Bone Marrow Aspirate Concentrate Augmentation for ACL Reconstruction: A double-blinded Randomized Control Trial

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The Evolution of ACL Surgery:

- Primary ACL Repairs
- Lateral Extraarticular Tenodesis, Reconstruction
- Intraarticular ACLR: Transtibial → Medial Portal
- Double Bundle ACLR
- Intraarticular Primary ACL Repair
  - Internal Brace?
  - Collagen Scaffolds?
- LET Augmentation with Primary, Revision intraarticular ACLR
- ACL Reconstruction with BMAC?
BMAC: What’s in it?

- 5x nucleated cells (0 in PRP)
- High WBCs
- 1.9% CD34+ Pluripotent Cells
- High b-FGF
Primary ACL Healing


Claes S, Verdonk P, Forsyth R, Bellemans J.
Avascular Necrosis
• Hypocellularity, centrally
• Necrosis $\rightarrow$ Cytokine release $\rightarrow$ GF’s
  • Cell migration, Proliferation, Revascularization

Remodeling:
• Cell Mediated Restructuring of the ECM
• Adaptive response to Mechanical Loading of graft

Ligamentization:
• Acquisition of histologic, biomechanical properties of native ACL
Primary ACLR
Ligamentization: ECM

Allograft integration in a rabbit transgenic model for anterior cruciate ligament reconstruction.

Bachy M, Sherif, Zadegan F, Petite H, Vialle F, Harnouche F

Grafted tendon
New cartilage deposition
The effects of BMAC on ACLR with Allograft tissue:

- The First Randomized Controlled clinical Trial (RCT)

OUR STUDY:
RCT ACLR BTB Allograft +/- BMAC

[Box]

Autologous Bone Marrow Aspirate Concentrate in Patients Undergoing Anterior Cruciate Ligament Reconstruction

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Authorized Representative: Nikhil Verma MD

Co-Investigators: Nikhil Verma MD, Brian J. Cole MD MBA, Adam Yanke, MD PhD, Jorge Chahla, MD PhD, Bernard R Bach Jr MD

Division of Sports Medicine, Midwest Orthopaedics at Rush, Rush University Medical Center, Chicago, IL, USA
To evaluate the effects of BMAC on graft ligamentization:

T2* MR imaging at 3 and 9 months.

T2* MR sequences:

Higher signals at 3 months:
  \[ \Rightarrow \text{Superior graft Remodeling} \]

Lower signals at 9 months:
  \[ \Rightarrow \text{Superior graft Integration and Homeostasis} \]
To evaluate the effect of BMAC on patient-reported outcome measures (PROMs) and failure rates 3, 6, 9, 12 & 24 months post-operatively

BMAC + BTB Allograft:

Failure rates: => Similar or lower with BMAC

### Signal Intensity Ratios:

<table>
<thead>
<tr>
<th></th>
<th>BMAC</th>
<th>Control</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ACL SIR at 3 months</strong></td>
<td>2.52 ±1.54</td>
<td>1.96 ±0.92</td>
<td>0.166</td>
</tr>
<tr>
<td><strong>ACL SIR at 9 months</strong></td>
<td>3.94 ±2.54</td>
<td>2.81 ±1.44</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Results: T2 MRI
# Results: Physical Exam

## Side-to-side difference on KT1000 (mm)

<table>
<thead>
<tr>
<th></th>
<th>Preop</th>
<th>6 weeks</th>
<th>3 months</th>
<th>6 months</th>
<th>9 months</th>
<th>P-value at 9 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMAC</td>
<td>1.54 ±1.47</td>
<td>0.31 ±0.91</td>
<td>0.27 ±0.92</td>
<td>0.25 ±0.79</td>
<td>0.17 ±0.60</td>
<td>0.339</td>
</tr>
<tr>
<td>Control</td>
<td>2.10 ±1.35</td>
<td>0.18 ±1.10</td>
<td>0.10 ±0.72</td>
<td>0.18 ±0.91</td>
<td>0.06 ±0.54</td>
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</table>

## Flexion ROM

<table>
<thead>
<tr>
<th></th>
<th>124 ±16.1</th>
<th>119 ±14.1</th>
<th>128 ±0.94</th>
<th>132 ±7.51</th>
<th>133 ±10.4</th>
<th>0.771</th>
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</thead>
<tbody>
<tr>
<td>BMAC</td>
<td>129 ±12.3</td>
<td>128 ±11.3</td>
<td>128 ±1.52</td>
<td>131 ±12.3</td>
<td>132 ±11.4</td>
<td></td>
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<tr>
<td>Control</td>
<td>1.31 ±0.60</td>
<td>0.75 ±0.78</td>
<td>0.95 ±0.52</td>
<td>0.75 ±0.62</td>
<td>1.09 ±0.30</td>
<td>0.890</td>
</tr>
<tr>
<td></td>
<td>1.19 ±0.54</td>
<td>0.86 ±0.66</td>
<td>1.14 ±0.66</td>
<td>1.25 ±0.64</td>
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</tbody>
</table>

## Extension ROM

<table>
<thead>
<tr>
<th></th>
<th>1.19 ±0.54</th>
<th>0.86 ±0.66</th>
<th>1.14 ±0.66</th>
<th>1.25 ±0.64</th>
</tr>
</thead>
</table>
Results: Flow Cytometry
## Results: Patient Reported Outcomes

<table>
<thead>
<tr>
<th></th>
<th>BMAC</th>
<th>Preop</th>
<th>6 weeks</th>
<th>3 months</th>
<th>6 months</th>
<th>9 months</th>
<th>P-value at 9 months</th>
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<tr>
<td><strong>IKDC</strong></td>
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<tr>
<td>BMAC</td>
<td>63.8 ±20.1</td>
<td>64.1</td>
<td>64.2</td>
<td>64.2</td>
<td>64.2</td>
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<tr>
<td>Control</td>
<td>61.7 ±16.8</td>
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<td>61.8</td>
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<td><strong>KOOS</strong></td>
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<td>0.830</td>
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<tr>
<td>BMAC</td>
<td>73.6 ±20.9</td>
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<tr>
<td>Control</td>
<td>73.5 ±11.8</td>
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<td>74.0</td>
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<tr>
<td><strong>VR/SF12</strong></td>
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<td>0.070</td>
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<tr>
<td>BMAC</td>
<td>42.1 ±11.0</td>
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<td>73.6</td>
<td>73.6</td>
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<tr>
<td>Control</td>
<td>40.5 ±10.6</td>
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<td>40.4</td>
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<tr>
<td><strong>VR12</strong></td>
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<td>0.002</td>
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<tr>
<td>BMAC</td>
<td>54.5 ±9.04</td>
<td>54.5</td>
<td>54.3</td>
<td>54.5</td>
<td>54.7</td>
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<tr>
<td>Control</td>
<td>52.5 ±9.82</td>
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<td>52.5</td>
<td>52.5</td>
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<td>52.5</td>
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Conclusion:

The first RCT evaluating BMAC Augmentation of Allograft ACL Reconstruction:

→ Significantly improved ACL Ligamentization on Radioimaging (3.94 and 2.81, respectively, p<0.05) at 9 months after surgery

Other Superior outcomes at 9 months (p<0.05):

- IKDC
- VR12 Mental Health
Thank you!!