

doi: 10.13241/j.cnki.pmb.2020.08.044

改良后入路 MIPPO 肱骨远端锁定钢板治疗肱骨下段骨折的疗效及对骨代谢的影响 *

张 勇¹ 郭维忠¹ 张 媛² 陶 可³ 马小军¹

(1 秦皇岛市第二医院创伤关节科 河北 秦皇岛 066600;

2 秦皇岛市第二医院消化肾内科 河北 秦皇岛 066600; 3 北京大学人民医院骨关节科 北京 100044)

摘要 目的:探讨改良后入路经皮微创锁定钢板内固定术(MIPPO)肱骨远端锁定钢板治疗肱骨下段骨折的疗效及对骨代谢的影响。**方法:**回顾性分析 2016 年 1 月至 2018 年 1 月我院收治的 85 例肱骨下段骨折患者临床资料, 通过治疗方式不同分为观察组 45 例和对照组 40 例, 观察组使用改良后入路 MIPPO 技术进行内固定治疗, 对照组使用传统切开复位普通钢板内固定治疗, 比较两组手术情况、骨代谢、肘关节恢复情况及不良反应的发生情况。**结果:**两组手术时间比较差异无统计学意义($P>0.05$), 观察组术中出血量明显少于对照组, 住院时间、骨折愈合时间明显比对照组缩短($P<0.05$); 观察组手术后 2 周、4 周、8 周时血清骨钙素(OCN)、碱性磷酸酶(ALP)水平均明显高于对照组($P<0.05$); 末次随访时, 观察组 Mayo 肘关节功能评分(MEPS)优良率明显高于对照组($P<0.05$)。**结论:**改良后入路 MIPPO 技术对肱骨下段骨折的内固定效果满意, 具有损伤小、术后恢复快等优点, 且有利于骨代谢。

关键词:肱骨下段骨折; 经皮微创锁定钢板内固定术; 骨代谢; 安全性

中图分类号: R683 文献标识码: A 文章编号: 1673-6273(2020)08-1596-05

Curative Efficacy of Modified Posterior Approach MIPPO Distal Humeral Locking Plate in the Treatment of Fracture of Lower Humerus and Its Effects on the Bone Metabolism*

ZHANG Yong¹, GUO Wei-zhong¹, ZHANG Yuan², TAO Ke³, MA Xiao-jun¹

(1 Department of Trauma and Joint, Qinhuangdao Second Hospital, Qinhuangdao, Hebei, 066600, China;

2 Department of Gastroenterology, Second Hospital of Qinhuangdao, Qinhuangdao, Hebei, 066600, China;

3 Department of Orthopaedics, Peking University People's Hospital, Beijing, 100044, China)

ABSTRACT Objective: To study the curative efficacy of modified posterior approach percutaneous minimally invasive locking plate internal fixation (MIPPO) distal humeral locking plate in the treatment of lower humeral fracture and its effects on the bone metabolism. **Methods:** The clinical data of 85 patients with lower humeral fracture admitted to our hospital from January 2016 to January 2018 were retrospectively analyzed. According to different treatment, those patients were divided into the 45 cases in the observation group and 40 cases in the control group, the observation group was treated with modified posterior approach MIPPO technique, while the control group was treated with traditional open reduction and internal fixation with common plate. The operation condition, bone metabolism, elbow joint recovery and incidence of adverse reaction were compared between the two groups. **Results:** There was no significant difference in the operation time between the two groups ($P>0.05$); the intraoperative bleeding volume in the observation group was significantly less than that of the control group, and the length of stay and fracture healing time in the observation group were significantly shorter than those of the control group($P<0.05$); the serum osteocalcin (OCN) and alkaline phosphatase (ALP) levels in the observation group were significantly higher than those of the control group at 2, 4 and 8 weeks after surgery ($P<0.05$); at the last follow-up, the excellent and good rate of Mayo elbow function score (MEPS) in the observation group was significantly higher than that of the control group ($P<0.05$). **Conclusion:** Modified posterior approach MIPPO technique has satisfactory effect on internal fixation of lower humeral fracture, it has the advantages of less injury and faster recovery after operation, and it's beneficial to bone metabolism.

