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A comparison between the use of a monolateral external fixator and the Ilizarov technique for pelvic support osteotomies

Pelvis destek osteotomilerinde tek taraflı eksternal fiksatör ile klasik Ilizarov tekniğinin karşılaştırılması

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Amaç: İhmal edilmiş doğuştan kalça çıkıklı olguların tedavisinde uygulanan pelvik destek osteotomilerinde Ilizarov tekniği ile tek taraflı eksternal fiksatör tekniğinin sonuçları karşılaştırıldı.

Çalışma planı: İhmal edilmiş doğuştan kalça çıkığı nedeniyle 17 hastaya tek taraflı eksternal fiksatör (TEF) (n=7) veya geliştirilmiş hibrid Ilizarov yöntemi (GHIY) (n=10) kullanılarak pelvik destek osteotomisi uygulandı. Tamamı kadın olan hastaların ortalama yaşı TEF grubunda 23.2 (dağılım 17-39), GHIY grubunda 25.9 (dağılım 17-36); ameliyat öncesi kısalık sırasıyla ortalama 5.5 cm ve 5.2 cm; fiksasyon süresi sırasıyla 201.5 gün (dağılım 185-241) ve 197 gün (dağılım 164-248 gün); izleme süresi sırasıyla ortalama 30.4 ay (dağılım 23-39 ay) ve 40.5 ay (dağılım 21-65) idi. İki gruptaki hastalar fiksatör ile ilgili duyulan rahatsızlıklar ve Paley sistemine göre sınıflandırılan tel dibi enfeksiyonları açısından karşılaştırıldı.

Sonuçlar: Tek taraflı eksternal fiksatör grubunda 3. derece tel dibi enfeksiyonu nedeniyle bir telin çıkarılması gerekti; bu sayı GHIY grubunda beşti. Yapılan ankette GHIY grubunda üç hasta, TEF grubunda ise sadece bir hasta fiksatörden çok rahatsız olduğunu belirtti. Diz hareket genişliği iki grupta benzer bulunmasına (p>0.05) rağmen, klinik izlemlerde fiksasyon süresince TEF grubunda diz hareketlerinin daha rahat olduğu ve fiksatörün çıkarılmasından sonra 90 derece hareket açıklığının daha kısa sürede (TEF'de 36 gün, GHIY'de 47 gün) elde edildiği gözlendi.

Çıkarımlar: Pelvik destek osteotomilerinde TEF daha düşük oranda tel dibi enfeksiyonu ve daha yüksek düzeyde hasta konforu nedeniyle tercih edilebilecek bir yöntemdir.

Anahtar sözcükler: Kemik uzatma; eksternal fiksatör; femur/cerrahi; kalça çıkığı/cerrahi/radyografi; Ilizarov tekniği; osteotomi/yöntem.

Objectives: We compared the results of monolateral external fixator and the Ilizarov technique for pelvic support osteotomies in the treatment of neglected congenital hip dislocation.

Methods: Seventeen female patients with congenital dislocation of the hip underwent pelvic support osteotomy using a monolateral external fixator (MEF) (n=7; mean age 23.2 years; range 17 to 39 years) or the hybrid advanced Ilizarov method (HAIM) (n=10; mean age 25.9 years; range 17 to 36 years). The mean leg discrepancies, durations of the external fixator, and follow up-periods in the MEF and HAIM groups were as follows, respectively: 5.5 cm and 5.2 cm; 201.5 days (range 185 to 241 days) and 197 days (164 to 248 days); 30.4 months (23 to 39 months) and 40.5 months (21 to 65 months). The two groups were compared with respect to patients' discomfort related to the use of external fixators and pin tract infections classified according to the Paley criteria.

Results: Overall, six pins required removal because of grade 3 pin track infections (5 in the HAIM group, 1 in the MEF group). The number of patients who reported extreme discomfort for the use of external fixator was three in the HAIM group and one in the MEF group. Although the range of motion of the knee was similar in both groups (p>0.05), clinically, patients treated with MEF exhibited a more comfortable range of motion of the knee with external fixation and, after removal of the fixator, reached a knee flexion of 90 degrees in a shorter time (36 days versus 47 days).

