

实验研究

光导纤维法对家兔胫骨骨折端间隙的活体观察

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摘要 本文观察了夹板和髓内针固定条件下家兔胫骨骨折端间隙在骨折愈合过程的变化。通过光导纤维法观察和图像处理系统分析测量, X 线片观察骨痂形成, 结果显示骨折端间隙均值随骨折时间增加而逐渐减小, 骨折端活动变化趋势与骨折后时间和肢体负重功能密切相关($P < 0.01$)。X 线片显示 6 周时均有桥梁外骨痂桥架于骨折端而愈合。研究结果揭示实验性家兔胫骨骨折端纵轴位移在 $0.33 \pm 0.17 \sim 0.95 \pm 0.43\text{mm}$ 范围内对骨折愈合有利。

关键词 骨折愈合 骨折端间隙 光导纤维法

骨折固定后骨折端显微位移是近年才注意到的问题, 然而对骨折固定系统所提供的骨端位移与骨折愈合速率及方式之间的关系尚知之甚少。我们选用光导纤维法对家兔胫骨骨折夹板与髓内针固定条件下的骨端间隙作了测量分析。

材料与方 法

1. 动物模型建立 实验选用健康大耳白家兔 34 只, 体重 $2.4 \sim 3.5\text{kg}$, 雌雄各半, 颗粒型标准饲料喂养, 不限制负重。将动物随机分为夹板固定组和髓内针固定组, 3% 戊巴比妥钠 1ml/kg 耳后静脉麻醉, 常规无菌手术操作, 低速牙科锯横行截断右胫骨中段。在截骨线上下各 5mm 处钻通两侧骨皮质, 不锈钢丝穿入, 两头露于胫骨内侧以固定硅胶观测管。硅胶管内径 6mm , 长 20mm , 一端剪开呈 Y 型, 分别固定于不锈钢丝上, 其长轴与胫骨纵轴垂直, 头端穿出皮肤。髓内针组用 $\phi 1.5\text{mm}$ 和 1.0mm 两根克氏针逆行穿入髓腔固定, 夹板组用内外两块夹板固定, 内侧夹板中部钻一 $\phi 9\text{mm}$ 孔以容硅胶观测管穿出。实验中动物因感染、腹泻致死 8 只, 26 只动物完成实验全过程, 每组各 13 只。

2. 光导纤维法观测 选用 Watanabe 关节镜 (Shinko Optical Works Co. Ltd, Japan), 光导纤维镜探头外径 5mm , 为直角型, 连接照像机。

采用冷光源, 光线通过光导纤维镜直接进入骨折端。观测时将光导纤维镜探头插入硅胶观测管至距骨折端 5mm 处, 骨折线在视野中心。每次观测均对踝关节普通位、被动跖屈和被动背屈三种不同状态时骨折端间隙变化照像记录。动物于术后当天及每周 2 次作连续性观测, 共 6 周, 每只动物共观测 13 次。骨折 3 周后, 被动跖屈和背屈的骨折端间隙无明显变化, 因此这 2 种状态只观察至术后 3 周。光导纤维法所获得的照片用图像处理系统 (北京仁和电子有限公司 IMA-3200 图像处理系统, 分辨率 $512 \times 512 \times 8\text{bit}$), 测量骨折端两点间距离, 测量精确度 0.0001mm 。

3. X 线观察 每只动物术后当天及每隔 2 周在麻醉下, 取踝关节普通位拍 X 线片对骨折端间隙进行图像分析, 并观察骨痂生长及骨折愈合情况。

结 果

两组动物均于术后 24 小时内可自行行走, 但患肢不敢负重。术后 3 天患肢可部分负重, 但动物不愿活动, 以静卧为主。术后 1 周活动较为自如, 至术后 3 周大部分动物跑跳自如, 双下肢能承受身体重量。

