类别：创伤学组
706868

老年髋部骨折类型、治疗方法与死亡率及其相关危险因素的分析

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目的　　研究老年髋部骨折类型、治疗方法与死亡率的关系及其相关影响因素。
方法　　回顾性分析研究我院 2011 年 1 月至 2013 年 12 月间手术治疗的 317 例老年髋部骨折患者临床资料，比较转子间骨折和股骨颈骨折的临床差异、病死率的差异，总结年龄、性别、骨折类型、手术时机、伤前健康状态、并发症、麻醉方式及术后并发症等资料，对相关因素进行单因素分析，明确老年髋部骨折患者死亡率的影响因素。
结果　　317 例老年髋部骨折患者均获得 1 年的随访，其中男性 101 例、女性 216 例；股骨转子间骨折 177 例、股骨颈骨折 140 例，1 年累计死亡 54 例。股骨转子间骨折患者死亡率明显高于股骨颈组，两组患者在性别、年龄、术前待手术时间及手术时间方面相比无显著性差异。单因素分析显示年龄、性别、骨折类型、合并疾病数量、ASA 评分、麻醉方式、术后并发症等因素在存活组与死亡组之间，差异有统计学意义(P＜ 0.05）。
结论　　老年髋部骨折的治疗与预防是临床医生面临的主要问题，手术治疗对于老年髋部骨折有着重要义。手术前充分了解患者的身体机能和健康状况，评估手术风险，深刻认识到转子间骨折和股骨颈骨折不同的临床特点，选择适宜的手术方法，制定合理的治疗方案，以提高患者术后机能恢复效果，降低并发症发生的可能，从而降低病死率。

关键字
参考文献

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老年股骨转子间骨折术后对侧髋部再骨折的原因分析

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目的　探讨股骨转子间骨折术后对侧髋部再骨折的原因。　**方法**　回顾性分析 2008 年 12 月至 2016 年 12 月收治的 274 例年龄≥65 岁股骨转子间骨折患者资料，男 89 例，女 185 例；年龄为 65～104 岁，平均 80.0 岁；左侧 133 例，右侧 141 例。骨折 AO 分型：A1 型 70 例，A2 型 192 例，A3 型 12 例。根据术后是否发生对侧髋部再骨折，将患者分为对侧再骨折组和对侧无骨折组，比较两组患者的年龄、性别、Singh 指数、初发骨折类型、受伤至手术时间、术后 6 个月髋关节 Harris 评分、Trendelenburg 征及髂腰肌肌力等因素进行单因素分析，对 *P*＜0.05 的因素再进行 logistic 回归分析。分析老年髋部股骨术后对侧髋部再骨折的原因。　**结果**　241 例患者术后获 6 个月随访，随访率为 88.0%。15 例患者（5.47%）发生对侧髋部骨折。对侧再骨折组与对侧无骨折组患者的术后 **6 个月**髋关节 Harris 评分平均分别为（73.47**±12.94**）分、（70.21**±13.55**）分，Trendelenburg 征阳性率分为 46.7%**（7/15）**、42%**（95/226）**,差异均无统计学意义（*P*＞0.05）。两组患者 Singh 指数平均分别为（1.33±0.49）级、（1.81±0.75）级，髂腰肌肌力平均分别为（3.07±0.70）级、（3.57±0.80）级，差异均有统计学意义（*P*＜0.05）。　**结论**　严重骨质疏松是造成股骨转子间骨折术后对侧髋部再骨折的病理基础，术后髋关节功能、尤其是髂腰肌肌力下降是导致患者摔倒的主要原因。防治骨质疏松，进行髋关节周围肌群、尤其是髂腰肌肌力的康复锻炼，是预防老年股骨转子间骨折术后对侧髋部再骨折的主要方法。

关键字

参考文献

附件:

老年股骨转子间骨折术后对侧髋部再骨折的原因分析

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【摘要】　**目的**　探讨股骨转子间骨折术后对侧髋部再骨折的原因。　**方法**　回顾性分析 2008 年 12 月至 2016 年 12 月收治的 274 例年龄≥65 岁股骨转子间骨折患者资料，男 89 例，女 185 例；年龄为 65～100 岁，平均 80.0 岁；左侧 133 例，右侧 141 例。骨折 AO 分型：A1 型 70 例，A2 型 192 例，A3 型 12 例。根据术后是否发生对侧髋部再骨折，将患者分为对侧再骨折组和对侧无骨折组，比较两组患者的年龄、性别、Singh 指数、初发骨折类型、受伤至手术时间、术后 6 个月髋关节 Harris 评分、Trendelenburg 征及髂腰肌肌力等因素进行单因素分析，对 *P*＜0.05 的因素再进行 logistic 回归分析。分析老年髋部股骨术后对侧髋部再骨折的原因。　**结果**　241 例患者术后获 6 个月随访，随访率为 88.0%。15 例患者（5.47%）发生对侧髋部骨折。对侧再骨折组与对侧无骨折组患者的术后 6 个月髋关节 Harris 评分平均分别为（73.47±12.94）分、(70.21±13.55）分，Trendelenburg 征阳性率分为 46.7%（7/15）、42%（95/226）,差异均无统计学意义（*P*＞0.05）。两组患者 Singh 指数平均分别为（1.33±0.49）级、（1.81±0.75）级，髂腰肌肌力平均分别为（3.07±0.70）级、（3.57±0.80）级，差异均有统计学意义（*P*＜0.05）。　**结论**　严重骨质疏松是造成股骨转子间骨折术后对侧髋部再骨折的病理基础，术后髋关节功能、尤其是髂腰肌肌力下降是导致患者摔倒的主要原因。防治骨质疏松，进行髋关节周围肌群、尤其是髂腰肌肌力的康复锻炼，是预防老年股骨转子间骨折术后对侧髋部再骨折的主要方法。

【关键词】　髋骨折；　骨质疏松；　骨折固定术，内；　肌力

Contralateral hip fracture after femoral intertrochanteric fracture operation: risk factors analysis *Yang Huan, Lin Peng, Liu Chenggang et al.*

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[Abstract] **Objective** To analyze the risk factors for contralateral hip fracture after operation on the intertrochanteric fracture. **Methods** Clinical data base of the patients with intertrochanteric fracture between Dec.2008 and Dec.2016 in our hospital was set up and these patients were divided into two groups. Group A: with contralateral hip fracture, Group B: without contralateral hip fracture. SPSS 18.0 was utilized for analyzing Singh index, Harris score, Strength of iliopsoas and Trendelenburg sign of the two groups. **Results** 274 patients were enrolled and 88.0%（241/274）followed up. Fifteen cases presented contralateral hip fracture(5.47%) ,in which showed 11 contralateral intertrochanteric fractures and 4 femoral neck fractures. All the contralateral hip fractures happened in 3 to 36 months after operation. Singh index and Strength of iliopsoas showed statistical difference with Mann-Whitney U test and logistic regression. However, Harris score between A and B groups showed no statistical difference, as well as Trendelenburg sign. **Conclusion** Osteoporosis is the pathologic basis for intertrochanteric fracture in older population. The main cause of second fall after operation of intertrochanteric fracture is the weakness of muscle around the hip, especially the weakness of the strength of iliopsoas. Therefore, anti-osteoporosis is essential of treating contralateral hip fracture, but at the mean time, takes the strength of iliopsoas into consideration and gain the full recovery of hip function in the first place.

[Key words] Hip fractures; Osteoporosis; Fracture fixation, internal; Strength of muscle

随着社会人口的老龄化发展，骨质疏松骨折日益增多，老年髋部骨折所占比例也越来越高。在临床工作中我们发现，老年股骨转子间骨折术后发生对侧髋部再骨折的患者也日益增多。国外文献[1, 14]报道的老年股骨转子间骨折术后对侧髋部再骨折发生率差异较大，分别为 2.9%和 9.2%，国内樊仕才等[3]报告的发生率为 2.64%（6/227）。虽然之前也有研究[2]将对侧髋部再骨折的原因归咎于骨质疏松，但近期的研究越来越地将关注点集中在摔倒、身体的活动能力及身体构造方面。本研究对 2008 年 12 月至 2016 年 12 月期间我院收治的 274 例老年股骨转子间骨折患者（≥65 岁）资料进行回顾性分析，比较术后对侧髋部再骨折与对侧髋部无骨折患者的 Singh 指数、术后 6 个月髋关节 Harris 评分、患髋髂腰肌肌力及是否出现 Trendelenburg 征，探讨影响对侧髋部再骨折的因素。

资料与方法

一、一般资料

病例纳入标准：①2008 年 12 月至 2016 年 12 月 5 年期间采用手术治疗的股骨转子间骨折患者，②年龄≥65 岁，手术患者。病例排除标准：非手术患者。本研究共纳入 274 例，男 89 例，女 185 例；年龄为 65～100 岁，平均 80.0 岁；左侧 133 例，右侧 141 例。骨折 AO 分型：A1 型 70 例，A2 型 192 例，A3 型 12 例。合并损伤：桡骨远端骨折 4 例，肱骨近端骨折 2 例，T_{12}压缩骨折 2 例，L_4压缩骨折 1 例，耻骨坐骨支骨折 1 例，同侧股骨干骨折 1 例。合并内科疾病：脑梗死后遗症 22 例，均为肢体活动能力下降侧骨折。受伤至手术时间为 1～26 d，平均 4.8 d。内固定方式：股骨近端防旋螺钉（proximal femoral nail antirotation, PFNA） 固定 271 例，微创内固定系统（less invasive stabilization system, LISS）钢板固定 2 例（0.7%），动力髋螺钉（dynamic hip screw, DHS）固定 1 例。Trendelenburg 征阳性诊断标准：患者单足站立时因对侧臀中肌、臀小肌肌力下降，对侧骨盆不能抬起，反而下降。检查髂腰肌肌力时患者于检查床边取坐位，大腿与躯干呈 90°，检查者一手扶住患者上身，另一手按住患者大腿，同时嘱患者一侧大腿做屈髋动作，即可检查髂腰肌肌力。

二、手术方法

274 例患者在全身麻醉或椎管内麻醉下，上牵引床对骨折进行复位，术中透视见骨折复位满意后，于股骨外侧切口行闭合复位内固定治疗（内固定物分别为 PFNA、LISS 及 DHS）。

三、术后处理

274 例患者术后常规给予静脉镇痛、抗凝、抗骨质疏松治疗，术后第二天即开始双侧股四头肌肌力锻炼，尤其强调股四头肌内侧头的锻炼。待股四头肌肌力达到 IV 级后即可下床站立，扶双拐患肢不负重行走，术后 1.5 个月复查 X 线后换单拐逐渐部分负重行走，术后三个月复查见骨折愈合良好，全负重行走。

四、分组

根据术后是否发生对侧髋部再骨折，将所有患者分为两组：对侧再骨折组与对侧无骨折组，比较两组患者的年龄、性别、损伤侧别、骨折类型、Singh 指数、住院日、受伤到手术时间、术中出血量、术后是否输血、手术时间、治疗方式、是否合并神经系统疾病、髂腰肌肌力、Harris 评分及是否出现 Trendelenburg 征等。