Conclusion: The use of MEF for pelvic support osteotomies seems to be preferable because it is associated with a lower rate of pin tract infections and a higher degree of patient comfort.

Key words: Bone lengthening; external fixator; femur/surgery; hip dislocation/surgery/radiography; Ilizarov technique; osteotomy/methods.

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Pelvic support osteotomy (PSO) is one of the therapy approaches to be chosen to improve locomotor function of the affected leg, to fix leg discrepancies, to treat Trendelenburg sign and to maintain hip functions in neglected congenital hip dislocations. The aims of these osteotomies described by various authors with small differences are abduction of proximal femur by subtrochanteric osteotomy and stabilize the hip joint.[1,2] Extensive valgus stress of knee and increase in inequity of leg lengths which may be seen after these ostetomies are solved with a second osteotomy through distal of femur in addition to well known classical İlizarov's technique.[3,4] The most common complication of external fixation is wire-root infections which may be seen in 95% of the cases.[5-8] In hybrid technique, arches and Schanz pins for proximal femur and Ilizarov's transosseose wires and classical Ilizarov's ring for the distal femur are being used. Although patients' comfort is increased with this technique, hygienic care of the patients become more difficult due to the arches in pelvic region. Monolateral fixation would be more advantageous than Ilizarov fixator at this point of view. But, a very well preoperative planning is necessary for using this technique in three dimensional operations like PSO.[10, 11]

In this study, newly developed monolateral external fixation technique is compared with Ilizarov external fixation technique in terms of patient comfort, complications due to wire, knitting duration and other complications.

Patients and methods

17 (who had enough time for observation) of 23 patients (who had PSO due to congenital hip dislocation) are evaluated retrospectively in İnonu University Orthopedics and Traumatology Dept and Sisli Etfal Hospital Orthopedics and Traumatology Dept between April 1996 – November 2000. 7 patients underwent monolateral external fixation (MEF) (Limb Reconstruction System, Orthofix, Verona, Italy) and 10 patients underwent "hybrid advanced Ilizarov Method (HAIM)"(4). Choose of fixation technique was determined by the surgeon. Average age of the patients who were all female was 23.2 years (range 17-39 years) in MEF group and 25.9 (range 17-36) in HAIM group. Preoperative leg discrepancies were 5.5 and 5.2 respectively, fixation periods were 201.5 days (range 185-241 days) and 197 days (range 164-248 days) respectively, observation periods were 30.4 months (range 23-39 months) and 40.5 months (range 21-65 months) respectively.

Trendelenburg signs were positive in all patients preoperatively. Hip pain was accepted as crucial in determining the need for operation. 4 standard questions were asked to the patients: 1. Is there pain by walking shorter than 500 m? 2. Does pain persist despite analgesic use? 3. Is there pain at rest? 4. Do you accept the surgical procedure which is explained you in details despite all side effects? Operation date was set for the patients who answered all the questions as "yes". Patients were asked to score their discomforts at 1-5 (1=no discomfort, 5= too much discomfort) before removing the fixator.

Wire-root infections were classified according to Paley system (1.degree= inflammation in soft tissue, 2.degree= infection in soft tissue, 3.degree= infection in bone).[8]

Preoperative planning

Determining precise amount of valgus

Biggest angle of passive adduction: It is measured by the help of the anteroposterior pelvic radiography taken during the widest passive adduction of the affected femur while the patient is in supine position (figure 1a). This method is used especially in determining the level of proximal osteotomy.

Pelvis falling angle (Trendelenburg position): It is measured by anteroposterior pelvic radiography while patient is standing on affected limb without any support (figure 1b).

The aims of the two radiographies taken are to determine the largest valgus angle without limiting the motions. This angle should not excess the angle of lateral wall of pelvis.

