

Capsuloperiosteal flap application for the stabilization of chevron osteotomy

Chevron osteotomisinin stabilizasyonu amacıyla kapsülperiosteal flep uygulaması

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Amaç: Hafif ve orta derecedeki intermetatarsal ve halluks valgus açılı olgularda uygulanan modifiye distal chevron osteotomisinin stabilizasyonu için kapsülperiosteal flep uygulama sonuçları değerlendirildi.

Çalışma planı: Halluks valgusu olan 25 hastanın (14 kadın, 11 erkek; ort. yaş 30.4; dağılım 19-43) 27 ayağına modifiye chevron osteotomisi uygulandı. Çalışma grubu, konservatif tedaviye yanıt vermeyen, ağrılı, 18-50 yaş arasında, intermetatarsal açının 17 derecenin, halluks valgus açısının 40 derecenin altında olduğu ve metatarsofalangeal eklemden osteoartritik değişiklikleri bulunmayan hastalardan oluşuyordu. Hastalar ameliyat öncesinde, ameliyat sonrası erken dönemde, altıncı haftada ve her altı haftada bir olmak üzere radyografik ve klinik olarak değerlendirildi. Klinik değerlendirmede Bonney ve Macnab'ın subjektif ve objektif değerlendirme sistemi kullanıldı. Ortalama takip süresi 22 ay (dağılım 8-67 ay) idi.

Sonuçlar: Ameliyat öncesinde ortalama 31.4° (dağılım 23°-40°) olan halluks valgus açısı, ameliyat sonrasında 12.8 dereceye (dağılım 4°-22°); ameliyattan önce 14.2° (11°-17°) olan intermetatarsal açı ise 9.6 dereceye (7°-14°) düştü. Olguların tümünde birinci metatarsofalangeal eklemin uyumu tamdı. Bonney ve Macnab subjektif skoruna göre, yedi ayak çok iyi (%25.9), 17 ayak iyi (%63), üç ayak orta (%11.1); objektif olarak ise 14 ayak çok iyi (%51.9), 11 ayak iyi (%40.7), bir ayak orta (%3.7), bir ayak kötü olarak değerlendirildi.

Çıkarımlar: Bulgularımız, orta dereceli, metatarsofalangeal eklemden dejeneratif değişikliği olmayan halluks valguslu olgularda, internal tespit materyali kullanmadan kapsülperiosteal flep ile stabilizasyonu artırılan modifiye chevron prosedürünün başarılı bir tedavi seçeneği olduğunu göstermektedir.

Anahtar sözcükler: Halluks valgus/fiziopatoloji/cerrahi; metatarsal kemikler/cerrahi; metatarsofalangeal eklemler; osteotomi/yöntem.

Objectives: We retrospectively analyzed the results of capsuloperiosteal flap application to stabilize the modified distal chevron osteotomy in patients with mild to moderate intermetatarsal and hallux valgus angles.

Methods: Modified chevron osteotomy was performed in 27 feet of 25 patients (14 females, 11 males; mean age 30.4 years; range 19 to 43 years) with hallux valgus. The study group was comprised of patients unresponsive to conservative treatment for painful deformity, at ages 18 to 50 years, and having an intermetatarsal angle less than 17°, hallux valgus angle less than 40°, and no osteoarthritic changes in the metatarsophalangeal joint. The patients were evaluated clinically and radiographically preoperatively and in the early postoperative period, in the sixth week, and once in every six weeks. Clinical assessments were made using the subjective and objective evaluation systems of Bonney and Macnab. The mean follow-up was 22 months (range 8 to 67 months).

Results: The mean preoperative hallux valgus angle, which was 31.4° (range 23° to 40°), decreased to 12.8° (4°-22°) postoperatively, with a corresponding decrease in the intermetatarsal angle from 14.2° (11°-17°) to 9.6° (7°-14°). Conformity of the first metatarsophalangeal joint was complete in all the cases. According to the Bonney and Macnab subjective scores, the results were excellent in seven feet (25.9%), good in 17 feet (63%), and moderate in three feet (11.1%). On objective evaluations, the results were excellent in 14 feet (51.9%), good in 11 feet (40.7%), moderate in one foot (3.7%), and poor in one foot.