Key words: Lower humeral fracture; Percutaneous minimally invasive locking plate internal fixation; Bone metabolic; Safety

Chinese Library Classification(CLC): R683 **Document code:** A

Article ID: 1673-6273(2020)08-1596-05

* 基金项目: 秦皇岛市科学技术与发展计划项目(201805A040)

作者简介: 张勇(1982-), 男, 硕士研究生, 主治医师, 研究方向: 创伤、关节外科, 电话: 18133859816, E-mail: fbgjgim@163.com

(收稿日期: 2019-07-23 接受日期: 2019-08-18)

前言

肱骨下段骨折是临床上较为常见的骨折损伤类型,多为高能量损伤。随着近年来交通事故的频发,该病的发病率也有升高的趋势^[1,2]。单纯的手法复位治疗该病较为困难,患者通常需接受手术治疗,但由于肱骨下段解剖结构较为复杂,其手术入路及内固定方式一直困扰着临床医师^[3]。在传统的钢板内固定治疗中,骨膜和软组织的剥离范围较广,容易对骨折端血供和局部软组织造成不必要的损伤,影响术后愈合时间^[4,5]。

随着近年来骨折固定理念由 AO 至 BO 的转变,微创化治疗在骨科手术中已占据着重要作用。经皮微创锁定钢板内固定术(MIPPO)既往多用于治疗胫骨干骨折,研究表明该方式具有切口小、创伤小等优点,对骨折生物学的完整性有保护作用,可缩短术后骨折愈合时间^[6,7]。本研究通过回顾性分析我院收治的肱骨下段骨折患者的临床资料,旨在分析改良后入路 MIPPO 技术对患者的内固定效果及其对患者骨代谢的影响。

1 资料与方法

1.1 一般资料

回顾性分析 2016 年 1 月至 2018 年 1 月我院收治的 85 例肱骨下段骨折患者临床资料。纳入标准^[8]:① 经影像学、X 线片等检查确诊为肱骨下段骨折,均为新鲜闭合性骨折;② 具有相关手术适应症,顺利完成手术;③ 临床资料完整,配合术后随访,随访时间>6 个月。排除标准^[9]:① 开放性骨折或合并病理性骨折;② 或合并同侧血管损伤(桡神经、肱动脉等)、上肢神经损伤等;③ 合并同侧上肢带其余部位骨折或脱位者(肘关节脱位、肱骨髁部骨折、尺桡骨骨折等);④ 既往合并患侧肘关节慢性疼痛史,对术后功能评估有影响者;⑤ 合并深静脉血栓。根据治疗方式不同将所有患者随机分为观察组 45 例和对照组 40 例,两组一般资料见表 1,组间差异无统计学意义($P>0.05$),具有可比性。

1.2 治疗方法

观察组使用改良后入路 MIPPO 技术进行内固定治疗:① 麻醉方式及体位:手术采用全身麻醉或臂丛神经阻滞麻醉,患者取健侧卧位,患肩外展 90°。置于托架软垫上,肘关节屈曲 90°度自然下垂;健侧上肢保持肩关节充分前屈上举,使之不妨碍患侧肱骨 X 线透视。② 切开入路:常规消毒、铺巾,取肱骨后侧正中入路,触及肱骨骨折端,鉴于骨折近端固定 3~4 枚螺钉,切口自骨折端以近 5~6 cm 开始,纵行切开皮肤、皮下组织及深筋膜,沿肱三头肌长头和外侧头之间外侧肌间隙进入,暴露骨折端、桡神经及伴行肱深动脉,辨认桡神经穿出外侧肌间隔的位置,再向近端追踪桡神经走行,确认桡神经及肱深动脉未受医源性损伤。第 2 个切口沿肱骨外上髁嵴纵行切开 2 cm 长的切口,循肱三头肌外侧头与肱桡肌间隙分离,显露肱骨外髁背侧。③ 复位内固定+必要植骨:清理骨折端血肿组织,适度旋转、牵引上臂,使骨折端获得初始复位,借助复位钳进一步获得骨折端解剖或功能复位。如有蝶形骨块,术中放置接骨板前使用克氏针 1~2 枚皮质骨螺钉固定蝶形骨块。选用合适长度的肱骨远端解剖锁定钛板(LCP, Synthes 公司,瑞士),LCP 自远端切口逆行插入,置于桡神经深面,紧贴肱骨背侧,于骨折远、近