The angle between the horizontal line drawn on pelvis and anatomical axis of femur informs us about the amount of valgus which will be administered (figure 1a, b). The angular value of A may be different in the radiographies taken in both positions. This is why, the abducting muscles prevents the fall

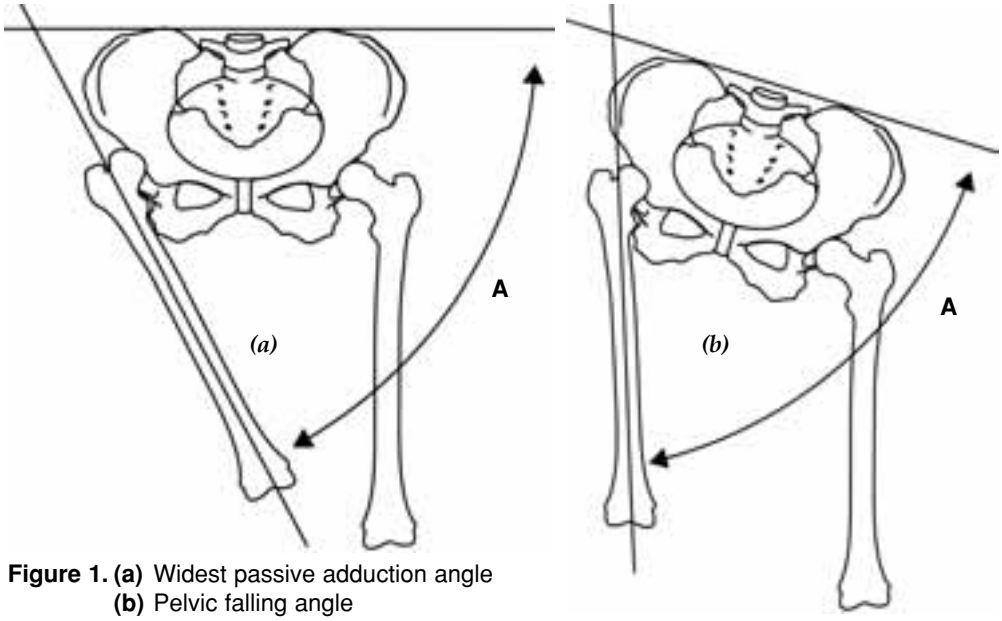

Figure 1. (a) Widest passive adduction angle **(b)** Pelvic falling angle

of pelvis to some degree in Trendelenburg position. As a result, the valgus angle which will be formed by operation can be calculated by adding 15-20 to the A angle measured in Trendelenburg position. The addition of 15-20 compensates the remodeling which may develop in the future.

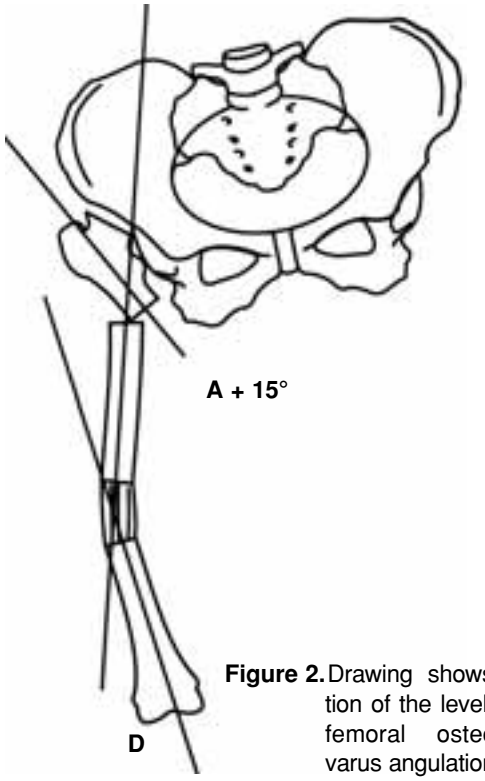

Figure 2. Drawing shows determination of the level of the distal femoral osteotomy and varus angulation

Determining the levels of osteotomy

Proximal osteotomy level: The portion of femur at ischion at anteroposterior pelvic radiography taken at the widest adduction position of affected limb is determined as the level of osteotomy.

