A Classification to Guide Surgical Treatment of Brachymetatarsia
Bradley Lamm DPM, FACFAS 1 Jordan J. Ernst DPM, MS, AACFAS 2
1- Chief, Foot and Ankle Surgery; Director Foot and Ankle Deformity Correction Fellowship
2 - Fellow, Foot and Ankle Deformity Correction Fellowship

Statement of Purpose
While numerous procedures have been described for the treatment of brachymetatarsia, there is no consensus in the literature on the optimal method of lengthening to treat this condition. The aim of our study was to present a classification system to accurately guide treatment of this complex pathology.

Methodology & Procedures
Our classification provides one number and 3 letters to define the deformity. The number assigned is the metatarsal affected, and the letter relates to the specific type of deformity. An A designation is given if the metatarsal is 10mm or more shorter than the appropriate metatarsal parabola length. The B designation is assigned if there is bowing to the metatarsal shaft, and a C if there is lack of congruency at the associated MPJ. Treatment is primarily based on the letter designation, or designations, of the deformity. Utilizing a treatment algorithm based on this classification, 123 brachymetatarsals in 83 feet were treated. All metatarsals with more than 10mm of shortening underwent distraction osteogenesis with external fixation. The external fixator spanned the metatarsophalangeal joint in all cases. If bowing of the metatarsal shaft existed, a corrective osteotomy was performed concomitantly.

Literature Review
The incidence of brachymetatarsia has been reported to be less than 1 in 1000 people, and is most commonly associated with an isolated congenital deformity (1). Acute and gradual correction have been described (2). MPJ stiffness and subluxation are two of the most commonly reported complications from brachymetatarsia correction, owing to the stretch placed on the peri-articular soft tissues during lengthening (3). In 2010, Lamm reported on a novel technique to avert this issue by spanning the lengthening fixator across the MPJ. The toe is then maintained in a rectus position during distraction osteogenesis, with the MPJ distracted 2-6mm. This also avoids the cartilaginous insult that can result from K-wire fixation of the joint (4).

Demographics
n = 150 metatarsals
83 patients

<table>
<thead>
<tr>
<th>Deformity</th>
<th>Metatarsal Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Met. &gt; 10mm short</td>
<td>1A  2A  3A  4A  5A</td>
</tr>
<tr>
<td>Bowing of Shaft</td>
<td>1B  2B  3B  4B  5B</td>
</tr>
<tr>
<td>MPJ Incongruency</td>
<td>1C  2C  3C  4C  5C</td>
</tr>
<tr>
<td>Short and Bowing</td>
<td>1AB  2AB  3AB  4AB  5AB</td>
</tr>
<tr>
<td>Short and MPJ Incongruency</td>
<td>1AC  2AC  3AC  4AC  5AC</td>
</tr>
<tr>
<td>Bowing and Incongruency</td>
<td>1BC  2BC  3BC  4BC  5BC</td>
</tr>
<tr>
<td>Short, Bowing, and Incongruency</td>
<td>1ABC  2ABC  3ABC  4ABC  5ABC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Avg. 30 years</th>
<th>Range (4-60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>70 Female</td>
<td>84%</td>
</tr>
<tr>
<td>Etiology (% patients)</td>
<td>Idiopathic - 58</td>
<td>Syndromic - 13</td>
</tr>
<tr>
<td></td>
<td>Prior Surgery - 7</td>
<td>Trauma - 5</td>
</tr>
<tr>
<td></td>
<td>70%</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td>Avg. Pre-op Metatarsal Shortening</td>
<td>15mm</td>
<td>Range (4-20mm)</td>
</tr>
<tr>
<td>Bilateral Disease</td>
<td>22 patients</td>
<td>27%</td>
</tr>
<tr>
<td>Metatarsal Affected</td>
<td>1st - 32</td>
<td>2nd - 11</td>
</tr>
<tr>
<td></td>
<td>3rd - 14</td>
<td>4th - 87</td>
</tr>
<tr>
<td></td>
<td>5th - 6</td>
<td>58%</td>
</tr>
<tr>
<td></td>
<td>7%</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>9%</td>
<td>4%</td>
</tr>
<tr>
<td>Presence of Deformity</td>
<td>A - 141</td>
<td>B - 18</td>
</tr>
<tr>
<td></td>
<td>C - 118 (lesser mets)</td>
<td>0 (1st mets)</td>
</tr>
<tr>
<td></td>
<td>94%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>100% lessers</td>
<td>0% 1st mets</td>
</tr>
</tbody>
</table>

Results
- More than 50% of patients presented from out of state, with 6 international patients
- The most common deformity was a 4AC
- An anatomic metatarsal parabola was restored in all patients
- There were no instances of post-operative metatarsophalangeal joint stiffness
- All patients returned to regular shoe gear

Analysis & Discussion
An all too often complication following brachymetatarsia surgery is MPJ stiffness. In our series, this complication was avoided by adhering to a surgical algorithm directed by our classification system. The Lamm technique of gradual distraction with MPJ spanning external fixation, coupled with deformity specific adjuncts, has proved effective not only in achieving the desired metatarsal length, but also in preserving MPJ function.

References