端各置入 1 枚螺钉获得骨折端初始固定,拧紧第 1 枚螺钉时,调整 LCP 轴向位置与骨干一致;取 1 块长钢板体外参照,在皮肤上标记每个螺钉孔获得螺钉精确定位,避开桡神经,选择目标螺孔,经皮微创开孔置入螺钉,C 型臂透视监测骨折复位满意,LCP 位置合适。如术前明确有桡神经断裂,行显微镜下神经修复,仅有桡神经挫伤,术中确认桡神经松弛无张力,不予特殊处理;冲洗伤口并彻底止血,考虑 C 型粉碎性骨折易发生骨延迟愈合及不愈合,于骨折断端植骨(同侧髂骨松质骨块或人工骨修复材料),切口内放置一枚引流管引出并固定,原位缝合肌筋膜,逐层关闭切口,无菌敷料加压包扎。

对照组使用传统切开复位普通钢板内固定治疗:采用臂丛神经阻滞或全身麻醉,患者取仰卧位,取前外侧切口,逐层切开,向内侧牵开肱二头肌,自肱肌和肱桡肌间分离,寻找、保护好桡神经,纵行分开肌外侧面纤维,将骨折断端显露后并仔细清理复位骨块,安置锁定加压钢板,予以自体松质骨植骨,切口内放置一枚引流管引出并固定,逐层缝合切口。

两组术后均常规使用抗生素预防感染,配合颈腕吊带 2~4 周,可在健肢的帮助下适当进行肘关节的被动活动,在骨折未完全愈合前避免进行上肢剧烈活动和持重物,术后定期复查 X 线片。

1.3 观察指标

1.3.1 围术期情况 记录两组手术时间、术中出血量、住院时间、骨折愈合时间。

1.3.2 肘关节功能恢复情况 于末次随访时,参照 Mayo 肘关节功能评分(MEPS)对患侧肘关节恢复情况评价,该量表包括疼痛、运动范围、稳定程度、日常活动四个项目,各项目分值分别为 45 分、20 分、10 分、25 分,总分 100 分,分值 ≥ 90 分评为优,75~89 分评为良,60~74 分评为可,<60 分评为差。

1.4 统计学分析

以 spss18.0 软件包处理实验数据,正态分布计量资料用均数 $\pm$ 标准差($\bar{x}\pm s$)表示,组间比较采用 t 检验,计数资料组间比较采用 χ^2 检验,以 $P<0.05$ 表示差异具有统计学意义。

2 结果

2.1 两组围术期情况比较

两组手术时间比较差异无统计学意义($P>0.05$),观察组术中出血量少于对照组,住院时间、骨折愈合时间比对照组显著缩短($P<0.05$),见表 2。

2.2 两组手术前后骨代谢指标比较

两组手术前血清 OCN、ALP 比较差异无统计学意义 ($P>0.05$),和手术前相比,两组手术后血清 OCN、ALP 水平均显著增加($P<0.05$),观察组手术后 2 周、4 周、8 周时血清 OCN、ALP 均显著高于对照组($P<0.05$),见表 3。

2.3 两组肘关节恢复情况比较

两组随访截止日期均为 2018 年 12 月 31 日,观察组随访时间 8~22 个月,平均(14.04 ± 1.84)月,对照组随访时间 8~23 个月,平均(14.18 ± 1.76)月;末次随访时,观察组 MEPS 评分优良率高于对照组($P<0.05$),见表 4。