五、统计学处理

应用 PASW Statistics 18.0 统计软件，计量资料用 x±s 表示，对侧再骨折组与对侧无骨折组患者的年龄、受伤至手术时间、住院时间、术中出血量、手术时间及髋关节 Harris 评分使用独立样本 *t* 检验，对性别、损伤侧别、骨折类型、是否合并神经系统疾病、术后是否输血、固定方式、Singh 指数、髂腰肌肌力及是否出现 Trendelenburg 征采用 x^2 检验。对 $P<0.05$ 的因素再进行二项式 logistic 回归分析，$P<0.05$ 认为差异有统计学意义。

结果

一．术后再发对侧髋部骨折情况及处理

术后 15 例（5.47%）患者发生对侧髋部再骨折，男 3 例，女 12 例；股骨转子间骨折 11 例，股骨颈骨折 4 例；发生对侧骨折的时间为术后 3.5 个月至 3 年（平均 20.1 个月）；再发对侧股骨转子间骨折患者行 PFNA 固定术后第 2 天即开始行股四头肌及髂腰肌抗阻锻炼，术后 1.5 个月内避免负重，同时给予钙剂及阿尔法骨化醇等抗骨质疏松药物；再发对侧股骨颈骨折患者行人工股骨头置换术（生物型假体），术后 3 周内仅行股四头肌抗阻锻炼，3 周后开始行髂腰肌抗阻锻炼，术后 1.5 个月内避免负重，同时给予钙剂及阿尔法骨化醇等抗骨质疏松药物。

二．术后再发对侧髋部骨折的影响因素

274 例患者的手术时间为 30～200 min，平均 65.3 min；术中出血量为 10～1 200 mL，平均 227.3 mL；住院时间为 3～65 d，平均 14.6 d。241 例术后获 6 个月随访，随访率为 88.0%。术后 6 个月髋关节 Harris 评分（**为何不给出末次随访时的髋关节 Harris 评分数据？答：因本文主要比较术后 6 个月时髋关节功能情况，在此引入末次随访数据容易引起读者混淆，因此未予纳入**）24.0～92.8 分，平均 70.4 分。对侧再骨折组患者术后 6 个月髋关节 Harris 评分为 55.8～92.8 分，对侧无骨折组为 24.0～92.0 分，进行独立样本 *t* 检验差异无统计学意义（$P>0.05$，表 1）。对侧再骨折组与对侧无骨折组患者的 Trendenleburg 征阳性率分别为 46.7%（7/15）、42.0%（95/226），进行 x^2 检验进行比较发现，两组比较差异无统计学意义（$P=0.726$）；髂腰肌肌力分别为 3.07±0.70 级、3.57±0.80 级，两组比较差异有统计学意义（$P<0.05$，表 1）。

表 1　对侧再骨折组（A）与对侧无骨折组（B）患者性别、损伤侧别、Singh 指数、骨折类型、术后是否输血、内固定、是否合并神经系统疾患、髂腰肌肌力及 Trendelenburg 征（+）的比较（例，%）

影响因素	A 组（n=15）	B 组（n=226）	x^2值	*P* 值
性别				
女	12（80）	153（67.7）	0.124	0.725
男	3（20）	73（32.3）		
损伤侧别			0.722	0.395
左	6（40）	116（51.3）		
右	9（60）	110（48.7）		
骨折类型			5.946	0.653
A1	5（33.3）	59（26.1）		
A2	10（66.7）	158（69.9）		
A3	0（0）	9（4）		
术后是否输血			0.713	0.870
是	2（13.3）	21（9.3）		
否	13（86.7）	205（90.7）		
内固定			0.202	0.904
PFNA	15（100.0）	223（98.7）		
LISS	0（0）	2（0.9）		
DHS	0（0）	1（0.4）		
是否合并神经系统疾病			1.607	0.205
是	0（0）	22（9.7）		
否	15（100.0）	204（90.3）		
Trendelenburg（+）			0.124	0.725
是	7（46.7）	95（42）		
否	8（53.3）	131（58）		

表 2　对侧再骨折组（A）与对侧无骨折组（B）患者年龄、住院时间、受伤至手术时间、术中出血量、手术时间及 Harris 评分的比较

影响因素	A 组均值（n=15）	B 组均值（n=226）	*t* 值	*P* 值
年龄（岁）	81.87±6.74	79.93±6.91	-1.051	0.294
住院时间（天）	14.27±5.18	14.40±7.25	0.071	0.943
受伤至手术时间（天）	4.60±2.77	4.86±3.47	0.287	0.774
术中出血量（ml）	160.67±92.39	230.22±192.95	2.568	0.017
手术时间（min）	63.00±14.61	64.98±26.08	0.290	0.772
Harris 评分	73.47±12.94	70.21±13.55	-0.906	0.366

表 3 对侧再骨折组（A）与对侧无骨折组（B）患者 Singh 指数与髂腰肌肌力的比较

影响因素	A 组秩均值（n=15）	B 组秩均值（n=226）	*Z* 值	*P* 值
Singh 指数	82.17	123.58	-2.441	0.015
髂腰肌肌力	73.73	124.14	-3.351	0.001

将表 1、表 2、表 3 中 P＜0.05 的因素（即术中出血量、Singh 指数及髂腰肌肌力进行二分类 logistic 回归分析，采用 Enter 法。结果见表 4，Singh 指数及髂腰肌肌力均为影响因素（P＜0.05）。

表 4　影响老年股骨转子间骨折术后对侧髋部再骨折的二分类 logistic 回归分析结果

影响因素	Wald 值	*P* 值	*OR* 值	95%*CI*
Singh 指数	4.952	0.026	0.325	（-2.710，-0.416）
髂腰肌肌力	3.964	0.046	0.584	（-1.010，-0.092）
术中出血量	0.217	0.641	1.000	（-0.003,0.003）

A　　B　　C　　D

E　　F　　G

典型病例：女性患者，84 岁，右股骨转子间骨折（31-A2.2）行闭合复位 PFNA 固定术后 6.5 个月，公园遛弯跨越低矮土墩时绊倒，再发对侧股骨转子间骨折（31-A2.1）（图 A～D）；再发骨折行闭合复位 PFNA 固定术，术后 6 个月复查功能位大体像（E～G），双髋 ROM：左：-10～120°，右-15～110°，外展 30°，内收 20°，内旋 40°，外旋 40°。髋关节 Harris 评分 79.24。

讨论

一、髋部骨性结构的特点

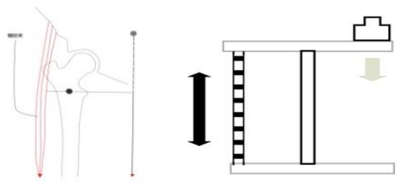
股骨近端骨承载了来自髋臼的压力，这部分压力主要由股骨近端的压力骨小梁和张力骨小梁分担，因此股骨近端张力与压力骨小梁的分布情况可以说明股骨近端骨质疏松的程度，这也正是 Singh 指数用来评估股骨近端骨密度的解剖基础[4]。压力与张力骨小梁的减少或缺失，会显著降低股骨近端的骨强度，从而使老年人遭受低能量损伤后即可造成骨折。通过对本研究两组患者的对比发现，对侧再骨折组患者的 Singh 指数与对侧无骨折组比较差异有统计学意义（$P<0.05$），说明对侧再骨折组患者的骨质疏松程度更严重，因此抗骨质疏松治疗仍是治疗老年股骨转子间骨折的基础。

二、髋部肌肉组织的特点

髂腰肌由髂肌和腰肌组成，腰大肌起于 T_{12}～L_4 椎体，髂肌起于髂窝，共同以髂腰肌肌腱止于股骨小转子，作用主要为屈曲和外旋髋关节。解剖上较长的垂直走行结构对人体站立、行走和跑动都具有极为重要的作用[8]。Gottschall 等[9]通过监测人体正常步行时的电生理发现，如果给予定量外力辅助，站立相末期和跨越相初期髂腰肌和股直肌的电活动分别下降 27%、41%，而行走相时髂腰肌和股直肌的肌肉电活动分别下降 26%、52%，由此认为髂腰肌和股直肌在行走时 2 个步相中对屈髋的贡献最大。髂腰肌由Ⅰ型慢收缩红肌纤维组成，是维持身体姿势的主要肌肉。通过肌

肉构筑研究[11-12]发现，髂腰肌的肌重是（295.6±16.77） g，高于股直肌[（158.7±10.5） g]、缝匠肌[（97.9±13.3） g]等屈髋肌。在屈髋肌群（髂腰肌、股直肌、缝匠肌和阔筋膜张肌）中，髂腰肌的屈髋力量最强大。Wickiewicz 等[10]认为，若肌肉的生理横切面积与肌重的比值大，则骨骼肌倾向于力量型构筑；而若肌纤维长与生理横切面积的比值大，则骨骼肌倾向于速度型构筑。髂腰肌的肌纤维长与生理横切面积比值相对较大，所以其倾向于速度型构筑，说明髂腰肌在运动时能进行快速收缩。跑步时大腿能否快速前摆和抬高与髂腰肌的收缩速度和力量有很大关系；而腰大肌也具有使腰椎前向和侧向运动的作用，因此髂腰肌是屈髋肌群和稳定躯干的核心肌。但是髂腰肌特别容易出现病理性短缩，尤其是对于活动能力下降、长期室内活动或卧床的患者，更容易发生短缩。因此，对于此部分患者，需要定期进行髂腰肌的功能锻炼以维持其收缩力。本研究即有 2 例患者因腰椎侧向不稳而摔倒,而其余 13 例患者均为跨越低矮障碍物需抬腿时未能完成弯腰、屈髋动作而导致摔倒。说明患者在需要快速完成屈髋动作时髂腰肌力量的不足导致屈髋动作未能完成，从而导致“足尖离地间隙”没有达到患者预期的高度而绊倒。本研究结果显示对侧再骨折组与对侧无骨折组患者的髂腰肌肌力比较差异有统计学意义（$P<0.05$），进一步行二分类 logistic 回归分析也显示髂腰肌肌力的减弱是老年股骨转子间骨折术后对侧髋部再骨折的危险因素。但本研究结果还显示对侧再骨折组与对侧无骨折组患者术后 6 个月的髋关节 Harris 评分比较差异无统计学意义（$P>0.05$）。

髂胫束起于髂嵴，止于胫骨平台外侧髁 Gerdy 结节。一般认为，髂胫束是大腿阔筋膜的纤维增强部分，其与上段所关联的臀大肌和阔筋膜张肌对髋关节的作用主要是伸、外展和外旋髋关节，除此之外还有稳定膝关节的作用。但事实上，髂胫束作为纤维增强束，其作用除了外展和外旋髋关节外，还有在行走过程中减少髋部过度内翻及股骨近端压应力的作用。因此，一旦髂胫束的强度减弱，股骨近端内翻趋势就会增加，股骨近端的压应力和剪切力就会相应增加(图 2)，结合患者骨质疏松，从而造成低能量损伤后髋部骨折。



