

случаях клинических признаков инфекции или ее предоперативного устранения проводили консервативное лечение. Для образования кости осуществляли метафизарную кортикотомию с последующей дистракцией по Илизарову, а у одного пациента вместо кортикотомии использовали сопутствующий надмышелковый перелом. 13 пациентов лечили аппаратом Илизарова для наружной фиксации, 1 пациента лечили аппаратом Orthofix.

Восстановление кости и устранение инфекции было успешным с последующими хорошими функциональными результатами, за исключением одного пациента, у которого был дистальный дефект. Длина конечности была восстановлена, достигнут хороший функциональный результат, но заживление было неудачным в месте артродеза голеностопного сустава. Одному пациенту потребовалась повторная остеотомия из-за преждевременной консолидации костного регенерата. У трех пациентов с проблемами заживления в зоне иссечения отмечались реакции на аутогенный костный трансплантат. Ни у одного из пациентов не было проблем в отношении консолидации костного регенерата, а поставленные перед операцией задачи по удлинению были достигнуты.

Introduction: Tibial fractures may lead to non union, osteomyelitis and/or bone loss. Infected tibial fractures and non unions require radical debridement of infected bone, and insufficient resection can result in failure. By use of distraction osteogenesis as introduced by Ilizarov it is possible to restore even large bone and soft tissue defects. The aim of this study was to evaluate the treatment in our department of tibial defects using internal bone transport by the Ilizarov technique.

Material and methods: In the period 1991-95 15 patients, 10 males and 5 females, median age 32 (10-54) years with tibial defects were treated by means of internal bone transport. Six defects were infected. Treatment comprised a radical excision of pathological bone and soft tissue, at the same time collecting tissue samples for microbiological analysis. In cases with clinically signs of, or preoperatively proven infection, a local application of gentamycin took place. In infections antibiotic treatment on a long term basis adjusted according to microbiological analysis and weekly blood tests of ESR and C-reactive protein was used. For bone formation a metaphyseal corticotomy followed by distraction according to Ilizarov was performed, yet in one patient using a co-existing supramalleolar fracture in stead of a corticotomy. Thirteen patients were treated with the Ilizarov external fixator and one with the Orthofix.

Results: Restoration of bone and eradication of infection was successfully followed by good functional results in all but one patient, who had a distal defect. Limb length was restored and good function was achieved, but with failure of healing in an intended ankle arthrodesis. Median lengthening index was 1,02 month pr. cm (0,57-2,13). Pin tract infections were noted in nine cases, treated with local wound care and systemic antibiotics. One patient needed a re-osteotomy due to a premature consolidation of the bone regenerate. Three patients with healing problems at docking site responded to autogenous bone. grafting. No patients had problems in consolidation of the regenerated bone, and the preoperative aims for lengthening were achieved.

Discussion and conclusion: Treatment of large tibial bone defects must be considered a limb saving procedure and a restorative procedure as well. The Ilizarov technique offers unique possibilities for that. The technique for bone transport is a demanding and a long lasting procedure, which is often troublesome for the patient. We have noted a number of difficulties during the treatments but few serious complications.

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Применение метода Илизарова под контролем функции нерва с помощью ССВП

Ilizarov apparatus application under control of neural function by SSEP

Для раннего обнаружения нервного компромисса, связанного с наложением аппарата внешней фиксации на нижние и верхние конечности, предлагается использовать управление неврологической функции Соматосенсорным Возбудителем Потенциалов (ССВП).

Шестидесяти пяти пациентам в возрасте от 5 до 17 лет накладывали аппарат Илизарова на нижние (60) и верхние (5) конечности для удлинения и/или исправления деформаций. Под общей анестезией проводился мониторинг функции периферического нерва использованием ССВП диагностическим оборудованием Cadwell Excel (Cadwell Corp., Kennewick, WA). Запись основной линии возбудителей потенциалов собирались непосредственно перед наложением аппарата. В последующем запись повторялась в течение всей операции. Более 10% продолжительности латентности и более 50% снижения амплитуды или наличие обеих считалось значительным и указывало на повреждение нерва. Один из нервов противоположной конечности также находился под контролем вариабельности внутриоперационного ответа из-за анестезии или прочих факторов.