2.4 安全性评价

随访过程中,两组上臂力线良好,未发生内固定松动、断裂

等现象;观察组无发生尺神经、桡神经损伤患者;对照组有 1 例患者发生出现桡神经损伤。

3 讨论

手术治疗是肱骨下段骨折患者的首选治疗方案,但由于肱骨

下段形态特殊,进入肱骨干的主要滋养动脉多数只有一支由中段内侧进入肱骨,传统的切开复位内固定治疗需剥离较大范围的骨膜和软组织,容易对滋养动脉造成不必要的损伤,增加术后延迟愈合、不愈合的发生率^[10-11]。此外,传统的切开复位内固定治疗通常采取前外侧或前侧入路,钢板置于肱骨的前侧或前

表 1 两组一般资料的比较($\bar{x} \pm s$, n(%))

Table 1 Comparison of the general factors between two groups [$\bar{x} \pm s$, n(%)]

Item		Observation group(n=45)	Control group(n=40)
Sex(M/F)		25/20	21/19
Age(years)		39.74 $\pm$ 6.33	40.01 $\pm$ 6.06
BMI(kg/m ²)		22.17 $\pm$ 1.83	22.24 $\pm$ 1.80
Injury to surgery(d)		4.05 $\pm$ 0.68	3.96 $\pm$ 0.74
OA type	A	11(24.44)	9(22.50)
	B	18(40.00)	15(37.50)
	C	16(35.56)	16(40.00)
Cause of injury	Traffic accident	25(55.56)	24(60.00)
	Fall	10(22.22)	9(22.50)
	Others	10(22.22)	7(17.50)

表 2 两组围术期情况的比较($\bar{x} \pm s$)

Table 2 Comparison of the perioperative conditions between two groups ($\bar{x} \pm s$)

Groups	Operation time(min)	Intraoperative bleeding volume(mL)	Length of stay(d)	Fracture healing time(weeks)
Observation group(n=45)	114.95 $\pm$ 17.84	98.45 $\pm$ 11.01*	12.84 $\pm$ 1.77*	14.94 $\pm$ 1.85*
Control group(n=40)	108.45 $\pm$ 19.11	161.91 $\pm$ 17.24	19.50 $\pm$ 2.06	20.71 $\pm$ 2.29

Note: Compared with the control group, * $P < 0.05$.

表 3 两组手术前后骨代谢指标比较($\bar{x} \pm s$)

Table 3 Comparison of the bone metabolic markers between two groups before and after treatment($\bar{x} \pm s$)

Groups		OCN(ng/mL)	ALP(U/L)
Observation group(n=45)	Before surgery	28.55 $\pm$ 3.04	78.12 $\pm$ 7.40
	At 2 weeks after surgery	31.94 $\pm$ 3.59* [#]	84.59 $\pm$ 5.78* [#]
	At 4 weeks after surgery	33.48 $\pm$ 3.20* [#]	89.85 $\pm$ 5.30* [#]
	At 8 weeks after surgery	40.91 $\pm$ 2.71* [#]	93.44 $\pm$ 6.17* [#]
Control group(n=40)	Before surgery	28.21 $\pm$ 3.29	77.98 $\pm$ 7.54
	At 2 weeks after surgery	30.02 $\pm$ 3.40*	81.24 $\pm$ 6.03*
	At 4 weeks after surgery	31.60 $\pm$ 3.17*	84.01 $\pm$ 5.23*
	At 8 weeks after surgery	36.19 $\pm$ 3.05*	88.18 $\pm$ 6.24*

Note: Compared with the before surgery, * $P < 0.05$; compared with the control group at the same time, [#] $P < 0.05$.

表 4 两组肘关节恢复情况比较[例(%)]

Table 4 Comparison of the recovery of elbow joint between two groups[n(%)]

Groups	Excellent	Good	Fair	Poor	Excellent+Good rate
Observation group (n=45)	23(51.11)	17(37.78)	5(11.11)	0(0.00)	40(88.89)*
Control group(n=40)	15(37.50)	13(32.50)	10(25.00)	2(5.00)	28(70.00)

Note: Compared with the control group, * $P < 0.05$.