Distalosteotomy level: A pattern is formed by orthoroentgenogram for determining the lengths of both legs (figure 2). Second osteotomy is simulated on middiaphysal region after the simulation of proximal osteotomy on this pattern and necessary varus (D) and the amount of lengthening are determined. Lateral distal femoral angle (LDFA) should be arranged as 87.°

Surgical technique

Patient is placed on the operation table in a position that the affected limb at the widest adduction and the other leg at traction with sacral support. Before osteotomy, the removal of femur head is necessary especially for relieving the pain in hip joints with degenerative changes. Lateral Watson-Jones incision or anterior mini incision may be used for removing femur head.

Monolateral external fixation technique

1.step: Level of osteotomy is marked by a Krischner (K) wire preoperatively. Under the scope control, 1.8 mm K-wire is placed in trochanteric region posterolaterally in an angle of A+15-20

degrees with long femoral axis. Second K wire, should be placed in the mid-point of proximal and distal osteotomies facilitating three dimensional (valgus, inner rotation, extension) corrections. In that case wire is going to be placed perpendicular to anatomical femoral axis at anteroposterioral level and with an angle of 5-15 degrees with first K wire at sagittal level (figure 3a, b). Aim is to rotate the proximal femur towards internally by 5-15 degrees when two K wires positioned parallel to each other (figure 3a, b). Third K wire is placed on distal femur with an angle similar two varus angle determined on the pattern and the positions of all K wires are checked with scope. Than, drilling is performed on K wire with a drill canula of 3.5 mm. Schanz nails of 5 mm are placed (figure 3a). After the first 3 nails, all angles are controlled by scope.

2.step: Second nail of trochanteric region is placed close to posterior cortex aiming to form an anterior angle (C) at sagital level (figure 3c). Pairs of Schanz nails are placed parallel to the first nails at mid and distal levels with the guidance of Orthofix clamps (Figure 3c).

3.step: Transvers incision is performed at the skin at the level of proximal osteotomy. Transvers incision facilitates the wound closure before valgus osteotomy. Holes are prepared with 2 mm K wire from the incision. After that, the bone strength is reduced for controlled osteotomy. Leg is moved to abduction loosing the joint of traction table. Acquired inner rotation is obtained immediately by positioning the clamps at proximal and mid levels parallel to each other. Clamps are fixed to the fixator trunk while keeping this position (figure 3d).

4.step: : Longitudinal incision is applied for distal osteotomy and osteotomy is completed with the technique which is used for proximal osteotomy. Distal clamp is attached to fixator at the same level with proximal clamps (figure 3d). Final corrections are done by controlling the contacts of bones by scope at osteotomy level.

5. step: After moving the patient to the carrier, range of motion of knee is controlled under general anesthesia. Facia lata is loosened percutanously at the nail roots, if necessary.

Advanced hybrid Ilizarov fixation technique [4]

1.step: 3 Schanz nails are administered to trochanteric region at different levels and from different directions forming valgus 15-20 degrees more than the planned valgus angle (figure 4a). Nails are fixed using 120° of arch. This arch should be placed letting three dimensional corrections (valgus, inner rotation, extension).

2.step: 2 Schanz nails are placed perpendicular to diaphysial axis at 1/3 mid-proximal femoral region.4 transfixation wires or one wire and 2 Schanz nails are placed at distal region (figure 4a). Connection between rings and rods is built by normal or telescoping rods, temporarily. 3 hinges are placed at the level which distal corticotomy will be performed, one is in lateral, and two are in anteroposterior position (figure 4b).

