

THE "CHECKMARK" PROCEDURE, A LESSER METATARSAL OSTEOTOMY: A Surgical Technique for the Correction of Transverse Plane Lesser Metatarsophalangeal Joint Deformities.

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Lesser metatarsophalangeal joint surgery and its indication for the treatment of metatarsalgia and digital contractures are well documented in the literature. The literature is replete with works that focus on the pathology associated with sagittal plane deformities, and reports of pathologic dislocation in the second toe date back to the early Twentieth Century. In 1937 Branch wrote about the pathologic dislocation of the second metatarsophalangeal joint and hypothesized that one of three occurrences could be implicated in this deformity. This includes an excessively long second metatarsal, the dorso-proximal force of the dorsal interossei muscles, and an aberrant innervation of these interossei muscles.¹ Less attention has been directed to the isolated transverse plane deformity of the lesser metatarsophalangeal joint and its surgical correction. However, in the last 20 years, interest in this deformity, its etiology and its treatment has increased. In 1989 Johnson and Price emphasized that such deformities were the result of midfoot transverse plain abnormalities.² Collins surmised that hallux valgus, rheumatoid arthritis, surgical error, overriding, underriding digits, trauma and amputations of adjacent digits could cause the deformity.³ Age and gender have been associated with these deformities as well.⁴ Coughlin implicated capsular imbalances, particularly in the plantar plate and aponeurosis, as the most likely cause. He added that joint effusion secondary to trauma and inflammatory processes, long 2nd metatarsals, rheumatoid arthritis, nonspecific synovitis, low collagen syndromes and idiopathic conditions could cause these deformities.⁵ More recently, authors such as Ford et al. have indicated that instability between the metatarsal head and plantar plate was a key contributor to subluxation at the metatarsophalangeal joint.⁶ Deland in 1992 emphasized that due to the stronger attachment of the plantar plate to the proximal phalanx, the subluxation of

the metatarsophalangeal joint is associated with malposition of the plate in relation to the metatarsal head.^{6,7}

As with the theories of the etiology of the lesser metatarsophalangeal joint transverse plane deformity, the treatment of this pathology has garnered increased attention in recent years. Suggested conservative therapy includes modalities such as strapping, padding, taping and accommodative extra-depth shoe wear. However, this type treatment may only provide temporary symptom relief in early, mild transverse plane deformities.^{5,9} Additionally, oral and injectable anti-inflammatory therapy has been recommended. However, the long term utilization of injectable anti-inflammatory agents is controversial.^{8,9} Repetitive use of the injections may actually exacerbate the dislocation deformity according to Yu.⁹ A number of surgical approaches to this difficult deformity have been sited in the literature. Collins studied 15 patients in which he utilized a soft tissue balancing procedure with extensor digitorum longus relocation. He reported no recurrences with a mean 2-year follow-up.³ In 1989 Johnson presented success with a limited ten-month follow-up in two cases in which he performed a medial transpositional distal metaphyseal osteotomy, capsular balancing and relocation of the FDL tendon beneath the metatarsal head.² Bogy, in 1992, reported success in 7 patients after applying a distal laterally-based wedge metaphyseal osteotomy to correct the medially-deviated 2nd lesser metatarsophalangeal joint. Six of the 7 patients were interviewed in this 3-year follow-up. Three were very satisfied; three were satisfied; and all would repeat the procedure.⁴ Phillips reported short term radiographic results of two cases in which a transpositional distal metaphyseal osteotomy was utilized.¹⁰ Conklin and Smith showed satisfactory results in 12 of 17 patients in which they utilized the Mini-Keller procedure without reattachment of the flexor digitorum longus to address

lesser metatarsophalangeal joint transverse plane deformities.¹¹ Goforth reported problems with purchase in 7 patients who had undergone through and through distal metaphyseal osteotomies for the correction of this problem in the 2nd metatarsophalangeal joint.¹² Berens reported three occurrences of malalignment in a group of 25 patients with 2nd metatarsophalangeal transverse plane deformities with whom he applied a distal rotational osteotomy procedure.¹³ In 1998 Miller described the use diaphyseal “Z” osteotomy and a cylindrical shortening osteotomy in two cases of the lesser metatarsophalangeal joint deformity.¹⁴

