Single Center Retrospective Comparative Analysis of a Novel Triplanar Correction System and Other Surgical Methods for Treatment of Hallux Abductovalgus Deformity

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Purpose and Literature Review

First tarsometatarsal joint (TMTJ) arthrodesis fixation constructs for hallux abductovalgus (HAV) correction have continued to evolve over time to improve patient outcomes and minimize recovery time. Locking plate technology has become more common as it allows for earlier weight-bearing and improved union rates (1,2,3,4). Tri-planar correction has become a hot button topic as a key consideration in HAV management, and resulted in the birth of novel surgical system which utilizes orthogonally placed, low-profile locking plates for bi-planar stabilization for fixation (5). Complications remain, however, as the hardware is itself may become symptomatic and require removal, ranging from 3% to 8% for locking plate constructs as reported in current literature (6,7). The purpose of the present study was to radiographically quantify correction using various fixation methods, in comparison to this biplanar locking plate construct. This study is also intended to determine the incidence of hardware complications to the first TMTJ after arthrodesis for HAV correction.

Methods

A retrospective review was performed on 31 patients (34 feet) to evaluate the efficacy of correction between a biplanar twin-locking plate construct (Group 1) and various other forms of 1st TMTJ arthrodesis (Group 2) for primary management of HAV and first ray hypermobility.

Radiographs were compared pre-operatively and at regular intervals to evaluate correction of HAV deformity based on IMA, HAA, TSP, and union rate (Table 1-4). AOFAS and LEFS scores were also collected both pre- and post-operatively to assess clinical improvement (Table 5). Complications were also recorded based on hardware used and return to the OR (Table 6).

Results

	Pre-Op IMA	Post-Op IMA	Mean IMA Correction	p-value
Group 1 (n=19)	16.62 ± 5.15	7.54 ±3.36	9.08	<0.0001
Group 2 (n=15)	14.92 ± 3.85	10.03± 4.21	4.89	0.0002

Table 1. Intermetatarsal Angle (IMA) pre-op, post-op and mean correction from pre- to post-op (in degrees), means reported with standard deviations.

	Pre-Op HAA	Post-Op HAA	Mean HAA Correction	p-value
Group 1 (n=19)	37.73 ± 8.20	21.15 ±6.76	16.58	<0.0001
Group 2 (n=15)	34.73 ± 7.38	24.14± 8.08	10.59	<0.0001

Table 2. Hallux Abductus Angle (IMA) pre-op, post-op and mean correction from pre- to post-op (in degrees), means reported with standard deviations.

	Pre-Op TSP	Post- Op TSP	Delta TSP	p-value
Group 1 (n=19)	5.47 ± 2.06	1.95 +1.13	3.53	<0.0001
Group 2 (n=15)	5.00 ± 1.81	3.20 ± 1.97	1.8	0.02

Table 3. Tibial Sesamoid Position (TSP) pre-op, post-op and mean correction from pre- to post-op, means reported with standard deviations

	% Union at 8 weeks (n)	% Union at 10 weeks (n)	% Union at Final Follow Up (n)	Mean Time to Union (weeks)	Mean Length of Follow Up (months)
Group 1	63.15% (12)	68.42% (13)	84.21% (16)	8.93 ± 5.37	10.58 ± 7.71
Group 2	66.67% (10)	86.67% (13)	100% (15)	8.0 ± 2.84	6.73 ± 4.01

Table 4. Time to union, as evidence by number of patients who had achieved union at 3 sequential intervals for Group 1 (n=19) and Group 2 (n=15). Mean time to union and length of follow up reported with standard deviation.

	Pre-Operative	8 weeks	p-value	12 weeks	p-value	Final Follow Up	p-value	Overall Improvement
Group 1								
AOFAS	51.56	68.50	0.003	68.33	.002	76.00	.001	24.44
LEFS (%)	59.17%	60.04	0.45	64.58%	0.172	82.66%	.019	23.50%
Group 2								
AOFAS	50.66	69.00	.09	87.33	.02	-	-	36.66
LEFS (%)	50.33%	54.58%	.384	72.92%	.11	-	-	22.58%

Table 5. Descriptive statistics of mean AOFAS (scale 0-100) and LEFS (Numerical values are reported on a range of 0-80 with the total divided by 80 to obtain percentage). Mean values at pre-determined follow up intervals with significance reported (p value), as reported by analysis of variance (ANOVA) models.

	Complication	Hardware related (y/n)	Return to OR
Group 1			
	Plate elevation, EHL entrapment	Y	Dorsal plate removal
	Medial screw back out	Y	Medial screw removal
	Dorsal plate elevation	Y	No
	Medial screw back out	Y	No
	Adhesive reaction	N	No
	Medial plate elevation, non-union	Y	Total construct revision
	Dorsal plate elevation, non-union	Y	Total construct removal
	Plate elevation, skin irritation	Y	Total construct removal
	Medial screw back out	Y	No
Group 2			
	Initial hardware failure, HAV recurrence	Y	N
	Metatarsal Elevatus	N	N
	HAV Recurrence	N	N

Table 6: Post-operative complications for Group 1 (n=19) and Group 2 (n=15), listed by type of complication, hardware involvement and return to operating room.