3.step: Proximal femoral osteotomy is performed by transvers incision at the osteotomy level marked inbetween two arches. Leg is moved to abduction by loosening the joint of traction table. Rods inbetween two proximal arches are fixed and a controlling graph is taken to check whether the distal proximal segment of femur is supporting the hip properly (figure 4b).

4.step: Distal osteotomy is performed inbetween 2nd and 3rd rings (figure 4c).

5.step: The procedures performed for monolateral external fixation technique are performed for the 5.step.

Postoperative period

Patienst were erected by help 3-4 times daily after second day. Load on operated leg was increased stepwise asking the patients to use their crutch. In order to prevent straight joint stiffness, exercises for maintaining range of motion were asked to be performed at the postoperative 2nd day. Alongation was performed on distal osteotomy line at the postoperative 7th day (4 x 0.25 mm/day) (figure 3e). Exercises for maintaining range of motion were performed continuously during waiting period. When satisfactory elongation was reached, mechanical axis was measured by getting elongation graph to correct the mechanical axis deviations before the thickening of callus.

Wound was cleaned twice daily with solutions with alcohol or povidone-iodine for wire root cleaning for about 1 week postoperatively. Routine daily wound care were done for the ones having no wire root infection. Treatments were determined for the patients in who wire root infections were observed according to the severity of infection. Local wire root care was done for 1st degree of infections. Local wire root care was done and appropriate oral antibiotics were used for 2nd degree of infection. Wire or nail removal, curettage, use of parenteral antibiotics and sequestrectomy if necessary were performed for 3rd degree of infection.

Fixators were removed in outpatient clinics or in operation rooms (under general anesthesia) upon the general status of patient. After the removal of fixator, operated leg was protected by brace for about 6-8 weeks (figure 5).

Student t-test and chi-square test were performed for statictical evaluation.