METHOD

The Operative Report logs of Alan Barth, DPM from 1997 to 2002 were reviewed by MLH. From this review a list of consecutive patients who had transverse lesser metatarsophalangeal joint deformities and whom had been treated with the “Checkmark” distal metatarsal osteotomy procedure was compiled. A total of 12 patients had this procedure during that five year period. These patients were contacted and asked to participate in a retrospective study of the procedure. The patients were invited to sign a consent, complete a questionnaire, undergo a clinical and radiographic examination. Each patient was assessed based on a modified American Orthopedic Foot and Ankle Society (AOFAS) Lesser Metatarsophalangeal Interphalangeal Scale (LMIS).¹⁵ MLH reviewed all preoperative and postoperative radiographs, patient charts and operative reports. Subjective and objective data was compiled and analyzed from this information. Patient age and gender of patient, systemic diseases, preoperative symptoms, fixation used and objective exam findings were recorded. Radiographic measurements included preoperative and postoperative IM angles, lesser digit adductus or abductus angles, metatarsal protrusion distance, and Seiberg’s indices. The investigator also included documentation of ancillary procedures completed with the procedure, repeat procedures and complications.

PROCEDURE

All patients received 1g of Ancef preoperatively for internal fixation prophylaxis. Following intravenous sedation, local anesthesia was obtained in the surgical foot utilizing .5% Marcaine plain. A linear longitudinal incision made over the metatarsophalangeal joint. A dorsal transverse plane capsulotomy is performed. The periosteal and capsular attachments are reflected through a linear longitudinal incision. A .045 k-wire is placed on the deviation side of the

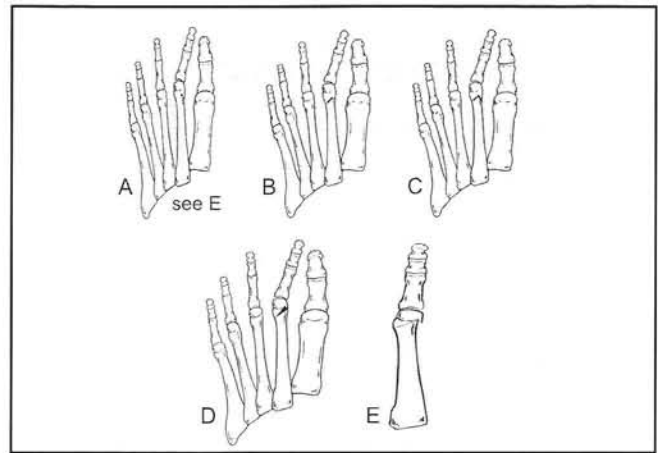


Figure 1.

metatarsal head at the metaphyseal-diaphyseal junction in a dorsal to plantar direction as an axis guide.(Figure 1A). A Reese osteotomy guide is placed over the k-wire. The osteotomy is created with three osteotomy arms. The first osteotomy arm is performed away from the guide and the deformity at a five degree angle towards the proximal end to the metatarsal. This osteotomy arm is created without interrupting the cortex contra lateral to the deformity. (Figure 1B) Next, the guide is rotated to create a second osteotomy arm perpendicular to the first arm. This second osteotomy arm crosses the cortex ipsilateral to the deformity. (Figure 1C) The third arm is made to connect the proximal ends of the first two osteotomies. This creates a wedge of bone which is removed from the metatarsal.(Figure 1D) The head is then rotated on the hinge in the direction of the deformity and relocated over the plantar plate. The metatarsal is also shortened. (Figure 1E)

A number of devices may then be utilized to fix the osteotomy, including mini-fragment screws, K-wires or compression staples as demonstrated in figure 2A-D. Postoperatively the patient is placed in a below knee non-weight bearing cast. The patient is given crutches and remains NWB in the cast for four to six weeks.