1. 光导纤维法成像测量结果分析

(1) 夹板固定组 踝关节普通状态下骨折

端间隙由术后当日平均 $0.96 \pm 0.43\text{mm}$ 逐渐变窄至 6 周时 $0.56 \pm 0.17\text{mm}$; 踝被动背屈时由术后 $0.82 \pm 0.45\text{mm}$ 变窄至 3 周时 $0.64 \pm 0.27\text{mm}$; 踝被动跖屈时由术后平均 $0.93 \pm 0.47\text{mm}$ 变窄至 3 周时 $0.65 \pm 0.35\text{mm}$ 。结果见表。

折端间隙由术后当日平均 $0.79 \pm 0.32\text{mm}$ 逐渐变窄至术后 6 周时 $0.33\text{mm} \pm 0.17\text{mm}$; 踝被动背屈时由术后平均 $0.76 \pm 0.31\text{mm}$ 变窄至 3 周时 $0.38 \pm 0.21\text{mm}$; 踝被动跖屈时由术后 $0.81 \pm 0.38\text{mm}$ 变窄至 3 周时 $0.39 \pm 0.22\text{mm}$ 。结果见表。

(2) 髓内针固定组 踝关节普通状态下骨

表 光导纤维法骨折端间隙测量分析 ($\bar{X} \pm \text{SDmm}$)

天数	夹板固定组			髓内针固定组		
	普通位	被动背屈	被动跖屈	普通位	被动背屈	被动跖屈
当天	0.96 ± 0.43	0.82 ± 0.45	0.93 ± 0.47	0.79 ± 0.32	0.76 ± 0.31	0.81 ± 0.38
4 天	0.77 ± 0.42	0.77 ± 0.37	0.76 ± 0.40	0.52 ± 0.34	0.51 ± 0.29	0.67 ± 0.43
8 天	0.66 ± 0.38	0.64 ± 0.36	0.70 ± 0.38	0.54 ± 0.37	0.59 ± 0.51	0.62 ± 0.53
12 天	0.66 ± 0.37	0.70 ± 0.35	0.70 ± 0.33	0.43 ± 0.31	0.44 ± 0.30	0.50 ± 0.42
15 天	0.72 ± 0.39	0.68 ± 0.33	0.75 ± 0.37	0.44 ± 0.31	0.45 ± 0.28	0.47 ± 0.31
19 天	0.66 ± 0.34	0.56 ± 0.25	0.59 ± 0.21	0.40 ± 0.21	0.47 ± 0.25	0.43 ± 0.24
22 天	0.63 ± 0.26	0.64 ± 0.27	0.65 ± 0.35	0.41 ± 0.21	0.38 ± 0.21	0.39 ± 0.22
25 天	0.58 ± 0.31			0.38 ± 0.19		
28 天	0.57 ± 0.33			0.43 ± 0.25		
31 天	0.55 ± 0.33			0.49 ± 0.26		
35 天	0.58 ± 0.29			0.42 ± 0.19		
38 天	0.59 ± 0.35			0.39 ± 0.20		
42 天	0.56 ± 0.17			0.33 ± 0.17		

从以上结果看出,髓内针组和夹板固定组骨折端间隙均值随时间的增加而逐渐减小,骨折端位移的变化趋势与骨折时间和肢体负重功能呈负相关关系。回归系数检验有非常显著性差异 ($P < 0.01$)。但髓内针组和夹板组两者均值间比较无显著性差异 ($P > 0.05$); 2 条回归曲线基本呈平行状态。从回归曲线看,踝被动跖屈和背屈时的回归曲线似乎比踝普通位较陡,但通过与踝普通位均值的方差分析和两相关系数检验均无显著性差异 ($P > 0.05$)。提示踝关节被动活动对骨折端间隙变化无明显影响,而间隙变化主要与骨折时间和肢体负重功能及肌肉主动收缩密切相关。