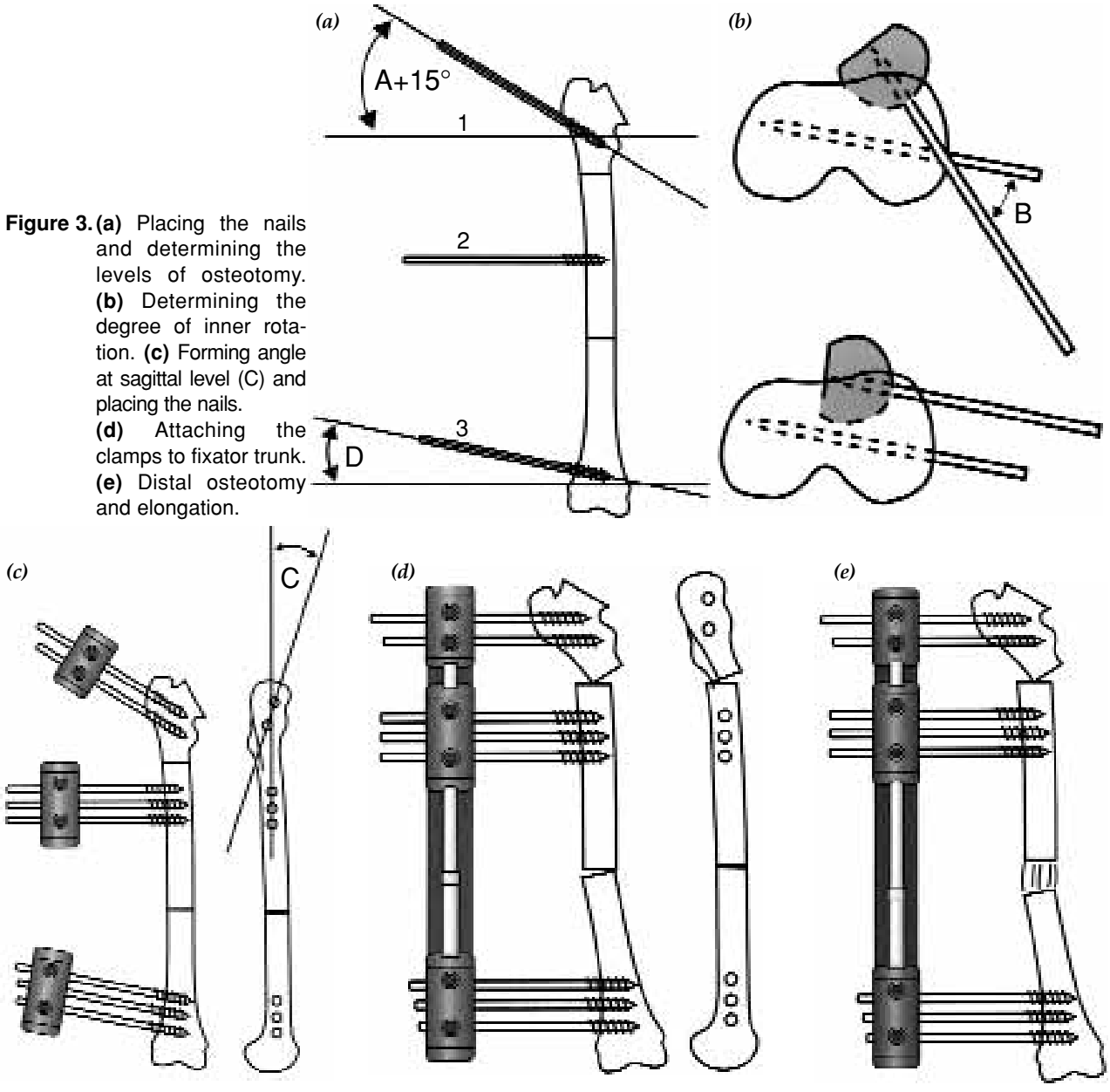

Figure 3. **(a)** Placing the nails and determining the levels of osteotomy. **(b)** Determining the degree of inner rotation. **(c)** Forming angle at sagittal level (C) and placing the nails. **(d)** Attaching the clamps to fixator trunk. **(e)** Distal osteotomy and elongation.