外侧,虽然该方式可减少术中的牵拉性损伤,但由于钢板主要置于肱骨下段稍前倾的棱柱形、扁形的骨面上,不利于扭转塑形,钢板和骨面不敷贴,固定效果欠佳,且手术时间较长、出血量较多,术后恢复较慢^[12-13]。

针对既往前外侧入路所出现的缺点,临床医师们也逐渐开始重视后入路方式的选择以治疗肱骨下段骨折,临床上对于肱骨下段骨折的后入路方式有两种,一种是由外侧入路,但在实际操作中钢板和外侧骨面难以获得满意贴附程度,尤其是用于复杂性肱骨下段骨折^[14]。另一种则是由肱骨下段后正中切口入路(即后入路),这种入路方式比标准后入路方式长度多出 10cm 左右,可为钢板固定提供更广泛的空间,且更加适用于低位肱骨干骨折,且不会移动桡神经,安全性较好^[15,16]。而在内固定支架的选择上,MIPPO 技术近年来也备受学者关注,该技术是一种符合生物学治疗原则的微创术是,具有不干扰骨折端内环境、保护骨折端血运、促进骨折早期愈合等优点,可帮助患者实现早期功能训练^[17-18]。

本研究将改良后入路 MIPPO 技术用于肱骨下段骨折患者的内固定治疗中, 研究结果显示使用该方式的患者在手术时间、术中出血量、骨折愈合时间、肘关节恢复情况等均优于传统传统切开复位普通钢板内固定的患者,且无尺神经、桡神经损伤发生患者,分析原因可能如下:① 切口解剖标记清晰,由后入路进入可减少对肌肉的损伤,且 MIPPO 技术属于微创技术,切口较传统切开复位患者的小,可降低术中出血量^[19];② 肱骨的张力侧处于肱骨后侧, 将钢板置于后方更符合生物力学要求,有利于骨折愈合;③ 在放置钢板的同时可从不同的方向锁定螺纹,不仅可较好的保持骨折位置的生物完整性,且可提高钢板的抗拔出能力,更好的保护骨膜,为骨折愈合和远期关节恢复提供有利环境^[20,21];④ 由后入路的方式,在肱骨后方骨面较为平坦,且肱骨下段存在前倾角,可允许钢板由远处延伸,更有利于长效固定,有助于关节功能的恢复;⑤ 后入路可更清晰的显露肱骨外侧的髁部,可在直视下放置螺钉,对于髁间骨折的患者可更好的完成复位。

骨折后,患者骨代谢会受到不同程度的影响,而通过血清中骨代谢指标的检测可进一步了解骨组织新陈代谢情况^[22,23]。OCN 是由成骨细胞所生成的骨特异性蛋白,其含量的变化可反映成骨细胞活性,是成骨细胞成骨能力和骨矿化的重要标志物^[24,25]。ALP 作为一种磷酸单酯水解酶,在人体的组织和体液中广泛存在,大部分来自于骨骼的骨细胞,参与者骨形成和骨钙化,对其的检测可了解骨形成状态^[26,27]。本研究结果显示两组患者在手术后血清 OCN、ALP 的表达和手术前比较均有上升趋势,而观察组的上升程度更明显,考虑和微创 MIPPO 技术对骨膜和髓腔的血液供应损伤较小有关,且通过后入路方式只需将肱骨干后面的骨膜细胞剥离,不会对滋养动脉动脉造成破坏,可保护骨折端血供,有助于成骨细胞的分泌,促进骨形成^[28,29]。Becker CA 等^[30]报道也显示使用 MIPPO 技术的大鼠在骨折愈合过程中,骨组织的膜内成骨和膜外成骨明显比传统的加压钢板固定更具有优势。

但在手术操作过程中,仍需注意部分问题:① 对于骨缺损的患者需进行植骨;② 从后入路的方式难度较大,应选择临床

经验较为丰富的医师进行;③ 在术后仍需注意积极的康复锻炼。此外,但本研究也存在着部分不足,所选患者均偏年轻,对于年纪较大的患者是否耐受仍需持续探讨,且本研究属回顾性分析、样本量较少,对于患者的选择结果方面可能存在着部分偏移。