A B

图 2 A 髂胫束起自髂嵴前方外侧，止于胫骨外侧髁、膝关节囊及腓骨头，有限制髋内翻趋势的作用 B.髂胫束限制髋内翻作用力学示意图

三、维生素 D 储备不足

维生素 D 又被称为 D 激素，是唯一可以在人体内合成的激素，其作用除了协助人体在肠道内对钙吸收外，还有增加肌肉力量的作用。基础研究[5]显示：$1,25(OH)_2D$ 可通过与肌肉细胞上的受体结合，引起 mRNA 的表达及增加肌纤维增殖分化相关蛋白的合成，从而在基因水平影响肌肉的增殖。而在非基因作用中，通过 Ca^{2+}-ATP 酶激活钙的内质网转运，使得钙储存增加，促进肌肉收缩[6]。有研究[7]认为，年龄、维度、日照时间、季节、皮肤覆盖及色素沉着等均可极大的影响维生素 D 在人体内的合成。随着年龄增加，$1,25(OH)_2D$ 和维生素 D 的受体逐渐减少，皮肤合成维生素 D 的能力就会下降。股骨转子间骨折患者年龄大且长期室外活动不足，造成日照时间严重不足，人体合成维生素 D 减少，又没有定期服用维生素 D 药物补充，导致肌肉力量下降，骨组织钙持续流失，进一步减少室外活动能力，如此恶性循环最终导致对侧髋部再骨折。

近期国内有学者[15]将老年髋部骨折术后再发对侧髋部骨折的因素进行了系统回顾和 meta 分析，认为女性患者、居住于养老院、骨质疏松、视力下降、老年痴呆、头晕症、存在呼吸系统即心血管系统疾病的患者初次髋部骨折后容易再发对侧髋部骨折。但通过本组研究发现，所有再发

骨折患者均除了偶有心血管系统疾患及骨质疏松外，均无其他上述疾患。本研究对侧再骨折组患者术后 6 个月髋关节 Harris 功能评分与对侧无骨折组比较差异无统计学意义（$P>0.05$），患者已弃拐行走，是在日常生活功能已基本恢复的情况下发生的低能量损伤。

经单因素分析，对侧再骨折组与对侧无骨折组患者的年龄、受伤至手术时间、住院时间、术中出血量、手术时间及髋关节 Harris 评分经独立样本 t 检验无统计学差异，对性别、损伤侧别、骨折类型、是否合并神经系统疾病、术后是否输血、固定方式及是否出现 Trendelenburg 征采用 χ^2 检验亦无统计学差异，说明患者自身情况如年龄、性别、损伤侧别、骨折类型，从受伤到围手术期的干预因素并不能影响其对侧髋部是否再次发生骨折。而合并神经系统疾病后遗症的患者，因为其本身肢体活动能力受限，平时活动范围较小，仅限于室内家人保护范围内活动，因此无再发骨折情况发生。樊仕才等[3]通过 6/227 例再发对侧髋部骨折病例研究后认为，1)老年股骨粗隆间骨折多由骨质疏松引起，骨折后活动能力下降导致骨量进一步丢失，骨的脆性增加;2)骨折术后肌肉萎缩，机体平衡能力差，行走不稳易摔倒；3）再发对侧骨折的病例均为术后一年左右，髋关节功能接近正常，对行走时再摔倒未予重视，这与本组研究结果基本相同。

本研究的不足之处在于本研究类型为回顾性分析，收集资料时容易产生偏倚，如用于髂腰肌肌力测定的 5 级 6 分法，不同检查者可能对肌力评定的结果有差异，因此需要有客观的检查仪器来评测髂腰肌的肌力；Singh 指数是基于影像学检查对骨质疏松程度的分级判定，不同观察者的评级可能存在差异，因此建议用双能 X 线骨扫描的检查结果作为骨质疏松程度的客观依据。

综上所述，严重骨质疏松是造成股骨转子间骨折术后对侧髋部再骨折的病理基础，但髂腰肌肌力下降是导致患者股骨转子间骨折术后快速屈髋能力下降、躯干和下肢不稳定而摔倒的主要原因。因此，防治骨质疏松，进行髋关节周围肌群、尤其是髂腰肌肌力的康复锻炼是预防老年股骨转子间骨折术后对侧髋部再骨折的主要方法。

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类别：创伤学组
682742

抗凝治疗老年髋部骨折围手术期抗凝桥接方案

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目的：探讨心血管疾病长期抗凝治疗老年患者髋部骨折的围手术期抗凝桥接方法。
方法：通过文献复习和病例分析，总结心血管疾病长期抗凝治疗老年患者髋部骨折后髋部手术围手术期抗栓治疗及预防出血平衡。
结果：冠状动脉支架术后DAPT治疗患者出血的高风险手术应该被推迟，金属裸支架（BMS）至少 6周。药物洗脱支架（DES）至少6个月。尽可能推迟到12个月以后，如果手术必须实行，裸金属支架置入6 周或药物洗脱支架后6个月内，尽可能不停DAPT，阿司匹林应终身服用；冠状动脉支架术后心脏高风险的患者接受低危的手术，应继续全剂量抗血小板治疗；对于需要尽早行手术病人，可以采用低分子肝素联合氯吡格雷桥接治疗。手术前，根据病人日常生活有无出血倾向，早期：个体化使用低分子肝素1-2次/日，保留氯吡格雷或阿司匹林，后期：单用低分子肝素或抗血小板药物，术前24小时停低分子肝素，术后24-48小时根据引流血情况恢复低分子肝素，可能延迟拔除引流管。术后24小时加用阿司匹林和氯吡格雷，3天后停低分子肝素。华法林抗凝治疗的瓣膜置换术后或房颤患者，术后继续低分子肝素注射，可以延迟至拔除引流管后2-3天加用华法林并监测至INR 2-3时停用低分子肝素。
结论：根据髋部骨折患者应用不同抗凝药物及心血管疾病风险，个性化调整围手术期治疗方案，可以安全施行骨科手术。

关键字

参考文献

类别：创伤学组
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利伐沙班与低分子肝素抗凝对老年髋部骨折围手术期隐性失血的对比研究

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目的：比较老年髋部骨折患者使用利伐沙班及低分子肝素抗凝对围手术期隐性失血的影响。方法：分析我院自 2012 年 1 月至 2016 年 12 月收治的老年髋部骨折患者 415 例，按照使用抗凝药物不同分为利伐沙班组（141 例）及低分子肝素组（274 例）。比较两组患者围手术期显性出血及隐性失血量的差异。结果：利伐沙班组患者隐性失血为 545.8±128.4ml，低分子肝素组为 568.5±148.3ml，两组患者隐性失血量无明显差异 (P=0.123)。尽管利伐沙班组术中显性失血略多于低分子肝素组 (352.4±124.6ml vs 325.8±104.3ml, P=0.022)，但两组患者术后引流量及总失血量均无统计学差异 (P 值均>0.05)。利伐沙班组患者共 5 例 (3.6%) 发生 DVT，低分子肝素组共 24 例 (8.8%) 患者发生 DVT，利伐沙班组住院期间 DVT 发生率明显更低 (P=0.046)，两组间出血事件均无统计学差异 (P 值均>0.05)。结论：老年髋部骨折术前使用利伐沙班预防血栓增加手术中显性失血量，但不增加围手术期隐性失血量及总失血量。

关键字
参考文献

类别：创伤学组
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DAA 入路、常规器械行高龄患者人工股骨头置换术的早期疗效评价

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【摘要】 目的　　探讨采用 DAA 入路同时使用常规器械进行高龄患者人工股骨头置换手术的早期疗效。方法 回顾分析 2016 年 7 月—12 月采用 DAA 入路，并使用常规手术器械微创入治疗的 18 例患者临床资料（A 组），并与同期采用后外侧入路髋关节置换术的 21 例患者（B 组）进行比较。两组患者性别、年龄、病因、病程及术前疼痛视觉模拟评分

（VAS）、Harris 评分系统（Harris hip score）、髋关节活动度等一般资料比较差异无统计学意义（P>0.05）。记录并比较两组患者手术时间、术中出血量、术后引流量、住院时间、切口愈合及并发症发生情况。术后采用 VAS、HHS 评分及髋关节屈伸活动度评价髋关节功能。
结果 两组患者平均手术时间、术中出血量、住院时间比较差异无统计学意义（p>0.05）。A 组患者术后第 1、5、12 天伤口周围疼痛 VAS 评分明显低于 B 组（p<0.05）。两组均获随访，随访时间 6～12 月，平均 8.2 月。A 组 1 例患者出现股外侧皮神经牵拉损伤；B 组未出现神经损伤。所有伤口Ⅰ期愈合。术后及末次随访时复查 X 线片示两组假体位置均良好，假体周围无明显透亮带，未见明显假体松动迹象发生。A、B 组术后 3 个月及末次随访时的 VAS、HHS 评分及髋关节屈伸活动度比较差异无统计学意义（P>0.05）。
结论 DAA 入路、常规器械可以实施高龄患者人工股骨头置换术，该手术术后早期患者疼痛较轻，利于高龄患者较快恢复。

关键字

参考文献

类别：创伤学组
687649

微创前侧入路治疗不稳定骨盆骨折的手术适应证探讨

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摘要 目的：探讨采用微创前侧入路治疗不稳定骨盆骨折的临床疗效及并发症，并和改良 Stoppa 入路比较，明确手术适应证。**方法**：回顾性分析自 2015 年 1 月-2016 年 10 月收治的 32 例符合要求的骨盆骨折患者。按照手术入路分为二组。用微创前侧入路治疗骨盆前环骨折 10 例，骨折按照按 AO／OTA 分型，其中 B2 型 8 例，C1 型 2 例。患者年龄 24～68 岁，平均 45 岁。选择同期使用改良 Stoppa 入路治疗的不稳定骨盆骨折 14 例，男 11 例，女 3 例，其中 B2 型 12 例，C1 型 2 例。致伤原因：交通伤 6 例，高处坠落伤 12 例，重物砸伤 4 例。临床评估指标包括手术时间、出血量、术后髋关节功能评分、手术并发症等。**结果**：所有患者获 6 个月至 14 个月随访（平均 10 个月）。微创前侧入路组手术时间 60～100 min(平均 80 min)，术中出血量 200～400 mL(平均 200 mL)，优于改良 Stoppa 入路组（手术时间 90～150 min；术中出血量 200～800 mL）。两组末次随访 Matta 功能评分优良率分别为 94%（/）和 92%（/）。并发症包括血管破裂 2 例；股外侧皮神经麻痹 1 例、腹股沟疝 1 例；腹壁血肿 1 例；切口感染 1 例。**结论**：对于涉及前环耻骨支骨折的 AO／OTAB2、C1 型损伤，与改良 Stoppa 入路相比，微创前侧入路手术可以缩短手术时间、减少