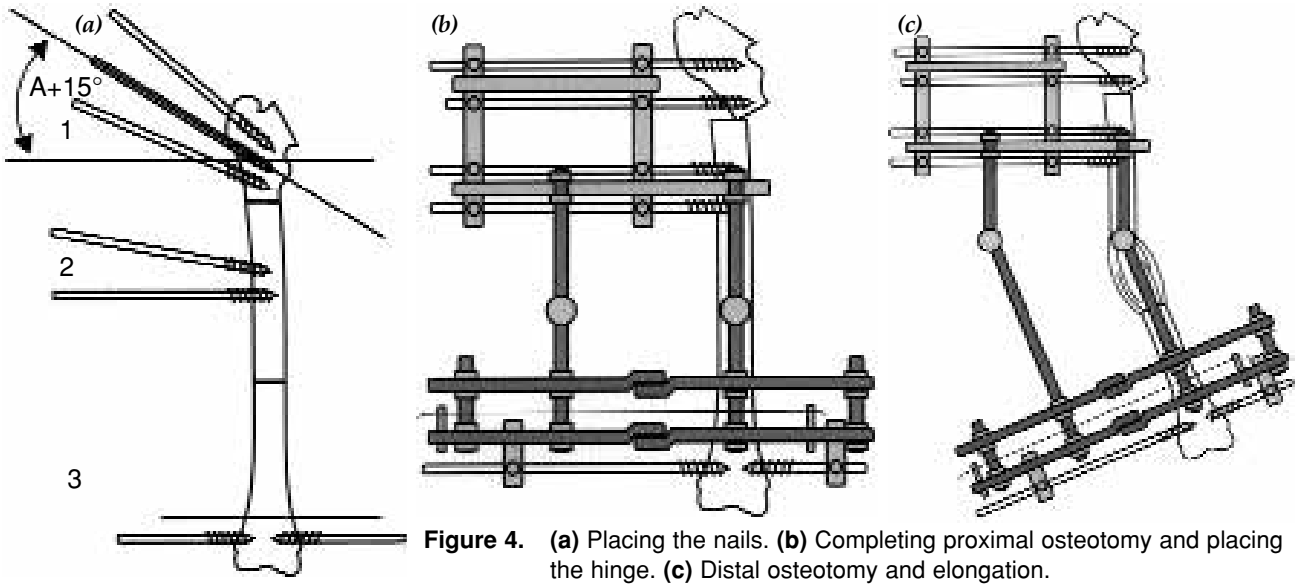

Figure 4. **(a)** Placing the nails. **(b)** Completing proximal osteotomy and placing the hinge. **(c)** Distal osteotomy and elongation.

Results

Shortness was observed more than 2 cm in 2 patients each from different groups in who fractures occurred at elongation site, postoperatively. In patient from hybrid advanced Ilizarov fixation group, satisfactory healing was thought to be observed radio graphically and partial loading to the operated leg was asked by loosening the fixating rods. Fracture was re-observed in the control radiography taken due to patient's complaint of severe pain during this loading exercise. Fixator rods were stabilized in outpatient clinic and compression was performed. Healing was observed without a need for additional surgical intervention. In the patient from monolateral external fixation group, fracture reoccurred with a minor trauma after removal of fixator. As patient rejected the second surgery, conservative treatment by long leg plaster casting was performed.

Ranges of motions were similar in both groups in long term follow-up ($p>0.05$). However, motions of knee were more easy for the patients in MEF group clinically and 90 degrees range of motion was achieved in a shorter period in the patients who had loss of motion at the end of elongation period (in MEF group = 36 days, in HAIM group= 47 gün).

In terms of discomforts up to fixator was reported as 5 points by one patient in MEF group but 3 patients in HAIM group.

Significant differences were observed among groups in terms of wire root infections. While only one nail from trochanteric region was being removed due to infection in MEF group, 4 nails form trochanteric region and 1 from chondular

Figure 5. The appearance of a patient with brace after external fixator removal.

region were removed in HAIM group and antibiotic treatment was started. Wire root infections in trochanteric region occurred in post-traction interval. As healing occurred in proximal osteotomy region, new nails were not placed in the place of the removed ones. However, a new nail was placed from distal lateral direction in the place of the medial oblique nail removed from the distal region. In MEF group, 1st degree of infection was observed in 16 nails, 2nd degree of infection was observed in 8 nails and 3rd degree of infection was observed in one nail of the total 56 nails, used. On the other hand, in HAIM group, the numbers were 38, 14 and 5 respectively; in total 100 nails, used.

Trendelenburg test was positive in 2 patients in MEF group and in 3 patients in HAIM group ($p>0.05$). There was no statistically significant difference among the groups in terms of lateral distal femoral angle, deviation of mechanical axis, age, duration of fixation.

Discussion

Two main problems of neglected high hip dislocations are limping and pain. PSO is a preferable treatment approach for the solutions.[12-14] Abductional osteotomy of proximal femur at one level which was formerly performed was modified by İlizarov adding distal femoral osteotomy.[3] Correction of shortness has become possible by repairing mechanical axis using this technique. Spreading the use of Ilizarov technique and also formulating preoperative planning and explaining the techniques in detail by Catagni et al [4] and Paley [15] led to increase the interest in osteotomies.

Two main disadvantages of external fixation are low acceptance by the patients and wire-root infections.[7, 8, 16-18] The use of very wide ring and transosseouse wires decreases patients' comfort and increases the difficulty of hygienic care. Monolateral fixators could be accepted more easily by the patients.[16, 18]. Hybrid systems are being developed with new fixators to combine the advantages of both fixation techniques for improving patient comfort. In hybrid system developed by Catagni et al,[14] arches and Schanz nails for hip region and combination of wire-nail for distal femur are being used. As the posterior part of the hip becomes free and less muscle groups are fixed with nails with these hybrid systems, movements of hip and knee become more comfortable. In Rancho technique developed by Green et al,[9] titanium nails replaced for wires. Patients' functioning and walking capacity are thought to be increased, physical rehabilitation is thought to be eased and the use of analgesics is thought to be decreased with these techniques.