2. X 线片测量结果分析 对 X 线片骨折端间隙的测量发现与光导纤维法的测量结果相符合,即随着时间的推移,骨折端间隙逐渐变窄。夹板组由术后平均 1.29mm 变窄至 6 周 0.63mm ,髓内针组由术后当日平均 0.79mm 变窄至术后 6 周 0.37mm 。方差分析显示各处理组间有非常显著性差异 ($P < 0.01$)。

根据 X 线片观察,两组实验动物均是通过桥梁外骨痂桥架于骨折端实现骨折愈合。术后 2 周骨折端已有少量骨痂形成,术后 4 周已有大量外骨痂,部分动物已形成梭形骨痂,术后 6 周时全部动物均有桥梁外骨痂桥架于骨折两端而愈合。

讨 论

骨折愈合是一个复杂的生物学过程,受许多因素影响,但有一点是明确的,即骨折愈合与骨折端局部应力应变环境密切相关^(1,2)。临床观察和动物实验研究已证明外骨痂形成量的多少,与骨折端一定范围内的活动量有关。但是骨折端多大活动度最适于刺激外骨痂形成,而又不导致骨折不愈合,目前还不了解骨折端所需活动与过度活动的界限。Greiff⁽³⁾用不同刚度钢板固定,发现加压固定骨端间隙为 $15\mu\text{m}$,不加压达 $200\sim 1200\mu\text{m}$,而不加压组 4 周可见梭形外骨痂,既使有 1.2mm 间隙也容易充填。Lindholm 等⁽⁴⁾观察大鼠胫骨骨折端每天用手法造成异常弯曲活动,发现有大量外骨痂形成。Good ship 等⁽⁵⁾和 Kenwright 等⁽⁶⁾用外固定架给予骨折端每天短时间周期性纵轴活动,结果均证实骨折端有一定活动时可刺激外骨痂形成,而且这种骨痂的强度与固定方法的刚度成反比。

Lippert 等⁽⁷⁾用 X 线摄影测量学测量石膏固定后胫骨骨折患者在行走时的骨折端纵轴活动,平均为 5mm 。Cunningham 等⁽⁸⁾通过安装在外固定架支撑杆上的应变传感器测量骨端周围骨针的纵轴挠屈变形,推测骨折端活动,发现骨折早期骨端活动较小,5 周时平均 0.28mm ,随后骨折端活动逐渐增大,骨折 11 周时平均为 0.43mm ,这种活动继而减小。顾华⁽⁹⁾用光导棒连接于手术显微镜观察了钢板、髓内针和夹板固定后兔胫骨骨折端间隙的变化,认为家兔实验性胫骨截骨后,骨折端纵轴活动在 1.2mm 范围内对骨折愈合有利。

本文以光导纤维法对骨折端间隙直接客观测量分析,显示夹板和髓内针固定后骨端间隙随骨折时间的推移而逐渐减小($P < 0.01$)。此法所得结果与 X 线片测量骨折端间隙的变化一致。X 线片观察两组动物术后 6 周均是由外骨痂桥架于骨折端实现骨折愈合。说明随着骨折的愈合进程,外骨痂逐渐形成与钙化,并桥架

于骨折端,骨端间隙逐渐变窄,骨端显微活动逐渐减小,桥架于骨折端的外骨痂承担更多的载荷,从而完成骨折愈合过程,这是一个新的功能适应过程,对外骨痂形成和骨折重建过程非常有益。

以往实验研究已证明弹性固定允许断端间有一定程度的活动,在一定范围内可加速骨折愈合。通过本实验的观察结果,表明实验性兔胫骨骨折,骨折端纵轴位移在 $0.33\pm 0.17\sim 0.95\pm 0.43\text{mm}$ 范围内对骨折愈合有利。小夹板局部外固定可给骨折端提供一个相对的弹性固定力学环境,在保证骨折部位相对稳定前提下,允许骨折端有一定范围内的纵轴活动,对骨折端无应力遮挡,对血运无破坏,对骨折的自然愈合进程无干扰,因而是一种简单有效实用的骨折固定方法。

