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Surgeons Experience and Consistency To Determine Surgical Procedures For Hallux Valgus

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ABSTRACT

There are various surgical techniques introduced for the treatment of hallux valgus deformity, however there is still considerable debate about the most appropriate one. This study analyses the consistency of interpretation of the deformity and data leading to a specific treatment indication among orthopaedic surgeons with different experience in the field.

Nine surgeons were divided into three groups according to their surgical experience, namely; group I, with over 10 years of experience; group II with 5–10 years of experience and group III with less than 5 years of experience. 50 feet with hallux valgus deformity were analysed twice in one month of time interval based on routine physical examination and angle measurements, and also some other parameters including joint congruence, evidence of arthrosis, prominence of bunion and grading of sesamoid.

Eventually more experienced surgeons paid less attention to measurements; however, their consistency for the surgical decision was higher. Conversely, less experienced surgeons paid more attention to the measured values however their consistency and matching rates for surgical decision were lower.

For more experienced surgeons, the measurable values were of less importance. Less experienced surgeons paid more attention to radiological parameters and their measurements were more consistent, however their uniformity in surgical decisions was lower compared to more experienced surgeons.

Key Words: Hallux valgus; surgery; hallux valgus angle; intermetatarsal angle; Fleiss Kappa index

Introduction

The term hallux valgus means outwards angulation of the first toe, though it is actually a complex deformity concerning various pathologies of the forefoot (1). In addition to conservative therapy, there are many surgical treatment methods described, that should correct all the components causing this deformity to preserve the biomechanical function of the forefoot (2). There are various surgical techniques introduced for the treatment of this problem, however considerable debate still exists about the most appropriate one (3). On the other hand, there is also a certain consensus for choosing the right surgical procedure with emphasis on the importance of a rough physical examination and radiologically observed features and measured angle values that show the severity of the deformity (4,5,6). This study analyses the consistency of interpretation of the deformity and data leading to a specific treatment indication among orthopaedic surgeons with different experience in the field.

Materials and Methods

After the approval by the institutional review board of the authors affiliated institutions, nine orthopaedic surgeons (1,2,3,4,5,6,7,8,9) with interest in hallux valgus surgery were grouped according to their surgical experience. Surgeons with more than 10 years of experience were in group I (1,2,3), surgeons with 5–10 years of experience were in group II (4,5,6) and surgeons with less than 5 years of experience were in group III (7,8,9). All surgeons were asked to evaluate 50

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feet with hallux valgus deformity. A medical history was obtained from the patients and all physical examination findings were recorded. Radiological examinations revealed standard dorsoplantar and lateral views as well as oblique lateral and axial sesamoid views of the whole foot. All radiographs were taken using a NS5000 X-ray machine (Siemens) at a source-to-image distance of 100 cm and were set to 50 kVp and 5 mAs with the patients at the standing weightbearing position. We retrieved the radiographic images using a picture archiving and communication system (PACS), and radiographic measurements were performed by using this PACS software. All the radiographic imaging and measuring systems were digitally set. The measurements and evaluations were performed only by the surgeons. One month after this first measurement, surgeons were asked to make a second measurement on the same feet, so two measurements were performed within one month interval.

We identified and assessed the following from the 20 radiographic parameters for evaluating the hallux valgus deformity from literature reviews; these parameters were selected according to the consensus meeting of these nine orthopaedic surgeons. During the consensus discussion, we excluded qualitative indices such as axial tibial sesamoid grade. Tibial sesamoid-second metatarsal distance and axial tibial sesamoid-second metatarsal distance were believed to be affected by differences in body size so they were also excluded. We also excluded other measurement methods as they had no sharp influence on the surgeons decision for any surgical intervention. These were namely interphalangeal angle, sesamoid rotation angle, first metatarsal cuneiform angle and metatarsus adductus angle. Instead, we used other parameters like joint congruency, evidence of arthrosis and presence or lack of a prominent bunion; all of that were questioned whether they were affecting the decision for surgical method. Joint congruency was determined on AP radiographs as the relation between the basis of the proximal phalangeal and first metatarsal head joint surfaces. The most inner and the most outer parts of the metatarsal and phalangeal joint surfaces were pointed. If the proximal phalangeal points were laterally migrated in relation to metatarsal head points it was considered as incongruent, whereas if the points were meeting each other it was considered as congruent joint. All radiographs were interpreted using an Osteoarthritis Atlas developed by Menz and colleagues (7,8), whereby the presence and size of osteophytes and the extent of joint space narrowing of the first metatarsophalangeal joint were assessed.