STUDY RESULTS

A review of Dr. Barth’s surgical records at the Kaiser Travelodge Surgery Center from 1997 to 2002 indicated that the Dr. Barth had performed this procedure for 12 patients. Three of the original patients were lost to follow-up. Two of these patients had moved without new contact numbers and could not be reached. The third patient denied knowledge of having the surgery in spite of radiographic confirmation of the procedure. Therefore, she was not included in the study. Consequently, nine of the

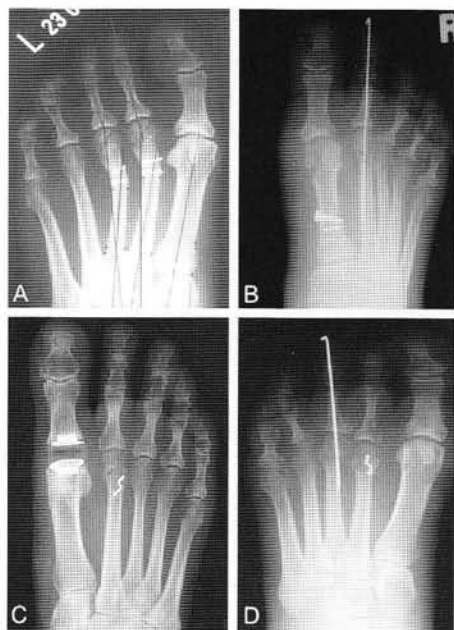


Figure 2.



Figure 3.

Table 1

Patient No.	1	2	3	4	5	6	7	8
Preop Pain	9	1	8	10	9	7	8	9
Postop Pain	0	3	0	6	4	2	3	0
Pain	Mod, daily	Mild, Occ	Mod, daily	Mod, daily	Mod, daily	Mod, daily	Mod, daily	Constant, Sev
Limits D A	Yes	No	Yes	No	No	Yes	Yes	Yes
Shoe Wear	Dress	No	Closed	Dress	No	Closed	Closed	Heels
Stiffness	Yes, severe	Yes	No	No	Yes, very sev	Yes, very sev	No	No
Calluses	Yes, ball foot	Yes 3rd PIPJ	Yes ball	Yes ball	Yes	Yes sub2345	Yes 2nd PIPJ	No
Pain	None	Mod, daily	Mild, occ	Mild, occ	Mod, occ	Mild, occ*	Mild, occ	Non
Limits D A	Yes	Yes	No	No	No	No*	No	No
Shoe Wear	Dres	No	No	Dress	No	Closed	No*	No
Stiffness	No	Yes, Very severe	No	Yes	Yes	Yes, not very*	No	Yes, not very
Calluses	Yes, ball foot	No	No*	No*	No*	No*	No*	No
Satisfaction with Motion	Somewhat	Yes	Yes	Yes	No	Yes	Yes	Yes
Activity	Dance-acting	Treadmill	Walks	Walk	Swimming	Walks	No recreation	Cycling
Complications	0	5yr recovery	0	?	0	0	0	0
Additional Sx	0	0	0	0	0	0	0	0
Pleased c Appearance	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Swelling	no	No	No	No	No	Yes	Yes	No
Postop PT	no	No	No	No	No	No	No	Yes
CC resolved by Surgery	Very Strongly Agree	Strongly Agree	Very Strong	Strongly Agree	Very Strongly Agree	Agree	Very Strongly Agree	Very Strongly Agree
Would you recommend Sx	Recommend	Pleased, not Recommend	Highly Recommend	Recommend	Recommend	Recommend	Recommend	Recommend
MLMIS	65	64	88	68	85	70	90	85