手术出血，熟悉局部解剖和无菌操作是防止术后并发症的关键。

关键词：骨盆前环；微创；stoppa 入路、并发症

关键字

参考文献

类别：创伤学组

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术前 CT 在骶髂关节空心钉置入中的应用

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【摘要】 **目的** 探讨术前骨盆 CT 在经皮骶髂关节通道螺钉内固定治疗中的作用。 **方法** 回顾性分析 2015 年 2 月至 2017 年 1 月收治且获得随访的 28 例骨盆后环损伤患者资料，男 21 例，女 7 例；年龄为 21～75 岁，平均 45.3 岁。骨折按 Tile 分型：B 型 17 例，其中 B1 型 8 例，B2 型 6 例，B3 型 3 例；C 型 11 例，其中 C1 型 8 例，C2 型 2 例，C3 型 1 例。5 例 C 型骨折采用骶髂关节空心钉结合 S1-髂骨椎弓根钉内固定，其余 23 例患者均采用骶髂关节空心钉内固定。术前一天进行骨盆 CT 扫描，并用 PACIS 软件进行骶骨水平位、冠状位、矢状位重建，预设出 S1、S2 骶髂关节空心钉通道及螺钉长度，术中在 C 型臂透视下，根据预设的通道进行置钉。并记录每枚螺钉置入时间、X 线投照次数，术后行 CT 扫描以验证空心钉是否按照预设通道置钉，以及螺钉长度是否合适。并应用 Matta 放射学标准评定骨折复位质量，末次随访时采用 Majeed 评分标准评定骨盆功能。 **结果** 28 例患者在 C 型臂透视下共置入 52 枚骶髂关节螺钉，术中每枚螺钉置入时间为 15～27 min（平均 21.4min），每枚螺钉所进行 X 线投照次数为 10～21 次（平均 14.3 次）。术后 CT 扫描提示所有骶髂关节螺钉均位于术前预设的通道内，无螺钉切出骨皮质及损伤血管、神经。术后骨折复位质量依据 Matta 放射学标准评定：优 22 例，良 3 例，可 3 例，优良率为 89.3%。28 例患者术后获 6～15 个月(平均 11.3 个月) 随访。末次随访时行骨盆 X 线片、CT 检查，均显示骨折愈合良好，螺钉无松动、断裂剂退出。末次随访时根据 Majeed 评分标准评定骨盆功能：优 19 例，良 7 例，可 2 例，优良率为 92.9%。 **结论** 利用术前 CT 进行骶髂关节空心钉通道的预设，可以使术中骶髂关节空心钉的置入更加安全，同时明显缩短手术时间及减少术中投照次数。

关键字

参考文献

附件：

术前骨盆 CT 在骶髂关节通道螺钉置入中的应用

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【摘要】 **目的**　探讨术前骨盆 CT 在经皮骶髂关节通道螺钉内固定治疗中的作用。 **方法**　回顾性分析 2015 年 2 月至 2017 年 1 月收治且获得随访的 28 例骨盆后环损伤患者资料，男 21 例，女 7 例；年龄为 21～75 岁，平均 45.3 岁。骨折按 Tile 分型：B 型 17 例，其中 B1 型 8 例，B2 型 6 例，B3 型 3 例；C 型 11 例，其中 C1 型 8 例，C2 型 2 例，C3 型 1 例。5 例 C 型骨折采用骶髂关节空心钉结合 S1-髂骨椎弓根钉内固定，其余 23 例患者均采用骶髂关节空心钉内固定。术前一天进行骨盆 CT 扫描，并用 PACS 软件进行骶骨水平位、冠状位、矢状位重建，预设出 S1、S2 骶髂关节空心钉通道，术中在 C 型臂透视下，根据预设的通道进行置钉。并记录每枚螺钉置入时间、X 线投照次数，术后行 CT 扫描观察空心钉位置并与预设通道进行对比。应用 Matta 放射学标准评定骨折复位质量，末次随访时采用 Majeed 评分标准评定骨盆功能。　结果　28 例患者在 C 型臂透视下共置入 52 枚骶髂关节螺钉，术中每枚螺钉置入时间为 15～27 min（平均 21.4min），每枚螺钉所进行 X 线投照次数为 10～21 次（平均 14.3 次）。术后 CT 扫描及血管超声提示所有骶髂关节螺钉均无切出骨皮质及损伤血管、神经，与预设通道的误差为 0～5mm(平均 2.2mm)。术后骨折复位质量依据 Matta 放射学标准评定：优 22 例，良 3 例，可 3 例，优良率为 89.3％。28 例患者术后获 6～15 个月(平均 11.3 个月) 随访。末次随访时行骨盆 X 线片、CT 检查，均显示骨折愈合良好，螺钉无松动、断裂剂退出。末次随访时根据 Majeed 评分标准评定骨盆功能：优 19 例，良 7 例，可 2 例，优良率为 92.9％。　结论　利用术前 CT 进行骶髂关节空心钉通道的预设，可以使术中骶髂关节空心钉的置入更加安全，同时明显缩短手术时间及减少术中投照次数。

【关键词】　CT；　骶髂关节；　通道；　空心钉；　C **型臂**

骨盆骨折为创伤骨科中最复杂也是最难处理的骨折之一，其中后环的损伤主要以骶髂关节骨折脱位或骶骨骨折为主。因为后环在连接躯干与下肢中起着枢纽作用，约占骨盆功能的 60%，对骨盆的稳定性起着决定性作用[1]。治疗方法有骶髂关节空心钉、骶髂关节钢板、后

环张力带钢板或螺栓及腰椎-骨盆固定等。其中经皮骶髂关节空心钉内固定因其微创、出血少、固定牢固、感染率低等优点而成为目前治疗骨盆后环损伤的经典方法[2]。但是因为骶髂关节位置深在、周围有重要脏器及血管神经包绕、本身解剖结构不规则等特点，易导致螺钉未能准确置入，损伤血管神经、严重者可到这患者死亡[3]。而术中 CT 和术中导航设备因为其价格昂贵［5-6］，仅在部分三级医院可得以实施。本文回顾性分析 2015 年 2 月至 2017 年 1 月收治且获得随访的 28 例骨盆后环损伤患者资料，采用术前 CT 进行骨盆的三维重建，并利用 PACS 系统进行骶髂关节空心钉通道的预设，术中严格按照预设通道进行置钉，取得满意效果，报告如下。

资料与方法

一、病例纳入标准与排除标准

病例纳入标准：2015 年 2 月至 2017 年 1 月收治且进行骶髂关节空心钉内固定的骨盆后环损伤患者。病例排除标准：①合并有严重心血管疾病、肝肾功能不全、凝血功能障碍等基础疾病的患者，②经过闭合复位，后环仍无法获得有效复位的患者，③髂骨新月形骨折线位于骶髂关节空心钉进针点以及前方的患者；④DanisIII区骨折的患者。

二、一般资料

本研究共纳入 28 例，男 21 例，女 7 例；年龄为 21～75 岁，平均 45.3 岁。致伤原因：交通伤 20 例，高处坠落伤 6 例，其他原因受伤 2 例。受伤至就诊时间为 52h 至 4 d，平均 17.2 h。骨折按 Tile 分型[7]：B 型 17 例，其中 B1 型 8 例，B2 型 6 例，B3 型 3 例；C 型 11 例，其中 C1 型 8 例，C2 型 2 例，C3 型 1 例。合并伤：失血性休克 3 例，直肠损伤 2 例，膀胱及尿道损伤 2 例，肺部挫伤 8 例，胸、腰椎骨折 3 例，颅脑损伤 5 例，骶神经损伤 2 例，所有患者均有前环损伤，其中单侧耻坐骨支骨折 10 例，双侧耻坐骨支骨折 6 例，耻骨联合分离 8 例，单侧耻骨坐骨支骨折合并对侧髋臼骨折 3 例，单侧髋臼骨折 1 例。四肢骨折 15 例。本组患者受伤至手术时间为 3～12 d，平均 6.4 d。

三、术前准备

1、常规准备

患者入院后，对合并有休克症状，生命体征不稳患者予以快速补液、输血、床单束缚或外固定架固定骨盆等处理，直肠、膀胱尿道损伤予以急诊处理。骨盆后环损伤移位明显者型患侧股骨髁上或胫骨结节骨牵引，牵引重量为体重 1/6～1/7。患者生命体征平稳后行骨盆 X 线片、CT 平扫及三维重建，观察复位情况。待骨折大体复位后安排手术。术前 1 d 行骨盆 CT 重建，并应用 PACS 软件对 CT 影像进行处理，规划出骶髂关节空心钉通道并作出标记。

术前晚上进行灌肠以确保术中C型臂投照清晰

2、通道螺钉设计

术前1d行骨盆CT扫描后，将CT影像通过PACS软件进行调整，按照骶骨冠状位、S1上终板水平位、骶骨矢状位进行重新排列，并调整骨盆位置，使骶骨冠状位上双髋臼顶处于同一水平线，S1上终板水平位上双股骨头中心处于同一水平线。如此，则在骶骨矢状位上，双髋臼的投影相同。然后将骶骨矢状位平片由一端向另一端逐层观察并在电脑屏幕上将骶骨前缘、骶椎椎体后缘及骶前孔切线标出。若S1无变异，则所有标记线重叠后可以于S1、S2椎体处各出现一圆形或椭圆形平面，此面中心点即为水平置入 S1、S2 空心钉的安全通道。骶骨中线处矢状位CT切面即X线或C型臂投照下骶骨侧位影像。于此处标记出S1、S2空心钉进针点于各自椎体中的位置并存储；若 S1 变异，则上述标记线重叠后不会于 S1 椎体处出现一圆形或椭圆形平面，或者平面窄小不足以容纳6.5mm或7.3mm空心钉，需要进行S1椎弓根轴位置钉，方法是于骶骨冠状位上于S1椎弓根最宽位置做一中线，并测量其于水平面的夹角，此即为术中椎弓根轴位置钉的头倾角。于 S1 上终板水平位上于 S1 椎弓根最宽位置做一中线，并测量其于水平面的夹角，此即为术中椎弓根轴位置钉的前倾角。术中将C 型臂按照测量出的 S1 椎弓根的头倾角和前倾角进行投照，本研究所涉及到的 S2 椎体均无变异，可进行水平置钉。因为骶骨的不规则性，其于S1和S2上的出口位、入口位角度也有所不同，我们选择矢状位上S1上终板切线与身体轴线的夹角作为S1出口位，S2上终板切线与身体轴线的夹角作为S2出口位，S1椎体前缘与身体轴线的夹角为S1入口位，S2椎体前缘与身体轴线的夹角为S2入口位。

四、手术方法

全麻效果满意后，根据骨盆环损伤情况和 S1 有无畸形采取不同体位，5 例 TileC 型需同时行后方髂腰固定或骶髂固定者、9例S1畸形需行S1椎弓根轴位置钉患者及其他8位患者采取俯卧位，6例患者采取平卧位。常规消毒、铺巾。①S1骶髂关节空心钉置钉：C型臂透视骨盆侧位，在双髋关节处于透视屏中心且透视图像成一同心圆时，水平向头侧及后侧移动C臂机，使S1椎体侧位投影位于显示屏中心区域，旋转显示屏影像，调整骶骨角度，使其和术前骨盆CT所示骶骨角度一致。对于S1无变异患者，按照术前CT所标识之空心钉进针点投影处做一0.5-1.0cm皮肤切口，沿切口置入一3.5mm粗斯氏针，使斯氏针尖端顶于预设之进针点处髂骨外板且成一点状，锤击斯氏针并透视调整角度，使其始终在显示屏上保持点状投影。突破三层皮质后更换成空心钉导针并在 C 型臂骨盆侧位监视下沿此通道继续前进约5cm，调整C型臂角度观察骨盆正位、S1入口位、S1出口位影像上空心钉导针位置，

