骨前结节和内外侧突之间的骨刺; (4) 跟骨结节内侧突跖侧面的骨刺; (5) 跟骨结节内侧突骨刺上下表面; (6) 小趾展神经及其周围组织, 其中 1 为小趾展神经, 2 为趾长屈肌, 3 为长屈肌, 4 为足底外侧神经, 5 为足底内侧神经, 6 为小趾展神经伴随动脉, 7 为小趾展神经伴随静脉, 8 为展肌, 9 为趾短屈肌, 10 为小趾展肌

图 1 跟骨骨刺及小趾展神经图片

外侧突及其周围的应力情况存在的个体差异有关。有限元模拟研究发现,跖筋膜后部承担着最大应力,其次是足底长韧带,而足底长韧带附着在前结节、前结节与内外侧突之间的骨面^[3]。这可能是跟骨前结节及内外侧突之间的骨面存在骨刺的原因。

跖筋膜是维持足纵弓的重要结构,当足跟着地时跖筋膜承受的牵拉力约为体重的 2~3 倍,其中间部后端承受最大的牵拉力^[3]。长期过度牵拉可造成慢性损伤和轻微撕裂,产生骨膜炎、纤维组织炎,从而引起足跟痛^[3,9]。跖筋膜炎是跟痛症的最常见病因^[2-3,10],又称为“跟骨骨刺综合征”,其典型症状包括晨起和休息后第一步疼痛,一般在适量活动后可缓解,运动过度可使症状加重^[11-12]。以往跟骨骨刺一直被认为是跖筋膜在跟骨结节内侧突的应力所致,并认为骨刺位于跖筋膜内,是跖筋膜的起点^[5-7]。但随着对跟痛症的深入认识,研究者发现跟骨骨刺位于趾短屈肌的起点处,是由足底肌肉骨化性肌炎形成的^[2]。我们对跟骨骨刺的研究发现,跟骨结节内侧突跖侧面与跟骨骨刺之间存在一条交界线,是跖筋膜与趾短屈肌附着骨面的分界线;跟骨结节内侧突骨刺上下两个面的粗糙程度不同,上面较光滑、下面较粗糙。这表明跟骨结节内侧突骨刺上下两个面接触的软组织不同,并不是都在跖筋膜里,而应该是上面与趾短屈肌接触,下面与跖筋膜相接触。

跟腱是全身最粗大的肌腱,承受着巨大的应力,超负荷运动容易发生劳损及慢性炎症^[13]。跟腱止点处和跖筋膜附着处应力均较大,容易发生骨刺。张庆等^[14]通过足踝部 X 线侧位片对跟骨骨刺与跟腱止点处的骨刺进行统计分析,发现跟骨骨刺发生率高于跟腱止点处骨刺的发生率。这与我们的研究结果不同。这可能是由于影像学检查不能分辨出较小的骨刺。此外,我们的研究也发现,小趾展神经在跟骨底面内侧缘转折到跟骨结节外侧突之间走行的一段被紧密的结缔组织和骨性结构包围,存在卡压的解剖学基础,与近期研究认为小趾展神经卡压可引起跟痛症的结论一致^[1,15-16]。

本研究的结果提示,跟骨骨刺为片状骨赘,且并非仅发生在跟骨结节内侧突;跟骨结节内侧突骨刺上下两个面接触的软组织不同,并不是都在跖筋膜里,而应该是上面与趾短屈肌接触,下面与跖筋膜接触;小趾展神经在跟骨底面内侧缘转折到跟骨结节外侧突之间走行的一段存在卡压的解剖学基础。

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(收稿日期:2018-11-01 本文编辑:李晓乐)