RADIOGRAPHIC EXAM PREDICTORS OF PLANTAR PLATE TEARS

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My disclosure is in the Final AOFAS Program Book. I have no potential conflicts with this presentation.
INTRODUCTION

- X-rays are usually taken at initial presentation of patients with pain in the forefoot. Radiographic findings in the forefoot are not well documented or well understood.

- Underlying osseous deformity has been well studied in posterior tibial tendon dysfunction and lateral ankle instability.

- Radiographic findings for 2nd MTPJ instability are not as well understood.

- Therefore, the **purpose of this study** is to:

  - Examine the radiographs of patients with suspected plantar plate tears and correlate common radiographic findings to observed intra-operative pathology.
METHODS

- Bilateral weight bearing radiographs (AP, oblique and lateral) were reviewed for 88 patients (106 feet) who underwent a dorsal approach plantar plate repair⁹.

- **Etiological/Originating Factors**
  - 1st intermetatarsal angle (AP)
  - Metatarsus adductus angle (AP)
  - Metatarsal parabola assessment (AP)
    - Hardy & Clapham’s arc method³
    - 2nd metatarsal protrusion distance⁴
    - Maestro’s method⁵
  - 1st metatarsal declination angle (Lateral)
  - Metatarsus primus elevatus (Lateral)
  - 2nd metatarsal declination angle (Lateral)

- **Resultant Factors/Sequelae**
  - 2nd metatarsal-phalangeal angle (AP)
  - 3rd metatarsal-phalangeal angle (AP)
  - Splaying of the 2nd and 3rd toes (AP)
  - Transverse plane splay >5° (AP)
  - 2nd metatarsal phalangeal angle (Lateral)

These findings were compared to intra-operative findings.
RESULTS – ORIGINATING FACTORS

- Of the 106 feet inspected intra-operatively, 97 were found to have plantar plate pathology. The incidence, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and odds ratios were calculated.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Incidence</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>First intermetatarsal angle &gt;12°</td>
<td>47.1%</td>
<td>51.5%</td>
<td>66.7%</td>
<td>94.3%</td>
<td>11.3%</td>
<td>2.127</td>
</tr>
<tr>
<td>Metatarsus adductus angle &gt;15°</td>
<td>70.7%</td>
<td>77.3%</td>
<td>22.2%</td>
<td>91.5%</td>
<td>8.3%</td>
<td>0.974</td>
</tr>
<tr>
<td>Hardy &amp; Clapham +/- 2 mm</td>
<td>50.0%</td>
<td>54.4%</td>
<td>50.0%</td>
<td>92.5%</td>
<td>8.9%</td>
<td>1.195</td>
</tr>
<tr>
<td>2nd metatarsal protrusion distance &gt;2mm</td>
<td>90.2%</td>
<td>97.9%</td>
<td>0%</td>
<td>92.0%</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Maestro – 1st Metatarsal &lt;10 mm</td>
<td>36.2%</td>
<td>39.4%</td>
<td>62.5%</td>
<td>92.5%</td>
<td>8.1%</td>
<td>1.081</td>
</tr>
<tr>
<td>Maestro – 2nd Metatarsal &gt;13 mm</td>
<td>65.3%</td>
<td>71.0%</td>
<td>50.0%</td>
<td>94.3%</td>
<td>12.9%</td>
<td>2.444</td>
</tr>
<tr>
<td>Maestro – 3rd Metatarsal &lt;9 mm</td>
<td>48.0%</td>
<td>52.1%</td>
<td>50.0%</td>
<td>92.5%</td>
<td>8.2%</td>
<td>1.089</td>
</tr>
<tr>
<td>First metatarsal declination &gt;20°</td>
<td>82.5%</td>
<td>90.4%</td>
<td>11.1%</td>
<td>91.4%</td>
<td>10%</td>
<td>1.181</td>
</tr>
<tr>
<td>MPE &gt;8mm</td>
<td>17.8%</td>
<td>19.5%</td>
<td>75.0%</td>
<td>88.9%</td>
<td>8.3%</td>
<td>0.727</td>
</tr>
<tr>
<td>Second metatarsal declination &gt;20°</td>
<td>87.3%</td>
<td>95.7%</td>
<td>0%</td>
<td>90.8%</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

- An odds ratio >1 = more likely to be diagnosed with plantar plate tear.
- An odds ratio <1 = less likely to be diagnosed with plantar plate tear.
RESULTS – RESULTANT FACTORS

- Of the 106 feet inspected intra-operatively, 97 were found to have plantar plate pathology. The incidence, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and odds ratios were calculated.

<table>
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<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral deviation of the 2\textsuperscript{nd} toe</td>
<td>45.2%</td>
<td>49.5%</td>
<td>33.3%</td>
<td>88.9%</td>
<td>5.8%</td>
<td>0.489</td>
</tr>
<tr>
<td>Medial deviation of the 2\textsuperscript{nd} toe</td>
<td>46.2%</td>
<td>50.5%</td>
<td>66.7%</td>
<td>94.2%</td>
<td>11.1%</td>
<td>2.041</td>
</tr>
<tr>
<td>Presence of splaying (2\textsuperscript{nd} and 3\textsuperscript{rd} digits)</td>
<td>59.4%</td>
<td>64.9%</td>
<td>77.8%</td>
<td>96.9%</td>
<td>17.1%</td>
<td>6.485</td>
</tr>
<tr>
<td>Transverse plane splay $&gt;5^\circ$</td>
<td>55.7%</td>
<td>60.8%</td>
<td>77.8%</td>
<td>96.7%</td>
<td>15.6%</td>
<td>5.434</td>
</tr>
<tr>
<td>Second metatarsal-phalangeal angle $&gt;12^\circ$</td>
<td>17.0%</td>
<td>18.6%</td>
<td>100%</td>
<td>100%</td>
<td>10.5%</td>
<td>n/a</td>
</tr>
</tbody>
</table>

- An odds ratio $>1$ = more likely to be diagnosed with plantar plate tear.
- An odds ratio $<1$ = less likely to be diagnosed with plantar plate tear.
DISCUSSION

- Increased length or declination of the 2nd metatarsal disrupts the delicate balance of the intrinsic musculature and ligamentous structures at the 2nd MTPJ.

- This is likely responsible for the increased stress on the plantar soft tissue structures and may be partially responsible for plantar plate tears.
  - Increased 2nd metatarsal protrusion distance
  - First intermetatarsal angle >12°
  - First metatarsal declination angle >20°
Resultant transverse plane splay of the digits is secondary to the disruption of the transverse tie-bar of the lesser metatarsals.

The tear in the plantar plate can cause sagittal plane instability, transverse plane instability or both, which will be seen on radiographs as mal-alignment of the digits.

- Sagittal plane instability – lateral 2\textsuperscript{nd} metatarsal-phalangeal angle >12°
- Transverse plane instability – transverse plane splaying of the 2\textsuperscript{nd} and 3\textsuperscript{rd} toes >5°
CONCLUSION

- The parameters presented here may now help interpretation and prediction of plantar plate pathology when accompanied by the proper physical exam findings.

- This data suggests that plantar plate pathology is likely associated with an underlying causative osseous deformity that, after the plantar plate tears, has resultant osseous changes.

- Therefore, the underlying osseous deformity should be corrected with the soft tissue pathology in order to provide superior results.

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REFERENCES


5. Maestro, M; Besse JL; Ragusa, M; Bertonnaud, E. Forefoot morphothpe study and planning for forefoot osteotomy. Foot Ankle: 8, 695-710, 2003.


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