Conclusion: Our results suggest that modified chevron procedure whose stability is improved by the use of a capsuloperiosteal flap without using any internal fixation material is an effective alternative for the treatment of patients with moderate degrees of hallux valgus without metatarsophalangeal joint degeneration.

Key words: Hallux valgus/physiopathology/surgery; metatarsal bones/surgery; metatarsophalangeal joint; osteotomy/methods.

Hallux valgus is an orthopedic disorder seen particularly in females.^[1, 2] Metatarsus primus varus, non-physiological shoes, pes planus, increased obliquity of the metatarsocuneiform joint, longer-than-normal first row, incompliance in the metatarsophalangeal articular faces, and increased valgus of the articular face of the first metatarsal head have been held responsible in the development of the disorder. Although hallux valgus looks simple, the algorithm of the surgical therapy is complex, and is controversial even today. About 130 surgical techniques have been defined till today. The purpose in surgical treatment is to eliminate the deformity without creating restriction in the range of motion and to remove pain. Functional biomechanics of the front part of the foot must be preserved when applying the surgical procedure.^[3] Distal chevron osteotomy is a procedure widely used in cases of mild and medium hallux valgus cases.^[4] Chevron osteotomy gives satisfactory results in general in cases with a hallux valgus angle of less than 40 degrees and an intermetatarsal angle of less than 15 degrees.^[2, 5] The purpose of this study is to show that modified chevron procedure with enhanced stabilization using capsuloperiosteal flaps and no internal fixing material is a successful option of treatment in clinically and radiologically moderate hallux valgus cases without degenerative changes in their metatarsophalangeal joints.

Patients and method

Modified chevron osteotomy was applied in the 1999-2004 period to the 27 feet of 25 young adult patients with medium level hallux valgus. Fourteen (56%) of the patients were females, and 11 (44%) were males. Painful deformity was present in both feet of 2 patients, and in one foot of 23 patients, all of which required surgery. Average age of the patients was found to be 30.4 (19-43 years), and mean follow-up period was 22 months (8-67 mons). Primary indication for surgery was the presence of pain. Surgery with cosmetic purposes was not applied. Patients with ages between 18 and 50 years of age, intermetatarsal angle less than 17 degrees and hallux valgus angle less than 40 degrees and with no osteoarthritic changes were preferred in the selection of patients. Complaints of the patients at presentation were pain, difficulties in wearing shoes, sensitivity on bunion, tingling in the dorsomedial of

first toe, and cosmetic complaints. Hallux valgus was present in at least one close relative of all the patients except one. Range of motion in the first metatarsophalangeal joint, whether or not motion was present with pain, existence of deformity in the second toe, existence of callosities, sensitivity on bunion, and hypoesthesia were sought in the physical examination of the patients. Subjective and objective evaluation systems of Bonney and Mac Nab were used in the clinical evaluation.^[6]

All the patients were evaluated in the preoperative period, in the early postoperative period and throughout the follow-up period with 6-week intervals radiologically with anteroposterior and lateral x-rays taken when standing on the foot according to the measurements of hallux valgus angle, distal metatarsal joint angle (DMAA) and intermetatarsal angles, and localization of tibial sesamoids and compliance of the metatarsophalangeal joint and were compared statistically. Results were statistically evaluated according to student t-test. Measurements were performed according to the criteria of American Orthopedic Foot and Ankle Society.^[7] The preoperative mean hallux valgus angle was found to be 31.4° (23-40°), the mean interphalangeal angle 14.2° (11-17°), and mean DMAA 13.1° (6-17°). Subluxation in the first metatarsophalangeal joint was found postoperatively in six feet out of 27. In the evaluation of sesamoid bones in the x-rays taken preoperatively, it was noted that there was subluxation/luxation of sesamoids of Grade 0 in two feet, Grade 1 in 12 feet, Grade 2 in 11 feet, and Grade 3 in two feet. Width of the feet of the patients was 9.6 (8-11.6) cm in the average.