Table 2

Patient No.	1	2	3	4	5	6	7	8	9	Mean
Age/Gender	54m	50f	65f	47f	53m	70f	47f	50f	54f	440(55)
	72	72	36	28	25	9	8	23	20	32.4mo
Fixation and ancillary procedure	2nd/2x2.0 screws PIPJ AD c .045 Austin c .062	1.5mm screws PIPJ AD c .045	1x .062 5th 2.0mm Synthes Screw	2,3,045 Kwire PIPJ ADc .045 K-wire Distal 1st Met Osteotomy	2 .062 3,4 .035 2nd PIPJ AD Cheilec- tomy 1st Tailor Bun Ost 5	2,3,4 cross kwire .035 Austin c cross .062	2nd k-wire Lapidus c screw and k-wire	2nd .062 k-wire PIPJ AD	2nd & 3rd k-wire .062 Tailors 2.0mm Screw	
Systemic Diseases	Osteo- arthritis	No PMH	No PMH	No PMH	HTN, GERD	HTN, Depression	No PMH	Osteo- arthritis	No PMH	
IM Angle PO	13	6	12	10	10	6	25	14	6	
PO	12	8	8	0	6	8	14	14	2	
Met Petrusion Distance	-3	-5	-3	+1	+4	-3	+3	+4	+4	
	-4	-3	-1	-1	+7	-3	+2	+8	+9	
Seiberg's Index	+2	No lateral	+2	No lateral	+3	No lateral	No Lateral	No Lateral	No Lateral	
			0		+1	0	0	+1	+2	
Abduction/Adduction	12 add	32abd 45abd	2nd 23add 3rd 16add	2nd40abd 3rd40abd	2nd 1add 3rd 9add 4th 0	36 add 25 add 13 add	16 add	18abb	15add 13add	
	6 add	14abd 8abd	20 abd 20 abd	22abd 34abd	4abd 2abd 2abd	14 add 12 add 0	12 abd	0	16 abd 2 abd	
Metatarsus Adductus Angle	12	16	6	26	16	14	19	6	24	
	15	6	4	24	20	16	15	10	27	
Sesamiod 2nd Met Distance	33	26	30	One Sesamoid	42	35	35	28	29	
	32	27	27		42	34	31	28	32	

twelve patients were included in the study. The average age at the time of surgery was 55. There were 7 female patients and 2 male patients. The mean follow-up time was 32.4 months, ranging of 8 to 72 months. The mean Modified Lesser Metatarso- Interphalangeal Joint Score was 75.44. All but one patient would recommend the surgery. One patient would highly recommend the procedure. This patient was a 65 year old female who was interviewed at 36 months after the procedure. The one patient who would not recommend the procedure was concerned about the residual pain that she had for 5 years following the procedure. It was noted that her preoperative pain score was 1

and her postoperative pain score was a 3. Additionally, this patient had surgery on both the 2nd and 3rd metatarsals. Her preoperative and postoperative radiographs are shown in figure 3A and 3B respectively.

The objective results indicated that Checkmark was successful in reducing pain and the transverse plane deformity of lesser digits. The mean visual analog scale pain score was reduced from 7.625 preoperatively to 2.50 postoperatively. This change was statically significant with a *P* value of 0.0008. All patients in the study had a reduction in the transverse plane deformity. The mean change in abduction or adduction was 19.1 degrees. This is 1.6 times

the average normal value of lesser digit adduction and abduction described by Coughlin⁵ which is 12 degrees from rectus. Of the four patients that had isolated 2nd metatarsal Checkmark osteotomies without concomitant 1st Metatarsal osteotomy procedures, all showed significant shortening of the metatarsal on which the surgery was performed. There was a mean increase of the metatarsal protrusion distance of 3.25mm. See Tables 1 and 2.

DISCUSSION

The results of this study are encouraging. The study does, however, have some limitations. The patient sample size would have to be much greater to increase the power of the study. Additionally, as a retrospective study it has the inherent weakness of limited preoperative evaluation. The study would greatly be enhanced by the analysis of objective data compiled by preoperative examinations. While this study is limited by its small subject number, the results, both subjective and objective, reflect very positively on the efficacy of utilizing the "Checkmark" metatarsal osteotomy for the correction of lesser metatarsophalangeal joint deformities.

CONCLUSION

Based on our retrospective study, the "Checkmark" Metatarsal Osteotomy appears to be a viable surgical option for the correction of the lesser metatarsophalangeal joint transverse plane deformity and the resolution of chief concerns that often persist with this deformity. Certainly, a larger study is required to validate the efficacy of this procedure.

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