综上所述,改良后入路 MIPPO 技术对肱骨下段骨折的内固定效果满意,具有损伤小、术后恢复快等优点,且有利于骨代谢。

参考文献(References)

- [1] Salvador J, Amhaz-Escanlar S, Castellón P, et al. Cerclage wiring and intramedullary nailing, a helpful and safe option specially in proximal fractures. A multicentric study[J]. Injury, 2019, 50(2): 415-419
- [2] Cai P, Yang Y, Xu Z, et al. Anatomic locking plates for complex proximal humeral fractures: anatomic neck fractures versus surgical neck fractures[J]. J Shoulder Elbow Surg, 2019, 28(3): 476-482
- [3] Gumina S, Candela V, Giannicola G, et al. Complex humeral head fractures treated with blocked threaded wires: maintenance of the reduction and clinical results with two different fixation constructs[J]. J Shoulder Elbow Surg, 2019, 28(1): 36-41
- [4] Asfuroğlu ZM, İnan U, Ömeroğlu H. Open reduction and internal fixation in AO type C distal humeral fractures using olecranon osteotomy: Functional and clinical results [J]. Ulus Travma Acil Cerrahi Derg, 2018, 24(2): 162-167
- [5] Sasai H, Fujita D, Seto E, et al. Outcome of limb fracture repair in rabbits: 139 cases (2007-2015) [J]. J Am Vet Med Assoc, 2018, 252(4): 457-463
- [6] Wang R, Xu W W, Orthopaedics DO. Minimally invasive plate internal fixation in limb fracture patients complicated with stress ulcer: Efficacy and impact on quality of life[J]. World Chinese Journal of Digestology, 2017, 25(12): 1123
- [7] İmren Y, Desteli EE, Erdil M, et al. Mid-Term Results of Minimally Invasive Plate Osteosynthesis and Circular External Fixation in the Treatment of Complex Distal Tibia Fractures [J]. Journal of the American Podiatric Medical Association, 2017, 107(1): 3-10
- [8] Lambert SM. Ischaemia, healing and outcomes in proximal humeral fractures[J]. EFORT Open Rev, 2018, 3(5): 304-315
- [9] Mitake T, Nishizuka T, Tatebe M, et al. Adult distal humerus trauma with surgical intervention: CT analysis of fracture pattern, causes, and distribution[J]. Nagoya J Med Sci, 2018, 80(2): 199-205
- [10] Stattin K, Hållmarker U, Ärnlov J, et al. Decreased Hip, Lower Leg, and Humeral Fractures but Increased Forearm Fractures in Highly Active Individuals[J]. J Bone Miner Res, 2018, 33(10): 1842-1850
- [11] Somerson JS, Hsu JE, Neradilek MB, et al. Analysis of 4063 complications of shoulder arthroplasty reported to the US Food and Drug Administration from 2012 to 2016 [J]. J Shoulder Elbow Surg, 2018, 27(11): 1978-1986.
- [12] Merolla G, Walch G, Ascione F, et al. Grammont humeral design versus onlay curved-stem reverse shoulder arthroplasty: comparison of clinical and radiographic outcomes with minimum 2-year follow-up[J]. J Shoulder Elbow Surg, 2018, 27(4): 701-710
- [13] Carbone S, Papalia M, Arceri V, et al. Humeral head inferior subluxation in proximal humerus fractures [J]. Int Orthop, 2018, 42