Patients were grouped according to their clinical complaints and radiological findings as normal-mild, moderate, and severe hallux valgus and moderate group was included in the study. Spinal or epidural regional anesthesia was used for all the patients. Tourniquet was applied to none of the patients. The mean operation period was 47 minutes (35-67 min.). All the patients were operated with the same method, with modified chevron osteotomy, and without using any internal fixation materials. Plication of the capsuloperiosteal flap was used for stabilization in addition to the geometric stability of the osteotomy. Circular walking cast was applied supported in-between the first and second toes to all

the patients till the healing of the soft tissue for 3 weeks. Patients were ambulated with crutches in the first postoperative day. They were allowed walking after the removal of the cast by giving their weight to their heels and by placing a spool between the first and second fingers. They were allowed to walk by giving full weight after healing was seen radiologically. The second operation for the patients those operated on both feet was performed three months later than the first operation.

Surgical technique

Following a fully medial curvilinear skin incision in the midline on the first metatarsophalangeal joint, capsuloperiosteal incision in the shape of "Y" with long arm in the proximal was made under spinal or epidural regional anesthesia. Capsuloperiosteal flap was lifted up with sharp dissection to expose the metatarsophalangeal joint. With the purpose of maintaining the blood circulation of the metatarsal head, separation of the periosteum and capsule was performed in restricted fashion. After making the excision of the bunion with bone saw, osteotomy was performed in "V" shape with an angle of 60 degrees, starting from the center of the metatarsal head and extending to dorsal and plantar directions towards proximal. After lateralizing the distal portion of the metatarsal head with a thickness of one-thirds of the metatarsal head at the most, the medial prominence of the proximal portion was re-excised with the saw. While holding the big toe in the required position of about 5° of valgus, the V-shaped distal capsuloperiosteal flap was fixed onto the metatarsal body using thick absorbable suture materials led through the hole opened from medial to lateral and dorsal to plantar. The remaining capsuloperiosteal structure was plicated onto the main flap with multiple sutures so as to create tension exceeding that in plantar, with the purpose of ensuring the reduction of the sesamoid. Layers were closed after control of the stabilization of the osteotomy, support was provided between the big and second toes, and short circular leg cast was applied.

Results

All the patients included in the study were radiologically and clinically evaluated in the preoperative period, in the early postoperative period, in the 6th postoperative week, and then every 6 weeks. Results were statistically evaluated according to student t-

test. The mean hallux valgus angle that was 31.4° (23-40°) preoperatively was found to be 12.8° (4-22°) postoperatively ($r=0.884$, $p<0.001$). An improvement of hallux valgus angle of 18.6° (%59.2) in the average was ensured. The average interphalangeal angle that was 14.2° (11-17°) preoperatively was found to be 9.6° (7-14°) preoperatively ($r=0.773$, $p<0.001$). An improvement of the interphalangeal angle of 4.6°lik (%32.4) in the average was ensured. DMAA that was 13.1°(6-17°) in the average preoperatively was found to be 11.5°(5-15°) in the average postoperatively ($r=0.942$, $p<0.001$). An improvement of 1.6° (%12.2) of DMAA was ensured in the average.

While there was subluxation in six feet out of 27 in the first metatarsophalangeal joint according to the x-rays taken preoperatively, the first metatarsophalangeal joint was compliant in all the feet according to the radiological controls in early postoperative period and in the sixth week following healing. While there was sesamoid subluxation/luxation of Grade 0 in two feet, Grade 1 in 12 feet, Grade 2 in 11 feet, and Grade 3 in 2 feet in preoperative x-rays, Grade 0 was seen in 14 feet in postoperative radiological controls, Grade 1 in 10, and Grade 2 in 3 feet. Grade 3 sesamoid luxation was seen in none of the feet postoperatively. No modification of the technique was performed during the operation according to the degree of sesamoid subluxation. Healing was observed in all the cases in the radiological controls in the sixth week. (Figures. 1a, 1b, 2a, 2b, and 2c)

In the radiological controls performed in the early postoperative period and in the sixth week following healing, no changes in radiological values were seen in 26 feet other than one foot. A shift of 2mm was seen in the osteotomy line in one foot. In this patient, the hallux valgus angle that was 32° preoperatively was found to be 12° in the early postoperative period and 16° in the post-healing period, the intermetatarsal angle that was 17° in the preoperative period was found to be 12° in the early postoperative period and 14° in the post-healing period, and DMAA that was 13° was found to be 11° in the early postoperative period and 13° in the post-healing period. No significant differences were found between the radiological values found in the early postoperative and post-healing periods.



