Low-intensity Pulsed Ultrasound
Accelerated Bone Repair

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Overview of Presentation

• What is low-intensity pulsed ultrasound?

• How is it utilized?

• Trials covering different aspects of LIPUS

• Strengths and weaknesses, major faults.

• Future of LIPUS
What is ultrasound?

- Sound waves with frequencies higher than the human ear can perceive.

- Most ultrasound devices range from 20kHz frequency up to several gigahertz.

- Mainly used in imaging of the body
What is LIPUS?

- Low-intensity pulsed ultrasound

- 1.5 MHz frequency that pulses with a width of 200μs, repeating for twenty minutes.

- Lower ultrasound frequency, which allows the sound to penetrate the skin, muscles, tissues and ligaments
How is it used?

- Device can vary from a large ultrasound machine, used for imaging to small handheld devices for home use.

- Handheld version has a small device and attached node that emits the ultrasound.

- Ultrasound is applied to directly over fracture site.
What is happening?

- Ultrasound applies small amounts of stress to the site of the fracture

- Stimulates cellular activity and blood-flow to the area. LIPUS has been shown to increase the activity of osteoblasts and chondrocytes

- Increase rate of ossification during callus stage of bone regeneration.
## Trials testing effectiveness of LIPUS

<table>
<thead>
<tr>
<th>Trial</th>
<th>Radiographic definition of fracture healing*</th>
<th>Mean days to fracture healing or fraction of patients healed (no. of weeks)</th>
<th>Statistical significance ($P$ value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LIPUS</td>
<td>Placebo</td>
</tr>
<tr>
<td>Malleolar</td>
<td>Callus formation</td>
<td>14/15</td>
<td>12/15</td>
</tr>
<tr>
<td>Handolin et al., 2005</td>
<td>Callus formation</td>
<td>8/10</td>
<td>9/11</td>
</tr>
<tr>
<td>Handolin et al., 2005</td>
<td>Callus formation</td>
<td>12th postop. week)</td>
<td>(12th postop. week)</td>
</tr>
<tr>
<td>Radial Kristiansen et al., 1995</td>
<td>Bridging of 4 cortices</td>
<td>61 ± 3 days</td>
<td>98 ± 5 days</td>
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<tr>
<td>Tibial Heckman et al., 1994</td>
<td>Bridging of 4 cortices Bridging of 3 of 4 cortices</td>
<td>114 ± 7.5 days</td>
<td>182 ± 15.8 days</td>
</tr>
<tr>
<td>Leung et al., 2005</td>
<td>Bridging 3 of 4 cortices</td>
<td>11.5 ± 3.0 weeks</td>
<td>20 ± 4.4 weeks</td>
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<tr>
<td>Emami et al., 1999</td>
<td>“Signs of healing like cortical thickening”</td>
<td>155 ± 22 days</td>
<td>129 ± 12 days</td>
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<tr>
<td>Rue et al., 2004</td>
<td></td>
<td>56.2 ± 19.6 days</td>
<td>55.8 ± 15.5 days</td>
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</tbody>
</table>

* Although individual trials may have reported other criteria for fracture healing, signs of radiographic healing were of interest for the current review.
Advantages to using LIPUS

- Shows slight advantage over traditional methods of fracture treatment (setting and cast).

- Easy and quick procedure with little discomfort for the user.

- Room for growth and expansion of technology
Disadvantages to LIPUS

- Trials conducted were mostly inconclusive and had skewed results (i.e. athletic patients)

- Has shown to not affect recovery of fractures in entire studies.

- Bias results with trials being conducted with members of companies selling devices.

- Devices being sold to the public are mostly placebo, with little to no effect on fractures
Future of LIPUS

- More robust studies, with wider range of patients
- More variations of tech, with designs specifically for regions of the body
- Further research into the effects of ultrasound on the chemical and molecular level of fractures.
- Expansion into other fields of medicine, such as drug delivery with implanted device, and add new applications.
Questions?