位置准确后继续前行，根据骨折类型选择是否贯穿双侧骶髂关节，测深后拧入相应长度之 6.5mm 或 7.3mm 空心钉；对于 S1 变异患者，按照术前所测量之头倾角和前倾角调整 C 型臂 S1 投照角度，完成后可在 S1 椎体前上缘出现一椭圆形轮廓，此即 S1 椎弓根轴位影像，于椭圆形轮廓中心以同样的方式置入空心钉导针，骨盆正位、S1 出口位、S1 入口位透视观察空心钉位置，角度及长度合适后测深，拧入相应长度之空心钉；②S2 骶髂关节空心钉置钉：因本研究所涉及的 S2 椎体均无变异，所有 S2 椎体的骶髂关节空心钉均进行水平置钉。置钉方式与 S1 水平置钉方法相同。根据患者损伤情况确定骶髂关螺钉进入深度及螺钉数量[8]。对合并骨盆前环损伤患者，闭合复位耻骨支或前柱空心钉内固定 18 例，钢板内固定 5 例，空心钉结合 Infix 内固定治疗 5 例。

五、术后处理

术后若患者身体条件允许，即刻行骨盆正位、出口位、入口位 X 线片、骨盆 CT 平扫及三维重建，以检测空心钉置入是否合适，有无切出、长度不适、骨折复位不良等。预防性应用抗生素。术后第 2 天换药，并行术后第 3 天指导患者在床上活动锻炼腰背部及双下肢肌肉力量。出院后嘱患者分别在术后 1 个月、2 个月、3 个月、6 个月、9 个月、12 个月、15 个月复查，根据复查时影像学资料指导患者下地负重行走及进行患肢功能锻炼。

六、观察指标及疗效评定标准

观察指标包括每枚螺钉置入时间、X 线投照次数、术后行 CT 扫描观察螺钉有无切出骶骨前缘骨皮质或者进入骶管、与预设通道之偏差距离、随访时间（末次复查日期减去手术日期）。根据患者术后摄骨盆 X 线片情况依据 Matta 评分标准[10]对骨折复位质量进行评定：优：骨折移位＜4 mm，良：移位为 4～10 mm，可：移位为 11～20 mm，差：移位＞20 mm。末次随访时采用 Majeed 评分标准[11]评定骨盆功能，优：85～100 分，良：70～84 分，可：55～69 分，差：＜55 分。

结果

28 例患者在 C 型臂辅助下下共置入 52 枚骶髂关节螺钉，术中每枚螺钉置入时间为 15～27 min，平均 21.4min；每枚螺钉所进行 X 线投照次数为 10～21 次，平均 14.3 次。术后 CT 扫描提示所有骶髂关节螺钉均无切出骶骨前方骨皮质及进入后方椎管。与术前预设通道相比较，误差为 0～5mm，平均 2.2mm。术后血管超声均提示无血管损伤。术后查体两例骶神经损伤症状无加重，余患者术后无神经损伤症状。术后骨折复位质量依据 Matta 放射学标准评定：优 22 例，良 3 例，可 3 例，优良率为 89.3％。28 例患者术后获 6～15 个月随访，平均 11.3 个月。末次随访时行骨盆 X 线片、CT 检查，均显示骨折愈合良好，螺钉无松动、断裂

剂退出，两例骶神经损伤患者症状已消失。末次随访时根据 Majeed 评分标准评定骨盆功能：优 19 例，良 7 例，可 2 例，优良率为 92.9％。

讨论

一、骶髂关节内固定的治疗现状

后环的稳定性在骨盆中占据主导地位，因此骶髂关节复合体对骨盆环的稳定性起着至关重要的作用。选择合适的方式治疗骶髂关节复合体损伤非常重要。常规的治疗方法有骶髂关节空心钉内固定、骶髂关节钢板内固定以及后环张力带钢板或螺栓固定。其中经皮骶髂关节空心钉内固定因其创伤小、中心位固定等优点[12]，被公认为是治疗骶髂关节复合体损伤的标准方法，较之于其他固定方式更加牢固而被广泛应用。由于骶髂关节周围解剖结构十分复杂，如何精确、安全地置入骶髂关节空心钉，是目前研究的热点和难点。常规的置钉方式是透视骨盆的出口位、入口位及正、侧位，在骶骨斜坡所显示的安全线以内置入螺钉，并无准确的关于置钉角度和长度的测量。置钉的准确率不高，容易出现损伤重要血管、神经等并发症，严重者导致盆腔大出血而导致患者死亡，同时因为需要反复的调整进针点、以及导针在出口位、入口位及侧位的角度，也导致手术时间延长以及透视次数增加所导致的医生、患者所受到的射线辐射增加。随着术中CT和导航系统的应用，骶髂关节置钉的准确率也大大提升。但是此类设备价格昂贵，操作不便，学习曲线较长，不适用于在基层医院开展此类手术项目。

二、术前骨盆 CT 在骶髂关节通道螺钉置入中的应用特点

通过术前骨盆 CT 对 S1、S2 骶髂关节空心钉通道的准确测量，可以准确判断 S1 是否畸形以及应该采用何种置钉方式，同时，术前在 CT 上对于骨盆的位置进行调整，术中患者的体位、C 型臂的投照角度也完全按照 CT 所设计的调整后的角度、方向进行投照，确保了置钉的准确性。本研究所涉及的患者 52 枚骶髂关节螺钉全部位于骨性通道内，均无切出骶骨前方骨皮质及进入后方椎管。与术前预设通道相比较，不超过 5mm，也足以证实了此类方法的准确性。而且无论 S1 变异与否均可置入空心钉。术中每枚螺钉置入时间为 15～27 min，平均 21.4min；每枚螺钉所进行 X 线投照次数为 10～21 次，平均 14.3 次，两项数据也均低于传统的置钉方式[16]。此方式所需设备简单，术前螺旋 CT，术中 C 型臂设备即可满足需求，所以可以在基层医院开展。

三、适应证及不足

通过对本组 28 例患者资料进行分析，我们认为术前 CT 在经皮骶髂关节空心钉内固定的适应症有：①单纯骶髂骨间韧带损伤，②骶髂关节脱位，③Denis 分型为 Ⅰ、Ⅱ型的骶骨骨折，④Tile 分型为 B、C 型的骨盆骨折，⑤Malgaigne 骨折。但对于髂骨进钉点周围粉碎性骨折、S1 椎体粉碎性骨折、骶骨骨折卡压神经经术前牵引症状不能缓解者，以及严重骨折疏松的患者不适合采用骶髂关节螺钉内固定进行治疗[17]。根据术前透视情况，对骨盆环损伤纵向移位明显者，经术前持续大剂量牵引（一般为体重 1/6-1/7）仍不能复位，以及对于旋转移位者，采用经皮 Schanz 钉反向闭合复位，通过术前、术中牵引、撬拨、反向旋转仍

不能闭合复位者（移位大于 10 mm），则改行切开复位内固定术。对骶骨变异者、尤其是骶椎腰化者，通过术前 CT 所测量的通道螺钉角度也可以用骶髂关节空心钉固定。

三、术中注意事项

尽管术前 CT 可以使我们在置入骶髂关节空心钉时更加安全有效，但根据我们在手术过程中遇到的问题，仍有以下几点值得注意：①手术操作中患者体位的轻微变动，以及因臀部肌肉丰厚导针在插入过程中容易出现形变，导致影像学“漂移”，操作时影像与之前所设定的影像存在一定误差，引起置钉方向的偏移。因此，我们在进行进钉操作时要轻柔。②术中应尽可能使用粗克氏针，用骨锤轻轻敲击，导针插入过程中不可过度用力。③置入一枚螺钉，需要置入下一枚螺钉时，需再次透视双髋关节，使双股骨头重新位于同心圆位置再次进行下一枚螺钉的置入。

本研究尚存在以下不足之处：为回顾性分析，由于我科运用 CT 对骶髂关节通道螺钉的设计时间不久，样本量偏小，大部分患者随访时间偏短，对远期并发症的分析可能存在偏差。

综上所述，利用 CT 进行术前的通道螺钉设计，术中严格按照设计的通道进行经皮骶髂关节空心钉内固定治疗骨盆后环损伤的疗效良好，具有手术创伤小、简便、快速等优点，是一种精确、安全、有效的治疗方法。

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类别：创伤学组
702656

艾滋病患者骨科手术流程和防护

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目的：探讨骨科人类免疫缺陷病毒（HIV ）感染者围手术期应用预防职业暴露相关防护规范化手术流程对医务人员减少职业暴露的作用。
方法：回顾性分析 2010 年 1 月至 2015 年 2 月收治的需行骨科手术治疗的 HIV 感染者共 66 例，其中给予切开复位钢板螺钉内固定术 42 例，脊柱椎间融合内固定术 11 例，关节置换术 9 例，带锁髓内钉固定术 4 例。术中精细操作、规范手术操作流程；严格执行预防职业暴露相关防护规范化手术流程。监测 2010 至 2015 年骨科手术医务人员发生职业暴露 38 例/ 次。
结果：医务人员发生一级暴露 24 例，二级暴露 9 例，三级暴露 5 例。在 38 例次职业暴露中，针刺伤是主要暴露主要方式占 76.31%，双手 29 例次（占 76.31%），左、右手发生职业暴露差异无统计学意义（ x^2 = 1.72，P = 0.189），左手高于右手（41.37% *vs* 34.94%）；各手指部位暴露统计：食指 31.57% ＞ 中指 15.78% ＞ 拇指 13.15% ＞ 手掌 7.89%；双手是职业暴露发生的主要部位，其次是黏膜溅染 9 例次（占 23.68%）；职业暴露损伤部位间差异具有统计学意义（ x^2 = 21.05，P ＜ 0.001）。经严格按照职业暴露后预防处理原则，无 1 例医务人员发生 HIV 感染。
结论：围手术期严格执行职业暴露相关防护规范化手术流程可以有效避免医务人员职业暴露后的感染。