Figure 1. Preoperative (a) and postoperative (b) radiographs of the patient.

Pain that was present in all the patients in the preoperative period had retreated completely in the postoperative period in 24 feet of the 22 patients (85.2%). In three patients (14.8%) however, there was pain upon walking for a long time. None of the

patients had difficulties when wearing shoes in the postoperative controls. Except for one patient that a slight shift was found in the osteotomy line in controls and that complained of the cosmetic appearance of the foot, satisfactory results were obtained in

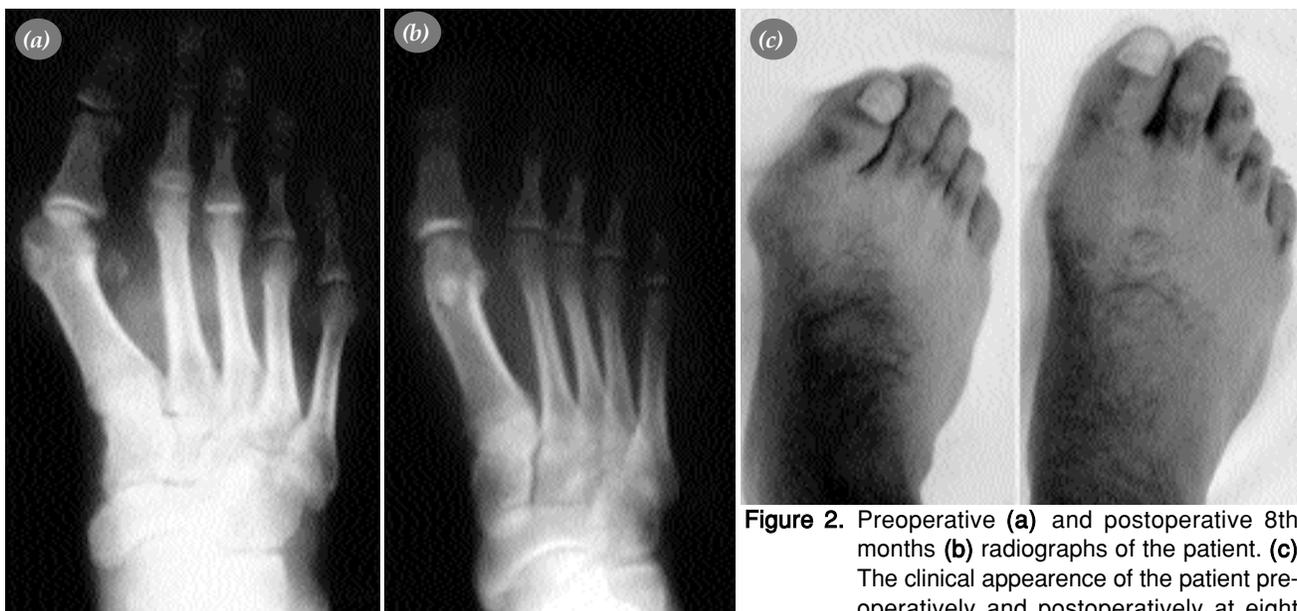


Figure 2. Preoperative (a) and postoperative 8th months (b) radiographs of the patient. (c) The clinical appearance of the patient preoperatively and postoperatively at eight months.

all the patients. Complaints of sensitivity on the bunion of 22 patients were relieved of this complaint after the operation. It was noted that the average foot width measured in the level of first and fifth metatarsophalangeal joints was reduced to 9.6 (8-11.6) cm in the preoperative period to 8.5 (7.3-11.2) cm in the postoperative period ($r=0.933$, $p<0.001$). An average reducing of 1.1 cm (11.5%) of the foot width was ensured.

The range of motion in the first metatarsophalangeal joint that was 66.2° ($52-73^\circ$) preoperatively was found to be 61.4° ($41-69^\circ$) ($p<0.01$) in the last controls. A loss in the range of motion was seen amounting to 4.8° (7.2%) in the average. Returning to normal activity and work was possible in the sixth week in 23 patients, and in the seventh week in two patients.