Finally, eight items were decided as a radiographic parameter at the consensus meeting, namely; hallux valgus angle (HVA), intermetatarsal angle (IMA), distal metatarsal articular angle (DMAA), proximal phalangeal articular angle (PPAA), joint congruency, lack or presence of arthrosis, existence of a prominent bunion and grading of sesamoid position (9,10).

For the treatment choice of surgeons, literature reviews were used as basic source. As treatment decision the most widely used techniques like proximal metatarsal osteotomy, midtarsal osteotomy, distal metatarsal osteotomy, Lapidus procedure, other arthrodesis procedures, soft tissue surgery and also some other methods were added to the questionnaire (11,12). Also, which of the above mentioned angle measurements and parameters affected their treatment choice was also questioned.

Statistical analysis was conducted by using IBM SPSS v. 22 (IBM SPSS; Turkey). The Kappa coefficient was used for categorical variables to maintain the consistency of the first and second measurement and the Fleiss Kappa coefficient was used to determine the consistency between the observers in the groups. Fleiss Kappa is considered a method to measure agreement between three or more raters. For quantitative data, the intraclass correlation coefficient (ICC) was used to determine intraobserver and interobserver consistency. Results with $p \leq 0.05$ were considered as significant.

Results

Although all groups were consistent for the HVA and IMA values, there was a still significant difference between the first and second values. In group I, there were significant differences between the first and second HVA and IMA measurements ($p \leq 0.01$). The highest matching rates for the HVA and IMA were 90.4% and 81.8%, respectively. There were no significant differences between the first and second PPAA and DMAA measurements in group I ($p > 0.05$). There were significant differences between the first and second HVA and IMA measurements in group II ($p \leq 0.01$). The highest matching rates for the HVA and IMA were 96.8% and 84%, respectively. On the other hand, there were also significant differences between the first and second PPAA measurements (5) and DMAA measurements (4

Table 1. Evaluation of first and second measurement correlations for the HVA, IMA, PPAA and DMAA

		SURGEON	aICC	95% CI		p
		1	0.893	0.819	0.938	0.001**
	Group I	2	0.904	0.838	0.945	0.001**
		3	0.842	0.738	0.907	0.001**
		4	0.968	0.944	0.982	0.001**
aHVA	Group II	5	0.939	0.895	0.965	0.001**
		6	0.845	0.742	0.909	0.001**
		7	0.906	0.040	0.946	0.001**
	Group III	8	0.911	0.848	0.948	0.001**
		9	0.894	0.820	0.938	0.001**
		1	0.818	0.700	0.892	0.001**
	Group I	2	0.666	0.478	0.796	0.001**
		3	0.532	0.300	0.704	0.001**
		4	0.840	0.735	0.906	0.001**
aIMA	Group II	5	0.791	0.659	0.876	0.001**
		6	0.819	0.701	0.893	0.001**
		7	0.807	0.683	0.885	0.001**
	Group III	8	0.827	0.714	0.090	0.001**
		9	0.412	0.154	0.618	0.001**
		1	0.158	−0.124	0.415	0.135
	Group I	2	0.081	−0.200	0.349	0.286
		3	−0.026	−0.299	−0.252	0.571
		4	0.222	−0.058	0.469	0.059
aPPAA	Group II	5	0.317	0.045	0.545	0.012*
		6	−0.072	−0.341	0.208	0.691
		7	0.552	0.325	0.718	0.001**
	Group III	8	0.372	0.107	0.587	0.004**
		9	0.305	0.031	0.535	0.015*
		1	0.093	−0.188	0.359	0.259
	Group I	2	−0.114	−0.378	0.168	0.786
		3	−0.013	−0.288	0.264	0.537
		4	0.848	0.747	0.911	0.001**
aDMAA	Group II	5	0.369	0.104	0.585	0.004**
		6	0.110	−0.171	0.375	0.221
		7	0.036	−0.242	0.309	0.401
	Group III	8	0.335	0.065	0.559	0.008**
		9	0.293	0.019	0.527	0.018*

[a]ICC: Intraclass correlation coefficient; HVA: hallux valgus angle; IMA, intermetatarsal angle; PPAA: proximal phalangeal articular angle; DMAA, distal metatarsal articular angle. *$p < 0.05$; **$p < 0.01$

and 5) (p≤0.05). There were significant differences between the first and second HVA and IMA measurements in group III (p≤0.01). The highest matching rates for HVA and IMA were 91.1% and 82.7%, respectively. There were significantly different matching rates for PPAA between the first and second measurements (p≤0.05; p≤0.01) and the highest matching rate was 55.2%. For the DMAA, two surgeons (8 and 9) showed significantly different matching rates between the first and second measurements (p≤0.05; p≤0.01) and the highest matching rate was approximately 33.5% (Table 1).