关键字
参考文献

类别：创伤学组
687942

下肢外伤性截肢残端问题的分析及处理

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【摘要】 **目的** 通过回顾性分析下肢踝以上外伤性截肢后残端问题的临床表现、原因、影响因素及手术治疗结果，探讨其外科处理及康复策略。
方法 1992 年 8 月至 2015 年 8 月共收治 100 例（109 侧）下肢踝关节以上外伤性截肢后因残端问题而进行手术治疗的患者，其中男 74 例、女 26 例；年龄 9～61 岁，平均（28.±12.）岁；小腿截肢 68 侧，大腿截肢 42 侧。致伤原因：交通伤 65 侧，重物砸伤 31 侧，机械绞伤 14 侧。从受伤截肢到因残端问题接受手术治疗的时间平均为 33.5 个月。对患者残端问题进行评价，将性别、单双侧截肢、截肢部位、创伤原因作为因素，截肢到首次残端修整术时间、软组织多余臃肿、皮肤瘢痕、皮肤溃疡、神经瘤、骨刺残肢痛作为评价水平，统计分析每一因素与各水平间的关系。通过 ADL 评分评价手术治疗前后的效果。 **结果** 16 侧行胫腓骨融合术，18 侧残端修整术≥2 次，双侧截肢者 21 例 28 侧，再截肢 9 侧。109 侧残端问题中有 71 侧（65%）原始截肢时未行残端肌肉固定成形术，瘢痕多者 56 侧（52.%），神经瘤 52 侧（48%），软组织过多臃肿皱褶 32 侧（30%），皮肤溃疡 19 侧（18%）。原始截肢到首次残端修整术的时间小腿截肢比大腿截肢长，差异有统计学意义（P=0.03）；大腿截肢软组织臃肿多于小腿截肢，差异有统计学意义（P=0.007）；单侧截肢组骨刺发生率显著高于双侧截肢组，差异有统计学意义（P=0.018）。65 例患者具备完整的入院康复初期、出院时康复末期 ADL 评分，入院时（84.3±7.3）分，出院时为（95.4±3.8）分，差异有统计学意义（P=0.000）。 **结论** 单双侧截肢、截肢部位是影响下肢创伤性截肢后残端问题的重要因素，首次手术残端骨、肌肉、神经处理合理正确与否是影响穿戴假肢主要因素。选择合适的患者进行现代外科手术技术处理及胫腓骨融合技术可获得良好的临床疗效。
【关键词】 下肢； 截肢，外伤性； 截肢残端； 因素分析，统计学； 外科手术

关键字
参考文献

类别：创伤学组
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内侧双钢板治疗 SchatzkerⅣ型胫骨平台骨折

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探讨单纯膝关节内侧切口双锁定钢板治疗 SchatzkerⅣ型胫骨平台骨折的疗效及临床体会。方法 分析２０１４ 年６ 月～２０１７ 年６ 月收治的 15 例 SchatzkerⅣ型胫骨平台骨

折患者临床资料，其中男性１０ 例，女性５ 例；年龄 22～54 岁，平均（31.5 ±6.0）岁。行膝关节内侧切口切开复位植骨、前内后内双钢板固定，处理半月板损伤、前交叉韧带下止点撕脱性骨折等合并伤。术后对膝关节远期恢复情况进行随访，根据美国特种外科医院评分系统（ＨＳＳ）标准评分。结果 15 例随访６ ～18 个月，平均（12．５ ±2.6）个月。ＨＳＳ 评分（总分 100 分）显示，１０ 例优，４ 例良，１ 例可，优良率 93%；结论 单纯膝关节内侧切口应用双钢板治疗 SchatzkerⅣ型胫骨平台骨折创伤较小，固定牢固，方便操作，整体稳定可靠，疗效好，临床治疗得到较好的结果，具有较高临床价值。

关键字

参考文献

类别：创伤学组

685629

跟骨牵引器在跟骨骨折闭合复位经皮微创中治疗的应用

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目的：探讨应用新型跟骨牵开器进行跟骨骨折闭合复位螺钉固定的复位效果及术后功能评价

方法：回顾性分析我院 2015-2016 年跟骨骨折 Sanders II-IV 型 45 例，其中 15 例跟骨骨折患者行新型跟骨牵开器进行跟骨骨折闭合复位螺钉固定。其中Ⅱ型 7 足，Ⅲ型 5 足，Ⅳ型 3 足。患者平均随访时间为 12 个月（6-24 个月），分别评价闭合组骨折术后的跟骨长度、宽度、高度、Bohler 角和 Gissane 角，并且评价三个月时足部评分系统评价手术疗效，采用 Maryland 评分。

结果：15 例获随访 6—8 个月。所有病例切口一期愈合，无发生皮缘坏死及钛板螺钉松动、断裂等并发症，Maryland 评分，优 9 足，良 4 足，可 1 足，差 1 足。跟骨长度、宽度、高度、Bohler 角和 Gissane 角与术前差异有统计学意义（P<0.01）

结论：采用采用跟骨牵引器牵开进行闭合复位经皮微创螺钉治疗可有效恢复跟骨的长度、宽度、高度、Bohler 角和 Gissane 角，损伤较小，并发症少，临床效果满意，是跟骨骨折有效的微创方法。

关键字

参考文献

类别：创伤学组
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后 pilon 骨折特点和新的分型系统

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目的 探讨后 pilon 骨折特点以及新的分型系统指导临床治疗的可行性。**方法** 2012 年 1 月到 2015 年 6 月收治累及后踝的踝关节骨折 406 例，根据入选及排除标准，共入组后 pilon 骨折 36 例，男 11 例，女 7 例；年龄 21-63 岁，平均 46.8 岁；左侧 18 例，右侧 18 例。根据骨折类型采用单纯后外侧入路或后外侧联合后内侧入路复位固定后 pilon 骨折，术后以 Burwell?Charnley 放射学评价标准判定关节面复位质量，末次随访根据 AOFAS 评分系统对术后踝关节功能进行评估，视觉模拟评分法评估踝关节疼痛情况。回顾分析损伤机制、骨折形态、手术入路和随访结果，总结后 pilon 骨折特点、以及基于损伤机制和骨折形态，能够指导手术入路的分类系统。**结果** 平均随访时间 18.2 月（12-36 个月），36 例（100%）合并外踝骨折，26 例（72.2%）合并踝关节后脱位，20 例（55.6%）合并 die-punch 损伤。平均后踝骨折面积为 31.4%（12-46%）。术后 Burwell-Charnley 分级：优 20 例，可 14 例，差 2 例。末次随访平均 AOFAS 评分 82.5 分（35-100 分）和 VAS 评分 1.6 分（0-5 分）。后 pilon 骨折特点：1、后踝骨折沿冠状面延伸至内踝后丘或丘间沟，常合并外踝斜形骨折；2、后踝骨折块常大于 25%和距骨一起向后脱位；3、合并胫骨后关节面 die-punch 损伤，多位于胫骨后内侧。4、内踝骨折向近端内侧移位，出现特征性的内踝双皮质影。根据损伤机制和骨折形态，总结了一个可以指导手术入路的新分型系统：Ⅰ型后踝为单一完整骨块，Ⅱ型后踝 2 部分骨折（Ⅱa）或者粉碎骨折（Ⅱb），Ⅲ型后踝骨折合并内踝完全骨折，根据骨折线累及内踝前丘，内踝完全骨折但前后丘没有分离（Ⅲa）和前丘骨折，前、后丘分离（Ⅲb）。**结论**：后 pilon 骨折是后踝骨折线累及内踝的特殊类型骨折，有其特殊的骨折特点，基于损伤机制的骨折形态的分型系统能够指导手术入路和治疗措施。

关键字

参考文献

附件：

Characteristics and proposed classification system of posterior pilon fractures

Running title: Posterior pilon fractures

Abstract

Background: To define the characteristics of posterior pilon fractures, and propose a classification system based on fracture morphology and operation application.

Methods: The records of patients with posterior pilon fractures treated from 2011 to 2015 were retrospectively reviewed. The injury mechanism, fracture morphology, surgical approach, and follow-up results were reviewed and analyzed.

Results: thirty-six patients, 18 males and 18 females, with a mean age of 48.9 years were included. Four characteristics were used to define posterior pilon fractures. A simple posterolateral approach or a combined posterolateral and posteromedial approach was used for reduction and fixation in all cases. The mean follow-up time was 28.2 months, and at the end of follow-up mean AOFAS score was 82.5 points (range, 35-100 points). Based on injury mechanism and fracture morphology, we classified posterior pilon fractures into 3 types that suggest the optimal surgical approach. Type I, a single complete fracture fragment; type II, a posterior malleolus fracture with 2 subtypes; type Ⅲ, a posterior malleolus fracture associated with complete medial malleolus fracture with 2 subtypes.

Conclusion: Posterior pilon fractures involve the medial malleolus. The proposed classification system based on injury mechanism and fracture morphology can guide the surgical approach to maximize outcomes.

Keywords: Posterior pilon; Ankle; Fracture; Classification

Level of Evidence： Level Ⅲ

INTRODUCTION

A posterior pilon fracture is a unique type of ankle fracture, and its injury mechanism and treatment principles are different from those of the trimalleolar fracture in the Lauge-Hansen classification, and also different from those described for the classic pilon fracture. The fractures have a low incidence and generally poor treatment outcomes.[4] Chen et al.[4] reported that the posterior pilon fractures occur in 6.4% of trimalleolar fractures, and Topliss et al.[19] reported that posterior pilon fractures occur in 5.6% of all pilon fractures based on computed tomography (CT) images. Huber et al.[8] initially applied the concept of "trimalleolar pilon fracture" to describe the posterior malleolus fracture in the coronal plane. Hansen et al.[17] summarized the characteristics of posterior pilon fractures, and considered it a special type of trimalleolar fracture, i.e., a posterior pilon fracture. The authors commented that the pathological features of posterior pilon fractures are different from those of the traditional ankle fracture and the classic pilon fracture, and it is very important to differentiate a posterior pilon fracture from an ankle fracture and classic pilon fracture in clinical practice.

Because of the low incidence and variation in fracture morphology, there is controversy over the practicable classification of posterior pilon fractures based on clinical features.[4,1,12] An ideal fracture classification system can suggest the injury mechanism and severity, guide the treatment, and predict prognosis.[18] At present, the various classification methods agree that posterior pilon fractures involve the entire coronal plane of the posterior malleolus.[23,10] However, no classification method is based on the injury mechanism, and none can summarize fracture morphology and guide treatment.

The most commonly used classification methods include the system developed by Yu et al.[23] that is based on CT cross-sectional images, and the system developed by Klammer et al.[10] that is based on the location and comminution degree of the medial malleolus fracture. However, neither method gives consideration to the injury mechanism or the comminution degree of the medial malleolus fracture, nor do they provide guidance for treatment or prognosis.

The purpose of this study was to review the clinical characteristics, treatments, and outcomes of posterior pilon fractures treated at our institution and propose a new classification that takes into account the injury mechanism and fracture morphology, and investigate the effectiveness of this method in guiding the selection of surgical approach to maximize satisfactory outcomes.

PATIENTS AND METHODS

Patients

The medical records of patients with ankle fractures treated at our institution from January 2011 to March 2015 were retrospectively reviewed. Inclusion criteria for this analysis were: 1) ≥ 18 and ≤ 75 years of age; 2) Ankle fracture involving the posterior malleolus; 3) Complete preoperative and postoperative CT imaging data; 4) Follow-up data for at least 24 months. Exclusion criteria were: 1) Fracture was a pathological or old fracture; 2) Gustilo type II or III open fractures or received conservative treatment; 3) Local soft tissue infection or systemic inflammatory response syndrome; 4) Fractures involving multiple segments or multiple bones in the same limb, or associated injuries in vital organs; 5) Ipsilateral ankle joint trauma and disease in history; 6) Neurological or psychiatric disorder. This study was approved by the Institutional Review Board of our hospital, and because of the retrospective nature of the study, the requirement of informed consent was waived. All patients provided consent for all surgical procedures performed.