- (4): 901-907
- [14] Kirsch JM, Khan M, Thornley P, et al. Platform shoulder arthroplasty: a systematic review[J]. *J Shoulder Elbow Surg*, 2018, 27(4): 756-763
- [15] Kruithof RN, Formijne Jonkers HA, van der Ven DJC, et al. Functional and quality of life outcome after non-operatively managed proximal humeral fractures[J]. *J Orthop Traumatol*, 2017, 18(4): 423-430
- [16] Bisaccia M, Meccariello L, Rinonapoli G, et al. Comparison of Plate, Nail and External Fixation in the Management of Diaphyseal Fractures of the Humerus[J]. *Med Arch*, 2017, 71(2): 97-102
- [17] Tetsworth K, Hohmann E, Glatt V. Minimally Invasive Plate Osteosynthesis of Humeral Shaft Fractures: Current State of the Art [J]. *J Am Acad Orthop Surg*, 2018, 26(18): 652-661
- [18] Chen CH, Huang YH, Hung C, et al. Finite Element Analysis of Tongue Type Calcaneal Fracture with Open Reduction and Internal Fixation with Locking Plate [J]. *Journal of Medical & Biological Engineering*, 2018, 38(1): 1-9
- [19] Kai-Hua Z, Nong C. Locking, Non-locking Neutralization Plates with Limited Excision and Internal Fixation for Treatment of Extra-articular Type a Distal Tibial Fractures[J]. *The Open Orthopaedics Journal*, 2017, 11(1): 57-63
- [20] Shinohara T, Takahashi S, Hirata H. Anterior interosseous nerve palsy mimicking rupture of the index flexor digitorum profundus after volar locking plate fixation of a distal radius fracture[J]. *Nagoya Journal of Medical Science*, 2017, 79(3): 421-425
- [21] Varghese VD, Smitham P, Howell S, et al. POWIFF- Prospective study of wrist internal fixation of fracture: A protocol for a single centre, superiority, randomised controlled trial to study the efficacy of the VRP (2.0) distal radius plate (Austofix) versus the VA-LCP (Depuy-Synthes) for distal radius fractures[J]. *Bmc Musculoskeletal Disorders*, 2018, 19(1): 131
- [22] Meng Z, Shibao L, Guowei L, et al. Effects of remote ischemic post-conditioning on fracture healing in rats [J]. *Molecular Medicine Reports*, 2017, 15(5): 3186-3192
- [23] Erkan G, Tayyar AT, AÇmaz Gz, et al. Role of osteocalcin, tumor necrosis factor-alpha and adiponectin in polycystic ovary syndrome patients with insulin resistance[J]. *Turk J Obstet Gynecol*, 2017, 14(2): 89-93
- [24] Shea MK, Dawsonhughes B, Gundberg CM, et al. Reducing Undercarboxylated Osteocalcin With Vitamin K Supplementation Does Not Promote Lean Tissue Loss or Fat Gain Over 3 Years in Older Women and Men: A Randomized Controlled Trial[J]. *Journal of Bone & Mineral Research*, 2017, 32(2): 243-249
- [25] Zhou H, Seibel MJ. Bone: Osteoblasts and global energy metabolism - beyond osteocalcin[J]. *Nature Reviews Rheumatology*, 2017, 13(5): 261-262
- [26] Roetker NS, Peng Y, Ashfaq A, et al. Adherence to Kidney Disease: Improving Global Outcomes Mineral and Bone Guidelines for Monitoring Biochemical Parameters[J]. *Am J Nephrol*, 2019, 49(3): 225-232
- [27] Qiao J, Huang J, Zhou M, et al. Inhibition of HIF-1 α restrains fracture healing via regulation of autophagy in a rat model [J]. *Exp Ther Med*, 2019, 17(3): 1884-1890
- [28] Chen L, Ma YP, Wang QF, et al. Clinical effect of minimally invasive technique on the treatment of osteoporotic humeral shaft fractures in elderly patients with locking plates[J]. *Chin J Orthop Traumatol*, 2018, 31(12): 1119-1123
- [29] Choudhari P, Padia D. Minimally Invasive Osteosynthesis of Distal Tibia Fractures using Anterolateral Locking Plate [J]. *Malays Orthop J*, 2018, 12(3): 38-44
- [30] Becker CA, Kammerlander C, Cavalcanti Kußmaul A, et al. Minimally invasive screw fixation is as stable as anterior plating in acetabular T-Type fractures-a biomechanical study [J]. *Orthop Traumatol Surg Res*, 2018, 104(7): 1055-1061