In group I, all surgeons first and second measurements for joint congruence, evidence of joint arthrosis and bunion were significantly different (p≤0.01). According to these evaluations, the highest Kappa values were 0.823, 0.687 and

Table 2. Evaluation of first and second measurement correlations for joint congruency, joint arthrosis, bunion, operation decision and grade of sesamoid

		SURGEONS	Kappa	p
Joint Congruency	Group I	1	0.823	0.001**
		2	0.541	0.001**
		3	0.623	0.001**
	Group II	4	0.831	0.001**
		5	0.611	0.001**
		6	0.200	0.136
	Group III	7	0.692	0.001**
		8	0.597	0.001**
		9	0.660	0.001**
Joint Arthrosis	Group I	1	0.380	0.001**
		2	0.382	0.007**
		3	0.687	0.001**
	Group II	4	0.672	0.001**
		5	0.766	0.001**
		6	0.179	0.087
	Group III	7	0.325	0.004**
		8	0.185	0.024*
		9	0.481	0.001**
Bunion	Group I	1	0	-
		2	0.370	0.006**
		3	1.000	0.001**
	Group II	4	1.000	0.001**
		5	1.000	0.001**
		6	0.137	0.309
	Group III	7	0.220	0.094
		8	0.234	0.070
		9	0.440	0.001**
Grade of Sesamoid	Group I	1	0.163	0.152
		2	−0.173	0.197
		3	0.246	0.001**
	Group II	4	0.897	0.001**
		5	0.517	0.001**
		6	−0.014	0.891
	Group III	7	0.222	0.025*
		8	0.276	0.003**
		9	0.174	0.090
Operation Decision	Group I	1	0.227	0.003**
		2	0.285	0.002**
		3	0.651	0.001**
	Group II	4	0.827	0.001**
		5	0.766	0.001**
		6	0.140	0.207
	Group III	7	0.295	0.001**
		8	0.183	0.076
		9	−0.024	0.809

*$p < 0.05$
** $p < 0.01$

1.000, respectively. Only one surgeons (3) first and second sesamoid grading measurement was similar ($p \leq 0.01$). The Kappa value of this evaluation was only 0.246. In group II, first and second measurements for joint congruence, evidence of joint arthrosis and bunion were significantly different ($p \leq 0.01$) for two (4 and 5) of the three surgeons. According to this evaluation, the highest Kappa values were 0.831, 0.766, 1.000 and 0.897, respectively. In group III, first and second measurements for joint congruence and arthrosis were significantly different ($p \leq 0.01$). Accordingly, the highest Kappa values were 0.692 and 0.481, respectively. On the other hand, there were significant differences for the existence of a prominent bunion (9) and for sesamoid grading (7 and 8) between measurements ($p \leq 0.01$). In this evaluation, the highest Kappa values were 0.440 and 0.276, respectively (Table 2).

In group I, all surgeons showed a significant similarity for the operation decision ($p \leq 0.01$). The highest Kappa value was 0.651. In group II, two (4 and 5) of the three surgeons' operation decision were similar and in group III only one (7) of the three surgeons operation decision was similar after the first and second measurements ($p \leq 0.01$). In this evaluation, the highest Kappa value was 0.827 for group II and 0.295 for group III (Table 2). The first analysis shows, that in all groups the HVA and IMA measurements were significantly different between the first and second measurements ($p \leq 0.05$). The highest HVA matching rate was for group III with 91.9% and the highest IMA match rate was for group II with 70.1%. In group III, PPAA and DMAA measurements were significantly different between the first and second measurements ($p \leq 0.01$). The highest matching rate for these measurements were 40.6% and 92.2%, respectively. In group I and group II there were no significant differences for PPAA and DMAA between the first and second measurements ($p > 0.05$). Similarly, second analysis showed that in all groups the HVA and IMA measurements were significantly different between the first and second measurements ($p \leq 0.01$). The highest HVA matching rate was for group III at 88.9% and the highest IMA matching rate was for group II at 74.6%. In group III, PPAA and DMAA measurements were significantly different between the first and second measurements ($p \leq 0.01$). The highest matching rates for these measurements were 18.8% and 19.1%, respectively. In group I and group II there were no significant differences for PPAA and DMAA between the first and second measurements ($p > 0.05$) (Table 3). Considering joint congruence, arthrosis, existence of a prominent bunion, sesamoid grading and operation decision based on the first and second analysis within the groups, the highest Fleiss Kappa value was seen in group III. The Fleiss Kappa values in the first evaluation were 0.525, 0.495, 0.624, 0.513 and 0.537, respectively. In the second evaluation they were 0.843, 0.441, 0.277, 0.539 and 0.255, respectively (Table 4).