Main issue for patient control is pain. Quality of lives of patients change due to pain and compliance to physical rehabilitation becomes low. Main source of pain is the fixation of muscles with the wires and nails which are used and wire root infections.[6, 7, 17] The increase in the numbers of wires and nails in classical Ilizarov's technique causes more pain and decrease in patient's comfort. Goldberg and Catagni [17] reported that the incidence of very frequent use of analgesics decreased by using Schanz nails instead of Ilizarov's wires. It is obvious that pain will be decreased and joint movements will become easier in MEF technique performed through laterally as anterior and posterior muscle groups are not fixed.

In clinical studies it is observed that the most frequent complication is wire root problems in Ilizarov's external fixation.[5, 9] These infections are frequently observed especially at the joint sites where skin is more labile and at the sites where soft tissue is thicker. As the wires used for Ilizarov external fixator passes through massive muscles of the limb, the risk for infection is higher. Manzotti et al[18] reported that they have observed 1st and 2nd degree of wire root infections in all of 15 patients who had undergone PSO by HAIM. However in only 3 of the patients the infected nail was removed and was replaced with a new one due to 3rd degree of infection. Same authors reported that wire root infection frequently occurs at proximal femoral region and in cases which the treatment has taken long time. Kocaoglu et al[19] reported that only 3 of 14 patients to whom PSO with İlizarov external fixation was administered due to CHD, had mild wire root infection. It is reported that these patients were treated with local wound care. Green et al[9] compared Rancho technique with classical Ilizarov method in terms of wire root infections and found out that Rancho technique decreased the rate of complications due to the wires used in Ilizarov fixator. As the number of nails used for monolateral fixation is fewer and these nails are administered at the sites

where soft tissue movements are less, the risk of wire root infection become less.[20]

In recent years clinical studies related with acute correction and elongation with monolateral external fixation are being published.[10, 11, 21] There is no doubt that forming angular deformities with two levels and with different directions is a more complicated intervention than the corrections on one level. In the literature there is no publication about PSO done with MEF technique. Elongations after one level and acute corrections, insufficient callus formation is thought to occur. Although Noonan et al[10] wroted that this technique decreases callus formation and increases complications over 14 years of age, it is reported that sufficient callus formation is achieved at approximately 300 acute correction cases with very few complications.[11, 21] Bone contact after osteotomy and the importance of the osteotomy technique are emphasized in 3 recent studies.

Another factor which effects the callus formation is the stability of external fixation system. In cases of insufficient stability, fibrous tissue formation is dominant to bone formation.[3] In biomechanical tests, it is shown that MEF is less stable only against scissoring forces than Ilizarov's external fixation.[22] In our study we have not observed mechanical insufficiency and loss of reduction due to fixators in both groups.

The advantage of Ilizarov's external fixation is the possibility of correcting the technical faults of operation without re-operation. For instance, insufficient valgus or varus can be corrected easily by adding hinges to the system. To compensate the technical faults occurred in monolateral systems, it is frequently needed to change the fixator or to replace the nails.[10] In recent years, fixators with hinges are developed to compensate the insufficiency of angular correction of axial fixators. However, these fixators are not easy to find in our country neither at the study period nor today. Having original and locally produced types of fixators (Limb Reconstruction System) which we used besides its extensive use was an advantage for us.

As a conclusion: according to our data from a limited number of patients, there is no significant difference between groups in terms of healing duration, range of motion at the end of the treatment and angular deformities after healing. However, our clinical observations revealed that MEF technique would be an alternative for HAIM as patients' complaints were lesser, rate of wire root infection was fewer, and patients' comfort was higher due to less muscle fixation with nails in MEF.

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