Fracture Detection Via Smartphone: A Proof-of-Concept Study

FIP World Congress of Podiatry
November 16, 2019
Miami, Florida, USA

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Conflict of Interest: co-inventor of disclosed prototype

Financial Disclosures: none
Acoustic Detection of Fractures

Theory

• Sound transmitted through bone will be modified if a fracture is present compared to intact bone.

• Analogous to nondestructive evaluation (NDE) used in mechanical engineering analyses.
Acoustic Detection of Fractures
Acoustic Detection of Fractures
Research
Research in biomedical engineering, biomechanics, and orthopedics has produced many studies evaluating bone density, fracture healing, prostheses loosening and joint mechanics through the application of vibration.
Acoustic Detection of Fractures

Practice

- Stethoscope /tuning fork test

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Fracture Detection Via Smartphone

FractureDx Prototype
- Smartphone with app.
- Bone conducting headphone
- Microphone with stethoscope bell
Study Protocol

- 36 trauma patients enrolled on a rolling basis
- Injury location: foot and ankle
- Injury age: 1-150 days
- Injured/contralateral limbs tested with prototype
- Standard foot and ankle x-rays obtained
- MRI obtained in two patients
Fracture Detection Via Smartphone

Results

5th metatarsal fracture and FractureDx screenshot comparing fractured 5th metatarsal (red curve) to the intact contralateral 5th metatarsal (white curve).
Fracture Detection Via Smartphone

Results

FractureDx statistical results of all fractures diagnosed by any means.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
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<tbody>
<tr>
<td>Sensitivity</td>
<td>90.91%</td>
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<tr>
<td>Specificity</td>
<td>57.14 %</td>
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<tr>
<td>Positive Predictive Value</td>
<td>76.92%</td>
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<tr>
<td>Negative Predictive Value</td>
<td>80.00 %</td>
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<tr>
<td>Accuracy</td>
<td>77.78%</td>
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**Results**
FractureDx statistical results for displaced fractures diagnosed by radiograph only

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Conclusions

- Prototype accuracy = 77.7%
- Accuracy increased in displaced fractures
- Some false positives may reflect “bone edema” only diagnosed on MRI
Future Directions

• Improved prototype design
• Signal analysis and processing improvements
• Larger study
• Bone density application with NASA/UMaine
References