Pre- and postoperative values of our patients are given in Table 1. Complications like recurrence of the deformity, hallux varus (over-correction), nonunion, or delayed-union were seen in none of the patients. In one patient that was operated from one foot, 2mm-shifting to the medial of the osteotomy line was seen; however, healing and a satisfactory result were obtained in this patient as compared to the previous condition. Permanent hypoesthesia was seen in one patient in the incision site postoperatively (3.7%), and joint stiffness in the first metatarsophalangeal joint was present in one (3.7%) patient that did not bother the patient much. In another patient (3.7%), a superficial infection was seen in the early postoperative period that retreated with empirical antibiotic therapy. No osteoarthritis changes of the metatarsophalangeal or avascular necrosis in the metatarsal head joint were seen in the last control x-rays of the patients. Bone density of the metatarsal head was slightly increased in two patients (7.4%). According to Bonney and MacNab subjective scores, 7 feet were scored as very good (26%), 17 feet as good (63%), and 3 feet were scored as moderate (11%); and according to objective scores, 14 feet were scored as very good (52%), 11 as good (40.5%), one foot moderate (3.7%), and one as poor (3.7%). Nineteen (76%) patients were very satisfied with their results, and 6 were satisfied (24%).

Discussion

Hallux valgus is a complex deformity of the foot. It not solely the lateral deviation of the big toe, but it is a clinical picture with deformities of the bones of the first row and other toes accompanying the clinical table. Pronation of the big toe is frequently accompanies the picture in addition to the lateral deviation of the big toes and varus of the first metatarsal bone.^[2]

Metatarsus primus varus, non-physiological shoes, pes planus, hereditary increased obliquity of the metatarsocuneiform joint, longer-than-normal bones of the first row, incompliance of the metatarsophalangeal articular faces, increased valgus of the articular face of the first metatarsal head are frequently held responsible in the etiology of this disease.

In the patients, intermetatarsal angle between the first and second fingers are frequently found over eight degrees, which is the upper limit of the normal, and the first metatarsophalangeal angle is frequently found over 15 degrees, which is the upper limit of the normal.^[2]

Clinical complaints of the patients must be taken into consideration when determining the surgical indication, as well as the radiological criteria. Whatever method is preferred, the purpose must be the permanent correction of the deformity and removal of the pain while preserving the range of motion, without creating a restriction in the range of motion. Easiness of the technique and familiarity of the surgeon are among the important factors that affect the success.^[3,8]

Selection of the patients has great importance in the surgical treatment of hallux valgus, whatever surgical procedure is applied. The first criteria in the interventions on the front part of the foot must be to treat cooperating and well-informed patients that have thoroughly understood the possible risks and results of the surgery.^[5] Surgical treatment of hallux valgus is developing rapidly in the recent years. Methods of surgical treatment can be grossly classified as soft tissue procedures, proximal metatarsal osteotomies, fusion of the joint, resection arthroplasty, and prostheses.^[2] The number of surgical procedures ranging from osteotomies performed on the

first metatarsal bone or proximal phalanx, to interventions on the soft tissue around the first metatarsophalangeal joint, to osteotomies on the basis of the metatarsal bone exceeds 130. The most suitable method must be selected according to the patients after analyzing the deformities and the clinical picture.^[1,2,4]

Among all the numerous surgical techniques defined, treatment of hallux valgus with chevron procedure is one method widely accepted with reasons like ease of application, shortness of the operation time, metaphyseal localization in the spongy region, stable osteotomy geometry in mechanical sense, provision of a wide contact area, and lack of postoperative pain. With the coming together of all these factors, a rapid healing, possibility of giving weight and ambulation in the early period, and low rates of avascular necrosis and non-healing, ensure a high rate of success.^[2,9,10,11] Together with these advantages, application of chevron osteotomy is not recommended for hallux valgus angles exceeding 40 degrees, intermetatarsal angle exceeding 20 degrees, and presence of osteoarthritis changes in the metatarsophalangeal joint.^[2,10,12,13]