Мониторинг с помощью ССВП оказался технически осуществимым и клинически надежным методом для оценки нервного компромисса во время внешней фиксации нижних и верхних конечностей. Данная методика может усилить безопасность операций по наложению аппаратов внешней фиксации, и таким образом, может быть ценным дополнением к хирургическому инструментарию.

Intoduction: Acute nerve injury is an uncommon but troublesome complication of external fixation. For the earlier detection of nerve compromise associated with external fixator application on the lower and upper extremities, we proposed to use intraoperative monitoring of neural function by Somatosensory Evoked Potentials (SSEP).

Method and materials: Sixty five patients, ranging from 5 to 17 years of age underwent Ilizarov apparatus application to the lower (60) and upper (5) extremities for limb lengthening and/or deformity correction. Apparatus was applied to the tibia in 33 cases, to the femur in 23 cases, to both tibia and femur in 4 cases, to the humerus in 2 cases, and to the forearm in 3 cases. After the induction of general anesthesia, peripheral nerve function monitoring was commenced by using SSEPs with Cadwell Excel diagnostic unit (Cadwell Corp., Kennewick, WA). Deep peroneal and posterior tibial nerves were evaluated in the lower extremities. In the upper extremities, median, ulnar, and radial nerves were assessed. For the stimulation, a pair of Nicolet needle electrodes was applied subcutaneously over the each examining nerve in the lower tibia or the lower forearm. Stimulus Intensity was set to 30 mA and maintained stable throughout surgery. Square wave pulses with a duration of 100 μ sec and a frequency of 4 - 5 per second were delivered to the nerves for a total of 200 repetitions for each resulting signal. The waves were passed through band-pass filters of 100-2000 Hz. Evoked potentials were subsequently recorded by the same type of electrodes at the popliteal fossa, lumbar and anterior cervical areas for the lower extremities and at the Erb's point and anterior cervical area for the upper extremities. Baseline evoked potential recordings were generated right before the apparatus application. Further recordings were continuously repeated throughout surgery. More than 10% latency prolongation and more than 50% amplitude reduction or both were considered significant and indicative of nerve injury. One of the nerves of opposite extremity was monitored as well for control of intraoperative response variability due to anesthesia or other factors.

Results: Significant deterioration or total loss of peroneal nerve SSEPs during apparatus application to the lower extremities occurred in 4 cases. Two of these patients were preoperatively normal and had symptoms of neurologic deficit postoperatively; the other two suffered exacerbation of pre-existing neuropathy.

Wire-related nerve injury was identified in one of these cases, whereas in the other 3 patients osteotomy with acute deformity correction appeared to cause the problem.

During apparatus application to the upper extremities, radial response attenuation was identified in 2 instances. No corrective actions were performed in one of the case which had humeral frame application, because changes did not reach criteria of significance. The patient experienced symptoms of sensory radial nerve deficit postoperatively. In the other case with forearm frame application, immediate wire removal was undertaken after the detection of response abnormalities. This resulted in substantial response restoration and prevention of postoperative nerve dysfunction.

Conclusion: SSEP monitoring was demonstrated to be a technically feasible and clinically reliable technique for the assessment of nerve compromise during external fixation of the lower and upper extremities. The technique may improve the safety of external fixation procedures, and therefore can be a valuable adjunct to surgical instrumentation.

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Послеоперационное обследование - больше функций в компьютерной системе планирования при исправлении деформаций нижних конечностей с помощью компьютера

Post-surgery examination - more functions in computer-aided planning system for lower extremity deformity correction

Создана компьютерная программа, позволяющая планировать процесс исправления деформаций нижних конечностей.