Posterior pilon fracture diagnosis

Two orthopedic surgeons reviewed patient data and analyzed imaging studies independently after training regarding posterior pilon fracture characteristics based on the classification methods described by Yu et al.[23] and Klammer et al.,[10] and the novel classification method described in this report. Diagnosis of a posterior pilon fracture was defined when the primary indicator and 1 of secondary indicators described below were identified. If the diagnosis of the 2 surgeons was different, the final diagnosis was decided by the research team (all authors of the study) after discussion. The primary indicator was defined as the posterior malleolus fracture line extending along the coronal plane into the posterior colliculus of the medial malleolus or the intercollicular groove, and 1 or more fracture fragments were present. Secondary indicators were: 1) The posterior malleolus fracture fragment was displaced proximally, and there was associated posterior dislocation of the ankle joint; 2) A die-punch fragment or depressed articular surface of the distal tibia was present; 3) Anteroposterior radiograph showed a double-cortical sign; 4) A lateral malleolus fracture was present.

Surgical techniques

Epidural or general anesthesia was used. A pneumatic tourniquet was applied around the upper thigh of the affected limb, and the patient was placed in the supine position on an orthopedic operating table. In all cases with a single fracture fragment or some of 2 fragments in the posterior malleolus, a posterolateral approach was used to expose the fracture sites in the posterior malleolus and lateral malleolus. A longitudinal incision was made between the lateral margin of the Achilles tendon and the posterior margin of the fibula. The length of incision was based on the lateral malleolus and posterior malleolus fractures. The soft tissues incised, and the sural nerve and small saphenous vein were protected. Reduction and fixation of the lateral malleolus fracture was performed via an approach between the peroneus longus and brevis and the extensor digitorum longus. The posterior tibial lip and the posterior joint capsule were then exposed between the flexor hallucis longus and the peroneus longus and brevis. Though fixation of the lateral malleolus may affect intraoperative fluoroscopy, reduction of the posterior malleolus can be achieved due to the traction of the posterior inferior tibiofibular ligament. In some cases, the posterior malleolus fragment was turned backward under direct vision, and reduction of the depressed die-punch fragment or the depressed articular surface was carried out using a bone hook. After bone grafting, temporary fixation performed using a fine Kirschner (K)-wire on the anterior tibial lip. Free bone fragments were removed when they were $\leq$ 2 mm. After reduction of the posterior malleolus, temporary fixation performed. Plate and screw fixation the performed after it was confirmed by fluoroscopy that the articular surface was flat.

For cases with multiple fracture fragment or comminuted fractures, a combined posterolateral approach was used. Reduction and fixation of the lateral malleolus fracture was performed via the posterolateral approach, and temporary fixation of the posterolateral fragment was carried out. Next, a longitudinal incision was made between the medial margin of the Achilles tendon and posterior margin of the tibia to expose the medial fracture site between the flexor digitorum longus and posterior tibial neurovascular bundle. The posterior tibial nerve and blood vessels were protected carefully. The posteromedial fragment was then turned over. In 15 cases, the die-punch fragment was located in the posteromedial side of the tibia. Reduction and temporary K-wire fixation was performed when fracture fragments were large enough, and fragments were removed when they were ≤ 2 mm. For comminuted fractures, a combined approach was used for reduction of the comminuted bone fragments and temporary fixation was performed under fluoroscopy. A one-third tubular plate or a posterior malleolus sliding plate was used for final fixation. In cases with complete medial malleolus fractures, the medial fracture line extended to the anterior colliculus of the medial malleolus, and a combined posterolateral and posteromedial approach was used. Namely, the posterolateral incision was extended along the posterior margin of the medial malleolus in an arc shape. After reduction, fixation was carried out using 4.0-mm cannulated screw. In 4 cases with the posterior malleolus fracture line involving the intercollicular groove, avulsion fracture of the anterior colliculus and separation of the anterior colliculus and posterior colliculus were observed. For these cases, the posteromedial incision was extended to the front of the prominence of the lateral malleolus to expose the fractured anterior colliculus. After temporary reduction of the anterior colliculus using K-wire, or 3.0-mm cannulated screw was used for fixation.

After the surgical procedures were completed, a drainage tube was place and the wound closed in layers. No external fixation was used.

Postoperative management and evaluation

The drainage tube was removed on the second day after surgery, and isometric contraction exercises if the quadriceps femoris, calf muscles, and lower limb were begun. Continuous passive motion training was also carried out. Partial weight-bearing was started 6 weeks after surgery, and normal activity was restored gradually beginning 12 weeks after surgery. Patients were followed-up at 1, 2, 3, 4, 6, 12 and 24 months after surgery, and then yearly to observe ankle joint function and fracture healing.

Burwell-Charnley radiographic criteria[3] were used to evaluate postoperative fracture reduction. At the last follow-up (24 months postoperatively), ankle joint and foot function were evaluated using the American Orthopedic Foot and Ankle Society (AOFAS) score.[2,5] A visual analogue scale (VAS) was used to evaluate knee joint pain during walking and resting.

Results

A total of 406 cases of posterior malleolus fractures were identified in the medical records search. Among them, 40 met the diagnostic criteria of a posterior pilon fracture. Of these, 2 cases were excluded because of incomplete preoperative data, 1 because of Alzheimer’s disease, and 1 because of an ipsilateral Lisfranc injury. Thus, 36 cases were included in the analysis.

Of the 36 cases, there were 18 males and 18 females with a mean age of 48.9 years (range, 20-73 years). Fractures were on the left side in 19 patients, and the right side in 17. Causes of the injury were falls from height in 15 patients, traffic injuries in 10, sports injuries in 8, and falls during bicycle riding in 3. All patients had closed fractures. In 2 cases there was local swelling, ecchymosis, and blisters in the soft tissue anterior to the ankle joint caused by suppression of the fracture end (Tscherne grade II). All cases were associated with lateral malleolus fractures. The average injury-to-surgery interval was 6.1 days (range, 1-13 days).

According to the Danis-Weber classification, 21 patients had type B and 15 type C lateral malleolus fractures, of which 26 (72.2%) had oblique fractures and 10 (27.8%) had transverse or comminuted fractures. Thirty patients (83.3%) had associated posterior dislocation of the ankle. Twenty patients (55.5%) had associated die-punch injuries with the bone fragments measuring 2-8 mm in diameter; in these patients the posteromedial articular surface of the tibia was involved in 15 cases and the posterolateral articular surface was involved in 5. Of 20 cases with associated die-punch injuries, small fragments (≤ 2 mm) were removed in 8 because they were too small to fix, and the larger fragments in the other 12 cases were reduced and fixed (autologous cortical bone grafts were used in 8 of these cases).

Anteroposterior radiographs showed a double-cortical sign of the medial malleolus in 10 cases. The intraoperative Cotton test was positive in 10 cases; 4 were Weber type B and 6 were type C. The mean percentage of posterior malleolus fracture fragments in the distal articular surface of the tibia was 31.4% (range, 12-46%). Plaster fixation was used in 28 cases, and calcaneal traction was performed for 8 cases.

According to the classification of Yu et al.,[23] 7 cases were type IIa, 5 were type IIb, and 10 were type III. Four cases with comminuted fractures of the posterior malleolus, and 10 cases with associated medical malleolus fractures could not be classified. According to the Klammer classification,[10] 12 cases were type I, 14 were type II, and 10 were type III. However, four cases could not be classified due to comminuted fractures of the posterior malleolus. Four cases could not be classified due to the posterior malleolus fracture line extending to the anterior colliculus of the medial malleolus, and the anterior and posterior colliculus was a complete bone fragment. According to Burwell-Charnley radiographic criteria, 18 cases were rated as excellent, 14 were fair, and 2 was poor.

The mean follow-up time for all 36 cases was 28.2 months (range, 24-51 months). Bone union was achieved in all cases at a mean of 14.6 weeks (range, 12-20 weeks). No neurovascular injury, wound infection, reduction loss, or internal fixation failure occurred in any patient. Screws were removed from 10 cases with tibiofibular joint fixation at 6-9 weeks after surgery (mean, 7.3 weeks). During the follow-up period, internal fixation devices were removed in 16 patients. The posterior tibial tendon was irritated by the posterior malleolus plate in 6 cases, and the pain was relieved after removing the plate. One patient had traumatic arthritis of the ankle joint, and the pain improved after arthroscopic debridement. On patient had continuous pain, stiffness, swelling of the ankle joint, and the pain was relieved with non-steroidal anti-inflammatory drugs.

At the 24 mon follow-up, the mean AOFAS score was 82.5 points (range, 35-100 points); 14 cases were rated as excellent, 14 were good, 6 were fair, and 2 was poor.

The mean VAS pain score was 1.6 points (range, 0-5 points) during walking and 0.5 points (range, 0-3 points) during resting.

DISCUSSION

In this report we have identified characteristics of posterior pilon fractures, and proposed a classification system based on the injury mechanism and fracture morphology on coronal CT. The system allows classification of all posterior pilon fractures, and can assist in choosing the appropriate surgical approach to optimize outcomes.

Posterior pilon fractures are a unique, independent ankle joint fracture involving the coronal plane of the posterior malleolus and the medial malleolus.[5,8] In the present study, we described 4 features that differentiate posterior pilon fractures from the traditional trimalleolar fracture and the classic pilon fracture (Figure 1). 1) The posterior malleolus fracture line extends along the coronal plane to the posterior colliculus of the medial malleolus or the intercollicular groove, and the fracture is usually associated with an oblique lateral malleolus fracture. 2) The posterior malleolus fracture is often larger than 25% of the entire articular surface, and dislocated posteriorly with the talus. 3) There is an associated die-punch injury in the posterior articular surface of the tibia, which is mostly located in the posteromedial side of the tibia. 4) Because the medial malleolus fracture is displaced proximomedially, there is a distinctive double-cortical sign of the medial malleolus on radiographs.

Posterior pilon fractures have a distinct anatomical basis and injury mechanism. The articular surface of the distal end of the tibia is concave, with the prominent medial malleolus and lateral malleolus together with a convex posterior lip (Figure 2). The top of the posterior lip is the attachment of the posterior tibiofibular ligament.[7] This anatomical arrangement limits posterior displacement of the talus, and becomes the anatomical basis of posterior pilon fractures.[6,11] During high-energy injuries from traffic accidents or falls, the ankle joint is in a plantar flexion position, while the foot is inverted. When the lateral edge of the foot touches the ground, the body's inertia imparts forward, downward, and outward forces to the lateral malleolus and posterior malleolus. This results in an oblique posterosuperior- to-anteroinferior fracture of the lateral malleolus, and fracture of the coronal plane of the posterior malleolus due to the impact of the posterior malleolus on the talus. These fractures are mostly intra-articular fractures with relatively large bone fragments, and the fracture line extends along the coronal plane of the posterior margin of the tibia to the posterior colliculus of the medial malleolus. This type of fracture is often associated with varying degrees of depression, comminution, and instability of the posterior portion of the tibia.[20] Jiang et al.[9] believe that an anterior pilon fracture caused by dorsiflexion of the ankle is often not associated with lateral malleolus fractures. Therefore, posterior pilon fractures caused by plantar flexion of the ankle are usually associated with lateral malleolus fractures.