Chevron osteotomy, described first by Corless, and then Johnson, is a method described for the purpose of correction of the angling of the big toe in cases of moderate hallux valgus with no degenerative changes in the metatarsophalangeal joint.^[14,15] Many modifications of this procedure were described, like using screws for fixation and removing the minor disadvantages like the risk of avascular necrosis of the metaphyseal head or over-correction. When osteotomy line is performed on just at the center of the metatarsal head, a better stability and more bone contact area can be obtained with less stiffness of the joint and better correction.^[2]

Fixation is a controversial topic in chevron osteotomy. Besides authors suggesting the fixation of the osteotomy line with a K-wire to increase stability^[10], many others suggest making use of the stable geometric structure of the osteotomy to avoid complications like infection at the basis of the screw of internal fixation, irritation of the soft tissues, migration of the wire, pain around the wire, feeling the screw head under the skin and the discomfort because of this feeling, and stress-shielding effect on the bone, and to apply cast after the operation, like

the method we have used.^[1,2,16,17,18,19] Again some other authors have let the foot free without applying any of the methods mentioned; however, high rates of reduction loss are reported in these studies.^[20] Opinions favoring the avoiding internal fixation are gaining weight in the reports of the recent years.^[1,2,16,17,18,19] Trnka and colleagues did not use screw fixation in their patients they treated with chevron osteotomy and obtained successful results.^[1] The wanted early mobilization and possibility of giving weight in the early period are ensured after orthopedic interventions with rigid internal fixation. However, besides the complications of the internal fixation mentioned above, materials like bioabsorbable implants, K-wire, mini Herbert screw, and Stofella implant ensuring dynamic compression used for fixation cause additional increases of cost. Particularly in cases that internal fixation cannot be made with economic reasons, we believe that our method can be a good alternative.

Although it has been shown that applying a cast reduces the loss of reduction, cast left in place for long periods will impair the comfort of the patient, and will cause stiffness in the metatarsophalangeal joint.^[1,12,17] Joint stiffness is reported in the literature with ratios ranging between 4.8 % and 42%.^[21,22] We also applied cast to our patients in the postoperative period, and limited the period of cast with three weeks till the healing of the soft tissue, and ensured the possibility of an early rehabilitation. We did not encounter joint stiffness and loss of reduction except one case (6%).

In the series of Klosck et al., the time of returning to work was found to be seven weeks in the average.^[20] In our series however, two patients returned to work within seven weeks, and others were able to return to work in the sixth week.

Securely fixing the distal capsular flap to the proximal bone fragment ensures the stabilization of the osteotomized fragments, and also speeds up the healing of the fragments thanks to the compression thus created. Allowing the patients to walk on their heels cause contractions of the muscles around the big toe, and this in turn contributes to the compression of the fragments and speeds up the healing.^[17] Healing was observed in all our patients within the sixth week. Rate of correction loss and recurrence is reported in the literature about 10%.^[17,20,21] In the pre-

sent series however, loss of reduction was seen in one (6%) patient, and recurrence of the deformity was seen in none. Complications like avascular necrosis, delayed-union, non-union, and arthrosis of the metatarsophalangeal joint were not seen.

Lateral capsular release and release of adductors are controversial for chevron osteotomy applications because of the risk of creating osteonecrosis in the metatarsal head. Meier et al. oppose lateral loosening, and report the ratio of osteonecrosis in the metatarsal head as 40%.^[23] Resch in their scintigraphic studies^[11], and Pochatka, Peterson and Trnka in their large series, report that lateral release does not impair the circulation of the metatarsal head, provided that it is performed according to the technique.^[18,24] Trnka et al. recommend the lateral release with an intra-articular approach, with the purpose of avoiding the vascular structures.^[1]

Adductor or lateral release was applied to none of the patients in this series. The required correction amount was achieved easily by fixing the medial capsuloperiosteal flap to the proximal, and there was no need for further soft tissue dissection.

We believe that more correction, better stabilization and compression can be ensured with the securely fixing of the capsuloperiosteal flap to the metatarsal body, the possibility of early mobilization speeds up healing by way of compression, and avoiding the use of internal fixation materials and application of cast for a short period minimizes the risk of complications. According to our clinic and radiological results, we believe that chevron procedure with enhanced stability by capsuloperiosteal flap without using internal fixation materials is a successful treatment option in moderate hallux valgus cases without degenerative changes in their metatarsophalangeal joints.

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