Предоперационное планирование устранения деформации с помощью компьютера с применением аппарата Илизарова может значительно повысить шансы на успех и облегчить процесс применения. Время, отводимое на создание клинически верной конструкции, значительно уменьшается при применении предоперационной программы планирования. К ранее созданной программе добавлена система планирования функциональности послеоперационной выверки. Эти функции позволяют модифицировать предоперационный план с тем, чтобы более точно отразить остеотомию и положение конструкции, действительно достигаемые во время операции. Это, в свою очередь, позволяет спрогнозировать процесс устранения деформации на весь период лечения, используя предварительно собранную конструкцию, составленную при предоперационном планировании.

Abstract We have previously reported here the development of a computer assisted surgery planning system for lower extremity deformity correction using the Ilizarov method. The hardware of the system is composed of an ultrasonic digitizer as input device, a HI plotter as output device, and a 386 / 486 Personal Computer, SuperVGA monitor, and a mouse. The main program is a menu-driven 2-D graphics program dividing the planning procedure into several major steps. More functions have been added to our program: Post-Surgery adjustments and Examinations. Since it is very difficult to make the osteotomy and place the external fixators exactly as they are planned in preoperative stage, the post-surgery adjustment is necessary to observe and predict the correction process. The functions of these additional components to the program include the modification of osteotomies and adjustment of the placement of the external fixator.

Introduction

In applying the Ilizarov technique for the treatment of lower limb deformities, external fixators are used during the whole treatment process [1]. There are three phases involved. The first phase consists of preoperative planning of deformity correction including frame preconstruction. This phase is greatly aided by our original computer program which determines the weight-

bearing axis of the bone, allows development of a strategy for deformity correction using up to three osteotomies, and provides specific information regarding the geometry of the preconstructed frame and the rate of deformity correction. The second phase is surgery when the frame is fixed on the deformed bone and the bone divided. In the third phase (correction), the relative positions of the frame components are changed at the prescribed rate. In this way, the deformity of the bone is gradually corrected.

It is very difficult for the geometry of the osteotomy or the position of the preconstructed frame as predicted from the preoperative planning phase to be exactly reproduced at surgery. So, it is essential that the computer-aided planning system is able to change the level of the osteotomies and adjust the position of the external fixator to mimic those actually achieved at. Only in this way can the system mimic the actual correction process and examine it frequently by comparing the x-ray film and the information provided by the system.

Functions Implementation

Two Functions have been added to the system in order to perform the post-surgery examination, "Osteotomy Adjustment" and "Frame Adjustment". The function "Osteotomy Adjustment" allows the user to change the level and orientation of each osteotomy from the original ones created during the preoperative planning phase. To effect this function, the operator opens the original, stored preoperative plan and alters the preoperative osteotomy site and orientation to reflect the actual osteotomy created during the surgery phase.

The function "Frame Adjustment" allows the user to move the preassembled frame now fixed to the bone during the surgery phase in the 2-D plane corresponding to the bone deformity plane. The movement of the frame is performed in two steps. First, the entire frame may be shifted by pointing the cursor anywhere in the area of frames and holding the mouse. When mouse moves, the whole frame will move along with the cursor. The second step is rotation of the frame. The rotation center will be at the point where the cursor pointed when shifting the components. The combination of shifting and rotation can be used to achieve repositioning of the frame to any orientation in the deformity plane.

Fig. 1 shows the presurgery bone shape with intended frame construction, orientation and osteotomy site and geometry. Fig. 2 shows alteration of the osteotomy level and orientation of the frame on tibia, using the "Postoperative Modify" feature of program. Fig. 3 shows the result of angular correction with the modified osteotomy level and frame location on the bone after surgery.

Summary

Computer-assisted preoperative planning of deformity correction using the Ilizarov apparatus can greatly enhance the success and ease of application of the process. The time spent creating a clinically appropriate frame is significantly reduced in our experience using the preoperative planning program. We have now added the post-surgery adjustment functionality to the planning program. These functions allow us to modify the preoperative plan to more accurately reflect the osteotomy and frame location actually achieved during surgery. This in turn allows us to predict the deformity correction for the whole treatment period using the preconstructed frame developed during the preoperative planning.

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