Discussion

Hallux valgus is a forefoot deformity that causes complaints because of its appearance and associated pain, and treatment options continue to be controversial. Primarily, conservative treatment methods are recommended and when they fail, surgical treatment methods should be discussed. Although cosmetic complaints also contribute to the surgical indication, the main indication is pain at the plantar site of the first metatarsal bone and difficulty in shoe wearing. On the other hand, the success of the surgery depends on the proper patient choice and right decision and correct application of the surgical technique (13,14). The surgical method chosen should correct all contributors of the deformity. However, over 150 surgical procedures are described in the literature for the treatment of this deformity, unfortunately none of them can properly address all components of the condition. The main aim of surgery is to achieve a proper metatarsophalangeal joint, to decrease the hallux valgus and intermetatarsal angles and to relocate the sesamoids under the metatarsal bones. This should reduce the pain and maintain or increase the joint range of motion. The chosen surgical method should in no way lead to a biomechanical deterioration of the forefoot function (15). The main criteria used to make an informed surgical procedure decision are; the patient's main complaint, findings from physical examination, hallux valgus and intermetatarsal angle values, metatarsophalangeal joint congruence, evidence of arthrosis, pronation of the hallux, age of the patient, peripheral circulatory status and patient expectations from the surgery. That is why properly assessed radiological images are mandatory prior to any hallux valgus surgery. Normal values of IMA and DMAA is considered below 10^0 whereas normal HVA should be under 15^0. Values above of the HVA and IMA are the most important determinants to assess the seriousness of the

Table 3. Evaluation of first (I) and second (II) measurement correlations between the groups for the HVA, IMA, PPJA and DMJA

			aICC	95% CI		p
aHVA	I. Measurement	Group I	0,793	0.694	0.868	0.001**
		Group II	0.898	0.843	0.937	0.001**
		Group III	0.919	0.874	0.950	0.001**
	II.Measurement	Group I	0.791	0.692	0.867	0.001**
		Group II	0.849	0.771	0.906	0.001**
		Group III	0.889	0.830	0.931	0.001**
aIMA	I. Measurement	Group I	0.515	0.351	0.666	0.001**
		Group II	0.701	0.573	0.805	0.001**
		Group III	0.609	0.459	0.738	0.001**
	II.Measurement	Group I	0.609	0.459	0.738	0.001**
		Group II	0.746	0.631	0.836	0.001**
		Group III	0.598	0.707	0.890	0.001**
aPPAA	I. Measurement	Group I	0.136	−0.027	0.326	0.056
		Group II	−0.074	−0.201	0.097	0.812
		Group III	0.406	0.232	0.576	0.001**
	II.Measurement	Group I	−0.024	−0.162	0.155	0.602
		Group II	0.090	−0.067	0.279	0.137
		Group III	0.188	0.019	0.377	0.014*
aDMAA	I.Measurement	Group I	−0.057	−0.189	0.116	0.752
		Group II	0.152	−0.013	0.342	0.057
		Group III	0.922	0.878	0.952	0.001**
	II.Measurement	Group I	0.094	−0.063	0.283	0.128
		Group II	0.127	−0.35	0.317	0.065
		Group III	0.191	0.022	0.380	0.013*

[a]ICC: Intraclass correlation coefficient; HVA: hallux valgus angle; IMA, intermetatarsal angle; PPAA: proximal phalangeal articular angle; DMAA, distal metatarsal articular angle. *$p < 0.05$; **$p < 0.01$

deformity (16,17). Our study shows that in all groups, HVA and IMA measurements taken within a month were similar although the values at the first and second measurement were not just equal. The matching rate was over 90% for HVA and over 80% for IMA, demonstrating that all surgeons paid special attention to these two angle measurements irrespective of how experienced they are.

Anatomical variations of the first metatarsophalangeal joint also contribute to hallux valgus deformity. The joint surface of the first metatarsal bone can be deviated laterally, which is best determined by DMAA. Another anatomical variation is the lateral deviation of the proximal phalangeal joint surface, which is best determined by PPAA. If these two conditions are present along with an improper metatarsophalangeal joint congruence, medial capsular repair alone cannot successfully correct the deformity, particularly if the metatarsal head joint surface is laterally deviated. In this case, a phalangeal or distal metatarsal osteotomy should be preferred. This demonstrates the importance of these two angles to facilitate the correct analysis of orthopaedic surgeons (18,19). The interesting finding from our study was that there was no significant difference in the two PPAA and DMAA measurements between experienced and less experienced surgeons. Although the two measurements of these angles performed by the less experienced surgeons were more similar, the matching rate was only 55.2% for PPAA and 33.5% for DMAA. In addition to this angle measurements, parameters like joint congruence, evidence of arthrosis and presence or lack of a prominent bunion are also important factors for the decision for hallux valgus surgery. Joint incongruence is a condition that results from a lateral deviation of the proximal phalanx in relation to the metatarsal head that might result in minimal subluxation and even it can sometimes lead to total incongruence. So the first metatarsophalangeal joint condition is