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Abstract of Original Articles

Observation of the rabbit tibial interfragmental gap in vivo by light guide fiber method

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In this article, changes of the healing process of rabbit tibial interfragmental gap treated with small splints and intramedullary nail fixation were observed. Through light guide fiber method, image pattern analysis measurements and radiographic analysis of the callus, the results showed that the mean value of fracture interfragmental gap decreased along with increasing of the time. There are also correlation between the tendency of changes of fracture and post-fracture time and burden of the limb ($p < 0.01$). Roentgenogram showed that the fractures were healed by the external bridge callus across the fracture site at sixth week. The results suggested that longitudinal displacement within $0.33 \pm 0.17 - 0.95 \pm 0.43$ mm of the experimental rabbit tibial fracture ends can facilitate bone healing.

Key words Fracture healing Fracture end gap Light guide fiber method Rabbit

Phagocytic function and heterogenicitic motive studies of surface wound healing

—Studies on the mechanism of Wei Nong Zhang Rou(2)

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Rabbit infected surface wound models were prepared. Wound exudation and surface wound cells were collected with modified Schilling stainless steel tube embedded in the hypoderm. The surface wound cells were stained with Wright-Giemsa stains. It was found that number of macrocytes(M) increased during process of the surface wound healing in external application of Chinese drug group, besides the wandering macrocytes were more than permanent ones. The differences were significant statistically. Through histochemical staining, there were very significant difference of the acid-phosphatase (AcP) and sugar metabolic rate-limiting succinate dehydrogenase (SDH) between surface wound healing and control group. It is suggested that external application of Chinese medicine can activate surface wound cells and elevate intracellular enzymic activity. It plays an important role in promoting surface wound healing.

Key words Surface wound healing Macrocytes Acid phosphatase Succinate dehydrogenase

A comparison between two kinds of internal fixation in treating fracture of patella

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Fifty-three cases of fracture of patella were treated with coarse silk thread cerclage internal fixation in 39 cases, and tension steel wire internal fixation in 14 cases. Three months postoperatively showed that the former was superior than the later. It is because in later group tail of the Kirschner pin brought a touching pain postoperatively, so recovery of the function was generally slower than the

former group. It is suggested that in the treatment of fracture of patellar the former method was first choice.

Key words Fracture of patellar Internal fixation of fracture Clinical study

Eighty-two cases of open tibio-fibular fracture treated with integration of traditional Chinese and modern medicine

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Better results were obtained in the treatment of **82** cases of open tibio-fibular fracture treated with integration of traditional Chinese and modern medicine. It is advised to let the open fracture becoming closed fracture after through debridement. During external fixation the patient kept in sitting position, let the affected limb hanging naturally in order to reduce the fracture ends in position correctly by means of gravity, then correct external fixation was applied instead of internal fixation. Application of drugs according to differentiation of symptom-complex in different stages and early functional exercises were emphasized.

Key words Fracture of tibia and fibula Integration of traditional Chinese and modern medicine

Compressive fracture of thoracic and lumbar vertebrae treated with buttock-shoulder style of training

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In this article, a kind of new functional exercise was introduced in the treatment of compressive fracture of thoracic and lumbar vertebrae. Twenty eight cases were treated. After a follow-up study of **3-41** months, satisfactory results were found in **24** cases. The characteristics of the exercise are small amplitude of movement, easy to be carried on, they were well accepted by middle and senile patients. The difference between the method and traditional therapy was introduced.

An analysis of reoperated cases following replacement of the femoral head in senile

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Twenty-nine reoperated cases following failure of replacement of the femoral head have been performed from March of **1979** to Feb. of **1992**. Regarding the main causes of **reoperation**, inappropriate between the head and acetabulum and loosening of the prosthesis; secondly **breaking** of prosthesis, infection and dislocation etc. were also mentioned. Prophylactic measures were suggested.

Key words Artificial femoral head Neck-shaft angle of the femur Anterior incline angle of the femur