If the angle of plantar flexion of the ankle is small, the size of the posterior malleolus fracture fragment is large. On the other hand, if the angle is large, the fragment is small and the degree of comminution and depression is greater. In the present study, 25 injuries were due to falls and traffic accidents, and the area of the fracture fragment was more than 25% of the entire articular surface. However, 8 cases were sport-related injuries and the average areas of the posterior malleolus fractures were 15.3% of the articular surface. When the medial malleolus is completely fractured, the fracture line of the lateral malleolus is relatively high, and the possible injury mechanism is that the foot is in a varus position at the time of fracture, and the force results in a transverse fracture or comminuted fracture of the lateral malleolus, while the backward impact of the talus on the medial malleolus results in a longitudinal fracture of the medial malleolus.[21] The anterior inferior tibiofibular ligament is relatively thin, and a torsional stress may result in an associated ligament tear or avulsion fracture.[14] Posterior malleolus fractures caused by torsion at the time of a traditional trimalleolus fracture are often small extra-articular Volkmann fractures.[15] Zhang et al.[24] studied 18 cases of posterior pilon fractures, and found that the pathological feature was vertical and torsional forces focused on the posterior malleolus, and that this was different from trimalleolar fractures and pilon fractures.

An ideal fracture classification should suggest the injury mechanism, reflect the injury severity, guide treatment, and predict the prognosis, and ideal classification of posterior pilon fractures has yet to be developed. Wang et al.[20] classified posterior pilon fractures into type I and II according to the relationship between the fibular fracture line and the inferior tibiofibular ligament. In type I fractures, the fracture line is located superior to the infra-tibiofibular syndesmosis, and there is no connection between the medial fracture fragment of the posterior malleolus and the anterior colliculus fracture fragment of the medial malleolus. In type II fractures, the fracture line is located on the same level of the infra-tibiofibular syndesmosis, and there is a connection between the medial fracture fragment of the posterior malleolus and the fracture fragment of the medial malleolus. This classification is suitable for evaluating the stability of the infra-tibiofibular syndesmosis, but it does not reflect injury mechanism, fracture morphology, guide treatment, or predict prognosis. Yu et al.[23,22] developed their fracture classification system based on CT cross-sectional images. Type I is defined as an avulsion fracture with a large fragment from the posterolateral Volkmann tubercle, which may be easily confused with the traditional trimalleolar fracture. Type II is defined as a single posterior bone fragment with a transverse or arc-shaped fracture line extending to the posterior aspect of the medial malleolus. Type III is defined as a fracture dividing the posterior malleolus into 2 parts (posteromedial part and posterolateral part). The authors suggest that torsional forces commonly result in type I fractures, and vertical force usually results in type II or type III fractures. This classification is not consistent with the agreement that posterior pilon fractures involve the entire coronal plane of the posterior malleolus, and type I fractures can be easily confused with traditional trimalleolar fractures. Moreover, it does not take into account the medial malleolus fracture, and the severity of the posterior malleolus fracture. Klammer et al.[10] proposed a classification system according to fracture morphology. Type I is defined as a long oblique fracture involving the entire posterior malleolus, with the base towards the posterolateral side. Type II is defined as a fracture dividing the posterior malleolus into a posteromedial part and posterolateral part. Type III is defined as the posterior fragment involving the posterior colliculus, or associated with a complete medial malleolus fracture. Though this classification system can assist in planning the surgical approach, it does not reflect the injury mechanism and does not include all fracture types. For example, this method did not classify the 4 cases in the present study with comminuted fractures of the posterior malleolus and the 4 cases with the posterior malleolus fracture line extending to the anterior colliculus of the medial malleolus, and the anterior and posterior colliculus as a complete bone fragment.

Based on the classification systems developed by Yu et al.[23] and Klammer et al.,[10] we propose a novel classification system of posterior pilon fractures according to injury mechanism and fracture morphology identified on CT cross-sectional images (Table 1). In our proposed system, type I fractures are defined as the posterior malleolus fracture fragment is a complete block, and a transverse, oblique, or curved fracture line involves the posterior colliculus of the medial malleolus. The possible mechanism of this type of fracture is that the foot is in a mild varus or neutral position at the time of injury, and the force of impact is vertical to the posterior malleolus resulting is a fracture of the posterior malleolus. Because the posterior malleolus fracture fragment is a complete block mainly located in the posterolateral side, a simple posterolateral approach can expose it and achieve reduction (Figure 3). Type II fracture is defined as the posterior malleolus separated into 2 or more fragments. Based on the severity of fracture comminution, type II is divided into type IIa and type IIb. Type IIa has 2 fracture fragments, posteromedial and posterolateral fragments, while type IIb is a comminuted fracture of the posterior malleolus (Figure 4). The possible injury mechanism of a type

IIa fracture is that a vertical force results in a posterior malleolus fracture, and internal rotation of the tibia results in infra-tibiofibular syndesmosis tension that separates the fracture fragments. The possible mechanism of the type IIb fracture is that the vertical force is more severe, or the ankle joint is in extreme plantar flexion at the time of injury (Figure 5). A type III fracture is defined as a posterior malleolus fracture associated with a complete medial malleolus fracture. Based on the morphology of the medial fracture, it is further divided into type IIIa and type IIIb fractures. In type IIIa, the posterior malleolus fracture line involves the whole medial malleolus; however, the anterior colliculus and the posterior colliculus are not separated, and the fracture line is in a “L” shape (Figure 6). In type IIIb, the posterior malleolus fracture line involves the posterior colliculus or the intercollicular groove, and the anterior colliculus is fractured and separated from the posterior colliculus (Figure 7). The possible injury mechanism of a type IIIa fracture is that the foot is in extreme varus, and the mediosuperior margin of the talus impacts the medial malleolus to result in a vertical fracture of the medial malleolus. The possible mechanism of the type IIIb fracture is that a vertical force results in a posterior malleolus fracture, and a torsional force results in an avulsion fracture of the anterior colliculus and separation of the anterior colliculus and posterior colliculus. Due to the extent of the medial malleolus fracture, the posteromedial incision should be extended distally, or an auxiliary medial incision should be used for reduction and fixation of the medial malleolus fracture. In type IIIb fractures, because the anterior colliculus fragment is small, it should be fixed with a tension band or a fine screw. In the present study, 12 cases had type I fractures and the posterolateral approach was applied and sufficient exposure of the fracture site was obtained. Furthermore, in the present study 10 patients had type IIa fractures and 4 had type IIb fractures. The combined posterolateral and posteromedial approach provided sufficient exposure, and reduction and fixation were performed under direct vision. Lastly, 6 patients had type IIIa fractures and 4 had type IIIb fractures.

There are a number of limitations of the current study. It is a retrospective study, and case selection bias is inevitable. Though we chose the time interval to be as long as possible, the incidence of the posterior pilon fractures is low and there have been no large studies to provide a parallel control group.[13,16] The small number of cases also limits the reliability of our classification method. Though we described 4 features of the posterior pilon fractures, we did not take into account the impact of the ligament injury on the stability of the ankle joint. The classification method was based on clinical findings; further biomechanical studies should be performed to examine the methods.

In conclusion, posterior pilon fractures have unique pathological features and clinical findings. The posterior malleolus fracture fragment is related to the degree of plantar flexion of the ankle joint at the time of injury, the posteromedial fracture morphology is related to the degree of inversion of the foot, and the degree of fracture displacement is related to the degree of internal rotation of the foot. The proposed classification method based on injury mechanism and fracture morphology can help guide the surgical approach to maximize treatment outcomes.

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Figure legends

Figure 1. Four characteristics of posterior pilon fractures. A) Computed tomography (CT) 3-dimensional reconstruction shows the posterior malleolus fracture line extends along the coronal plane to the posterior colliculus of the medial malleolus, and there is a posterosuperior-to-anteroinferior oblique fracture of the lateral malleolus. B) Lateral radiograph shows the posterior malleolus fracture is relatively large with posterior dislocation of the ankle joint. C) CT axial image shows a die-punch injury of the posterior tibial joint. D) Anteroposterior radiograph shows a double-cortical sign of the medial malleolus.

Figure 2. Computed tomography (CT) cross-sectional scanof the posterior malleolus shows that the prominent posterior lip of the tibia forms the posterior wall of the concave articular surface of the ankle joint, which blocks the talar dislocation.

Figure 3. Based on our proposed classification system, the type I fracture has a single complete bone fragment in the posterior malleolus. A) Computed tomography (CT) axial image shows that the oblique fracture line of the posterior malleolus involves the medial malleolus. B) CT axial image shows that the transverse fracture line of the

posterior malleolus involves the medial malleolus. C) Lateral radiograph shows the posterior malleolus fracture, and the posterior dislocation of the ankle joint. D) CT 3-dimensional reconstruction shows a single fragment of the posterior malleolus, and an oblique fracture of the lateral malleolus.

Figure 4. Based on our proposed classification system, the type IIa fracture has 2 (posteromedial and posterolateral) fracture fragments in the posterior malleolus. A) Computed tomography (CT) axial image shows 2 fracture fragments in the posterior malleolus. B) CT 3-dimensional reconstruction shows that the posterior malleolus fracture line involves the intercollicular groove of the medial malleolus. C) CT 3-dimensional reconstruction shows 2 fracture fragments in the posterior malleolus. D) Postoperative radiograph shows that fracture reduction and plate and screw fixation of the posterior malleolus were performed via the combined posterolateral and posteromedial approach.

Figure 5. Based on our proposed classification system, the type IIb fracture has a comminuted fracture of the posterior malleolus. A) Computed tomography (CT) axial image shows 2 fracture fragments in the posterior malleolus and lateral malleolus, and the posteromedial fracture involves the medial malleolus. B) CT axial image shows a comminuted fracture of the posterior malleolus, and the posteromedial fracture involves the medial malleolus.

Figure 6. Based on our proposed classification system, the type IIIa fracture has a posterior malleolus fracture involving the anterior colliculus of the medial malleolus and the medial malleolus has a complete fracture without separation of the anterior colliculus and posterior colliculus. A) Computed tomography (CT) axial image shows a transverse fracture of the posterior malleolus, and the posteromedial fracture involves the anterior colliculus of the medial malleolus. B) CT axial image shows that the posteromedial fracture involves the anterior colliculus of the medial malleolus, and the fracture line is in an "L"-shaped. C) CT 3-dimensional reconstruction shows that the posterior malleolus fracture involves the anterior colliculus of the medial malleolus. D) CT 3-dimensional reconstruction shows the posterior malleolus fracture with a complete bone fragment extending to the anterior colliculus of the medial malleolus.

Figure 7. Based on our proposed classification system, the type IIIb fracture has a posterior malleolus fracture line involving the posterior colliculus or the intercollicular groove, avulsion fracture of the anterior colliculus, and separation of the anterior colliculus and posterior colliculus. A) Computed tomography axial image shows the transverse posterior malleolus fracture, and the posteromedial fracture involving the posterior colliculus of the medial malleolus. B) CT3-dimensional reconstruction shows the posterior malleolus fracture and the avulsion fracture of the anterior colliculus. C) Anteroposterior radiograph shows a double-cortical sign of the medial malleolus, indicating a medial malleolus fracture. D) Lateral radiograph shows posterior

dislocation of the ankle joint, a posterior malleolus fracture, and an avulsion fracture of the anterior colliculus of the medial malleolus.