Table 4. Evaluation of first (I) and second (II) measurement correlations between the groups for joint congruency, joint arthrosis, bunion, operation decision and grade of sesamoid

			Fleiss Kappa
Joint Congruency	I. Measurement	Group I	0.228
		Group II	0.250
		Group III	0.525
	II. Measurement	Group I	0.508
		Group II	0.390
		Group III	0.843
Joint Arthrosis	I. Measurement	Group I	0.102
		Group II	−0.129
		Group III	0.495
	II. Measurement	Group I	0.094
		Group II	0.284
		Group III	0.441
Bunion	I. Measurement	Group I	−0.111
		Group II	−0.145
		Group III	0.624
	II. Measurement	Group I	0.083
		Group II	−0.220
		Group III	0.277
Operation Decision	I. Measurement	Group I	0.103
		Group II	0.019
		Group III	0.513
	II. Measurement	Group I	0.050
		Group II	−0.030
		Group III	0.539
Grade of Sesamoid	I. Measurement	Group I	0.164
		Group II	0.038
		Group III	0.537
	II. Measurement	Group I	−0.068
		Group II	0.144
		Group III	0.255

very important for the progression of the deformity. In incongruent joints, the deformity might rapidly increase over time (20,21). While planning a surgical intervention, arthrosis of the first metatarsophalangeal joint should be taken into consideration; particularly in incongruent joints with arthrosis, any attempt for reduction might result in pain and joint stiffness (22). Another and probably the most striking component of a hallux valgus deformity is the existence of a prominent bunion. Swelling over this medial prominence with a thickened underlying bursa and irritation of the dorsal cutaneous nerve is the main reason for the pain received. The progressing subluxation of the joint results in sagittal sulcus formation on the medial side of the metatarsal joint surface; depending on the severity of the deformity, the location of this sulcus changes. It should be remembered that it is located more medially in mild deformities and more laterally in moderate and severe deformities. On the other hand, in moderate and severe deformities the sagittal sulcus might locate at the center of the metatarsal head. In this case, if it is taken as the hind point while resecting the medial prominence, it might result in too much bone resection (23,24). We have seen in our study that all orthopaedic surgeons paid attention to these parameters; namely joint condition, evidence of arthrosis and presence or lack of a prominent bunion. The sesamoid bone mechanism makes the first metatarsophalangeal joint different from the

other toe joints. Sesamoid bones are settled in a plantar bed consisting of dense fibrous tissue. The distal site of this bed adheres firmly to the phalangeal base, whereas ligamentous and muscular structures insert to the lateral site. During standing position, this sesamoid bed conducts part of the pressure to the metatarsal head, so pressure over the flexor tendons is decreased. Normally, sesamoid bones do not move away from the midline. However, the lateral deviation of the first toe and muscular forces in hallux valgus push the sesamoids laterally and the medial joint ligaments become firm. The sesamoid grading is made according to its lateral replacement and provides important information about the severity of the hallux valgus deformity (25,26). Although all surgeons paid attention to sesamoid grading in our study, the paid attention and matching rate was lower compared to other evaluation criteria. The main aim of hallux valgus surgery is to relieve pain, correct the cosmetic appearance and maintain function (27). When a surgical intervention is planned for a hallux valgus deformity, the surgeon should evaluate physical and radiological findings and target the basic complaints to choose the correct procedure. In addition to the evaluation criteria, there is no doubt that one of the most important parameters affecting the surgeons choice will be his or her experience (28). Naturally, there are some limitations of the current study. Although the study cohort is very well organized, experience of a surgeon in a certain field cannot be explained by the years spent at this field alone. Factors, like number of performed operations and capability to make various interventions should also be taken into consideration. Besides, the various degree of the deformity makes the chosen patient group somewhat heterogenous.

In conclusion, our study demonstrated that, for more experienced surgeons, the measurable values were of less importance and but their consistency in surgical decision was more similar. Less experienced surgeons paid more attention to radiological parameters and their measurements were more consistent, however their uniformity in surgical decisions was lower compared to more experienced surgeons.

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