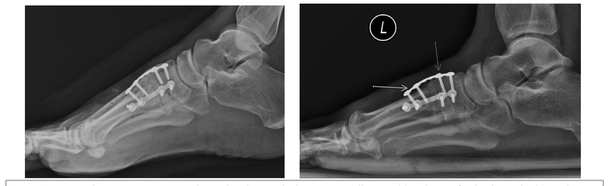

Figure 1: Immediate post-operative lateral radiograph depicting well seated hardware for biplanar locking plate construct (top). Post-operative lateral radiograph taken at 8 weeks. White arrow depicting dorsal plate elevation. Gray arrow depicting proximal dorsal locking screw failure (bottom).

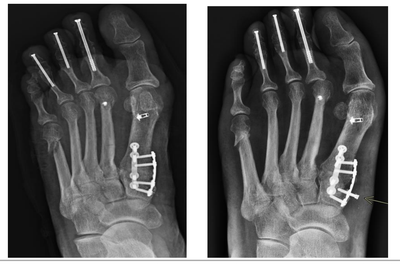

Figure 2: Immediate post-operative AP radiograph depicting triplanar HAV correction with well seated hardware for biplanar locking plate construct (left). Post-operative AP radiograph taken at 12 weeks. Medial locking screw failure and subsequent backing out, as shown by gray arrow (right).

Analysis & Discussion

Willeger et al., performed a systematic review of 29 publications which evaluated first TMTJ arthrodesis in management of HAV, and found an overall IMA correction of 9.12˚ for screw fixation, 9.75˚ for staple fixation and 12.41˚ for combined locking plate with screw fixation (8). The results of the present study demonstrate the ability to fully reduce three radiographic parameters of hallux valgus from preoperative levels throughout the postoperative time period based on radiographs taken at final follow up. We found a mean improvement in IMA, HAA, and TSP of 9.08°, 16.58°, and 3.53, respectively, for Group 1. Group 2 demonstrated a mean improvement in IMA, HAA, and TSP of 4.89°, 10.59°, and 1.8, respectively These results correlate with what has been previously reported for this procedure. Comparing the immediate postoperative and final follow up films, there was no loss of correction nor HAV recurrence at time of final follow-up. (Tables 1-3).

In terms of correction alone, this study seems to depict the biplanar locking plate fixation used in a modified first TMTJ arthrodesis as the more effective technique for management of HAV.

In the aforementioned study, Willeger et al., found non-union rates of 5.1% for screw fixation, 3.4% for staple fixation, 1.1% for locking plate fixation, and 8.1% for pin fixation (8). Similar results were found in a retrospective review of locking plate versus crossing screw fixation by Devries et al., which reported a non-union rate of 1.5% for locking plates and 10.6% for two or three crossing screws (3). Ray et al., reported a 4.0% (4/101) and 5.4% (2/37) non-union rate in two retrospective studies using a biplanar locking plate system, the method of fixation analyzed in Group 1 of this current review (9, 12). The current study revealed comparable rates of non-union in both cohort groups, with 10.53% and 0%, for Group 1 and 2 respectively. Of note, 68.4% of patients in Group 1 achieved union by week 10 postoperatively compared to 87% in Group 2. (Table 4).

The present study reported overall rates of postoperative complications related to hardware was 42.11% of Group 1, and 6.7% in Group 2. Overall, reoperation rate for Group 1 was 26.32%, requiring either partial or complete removal of hardware, which was significantly greater than what has been previously reported (8). (Table 6). Radiographs depicting hardware failures for Group 1 are shown in figures 1& 2.

Conclusion

The results of the current retrospective review lend credence to the powerful correction achieved by biplanar locking plate construct as part of a 3D HAV correction system, but raise questions to the quality of the hardware provided in the set, due to increased hardware complication rates and need for hardware removal. These subsequent procedures for removal not only increase potential risk for postoperative infection but also increase the financial burden on the patient and hospital.

Primary 1st TMTJ arthrodesis has proven to be an effective and reliable technique for the management of first ray hypermobility and severe HAV deformity, typically with high union rates and patient satisfaction. A newfound emphasis on frontal plane rotation of the first metatarsal and sesamoid complex has prompted the advent of the surgical systems to address deformity correction in all three planes. This review, in correlation to previous studies, reports effective tri-planar correction when utilizing this unique 1st TMTJ arthrodesis system. However, these findings also illuminate a possible drawback of this individual surgical system and the quality of the hardware itself. Future studies should be performed to determine the quality of the hardware included in the system along with an extensive cost analysis that evaluates implications of subsequent procedures for this specific system.

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