Biomechanical Factors Associated with Knee Pain in Cyclists: A Systematic Review of the Literature

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Purpose

- This systematic review will focus on literature related to positioning on, and configuration of the bicycle that can influence forces acting on the knee and their potential effects on injury. This review also serves to present recommendations for rehabilitation and injury prevention based on the findings in current literature. The goal of this research was to develop an algorithm that can be used in guiding decision making for the sports medicine practitioner.

Clinical Relevance

- Roughly thirty-three million United States residents ride a bicycle an average of 6 days/month for an average of >1 hour/day.
- Knee pain is the most common overuse injury in cycling.
- Elite professionals: 38% traumatic injuries and 62% overuse injuries
- Anterior knee pain is the most common complaint among cyclists seeking medical care, and accounts for 25% of overuse injuries in cycling.
- The iliotibial band (ITB) is the most common cause of lateral knee pain in cyclists.
  - Hills can cause repetitive forceful shearing at the knee
  - Too steep gradient
  - Saddle too high or too far forward
- Medial knee pain can also be experienced by cyclists
  - Patellar tendinopathy
  - Medial plica syndrome
  - Medial meniscus tear
- The high demand of pressure during the downstroke is the proposed mechanism for the development of PFPS or “kicker’s knee”
  - More common in females
  - High Q angle predisposes individual to condition
  - Incorrect saddle position has a negative effect on knee biomechanics

Methods

- Review Protocol
  - Based on Preferred Reporting Items for Systematic Reviews and Meta- Analyses (PRISMA) guidelines
- Search Terms
  - knee injuries, knee pain, cycling, cyclist, and overuse
- Data Extraction
  - Knee pain, cycling parameters, number of subjects, gender, EMG activity, bike fit, and limitations
- Grading the Evidence
  - Downs and Black Questionnaire was used
- Consultation between all 4 researchers and faculty advisor to resolve discrepancies
- Risk of bias included level of randomization and level of evidence

Results

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Year</th>
<th>Participants</th>
<th>Methods</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gregersen CS, Hull ML, Hakansson NA</td>
<td>2013</td>
<td>10 healthy cyclists (6 women and 4 men) and 10 competitive cyclists</td>
<td>10 minute cycling trial conducted, measuring coronal and sagittal plane kinetics</td>
<td>No decreases in total pedal force or force applied on the right and right lower leg.</td>
<td>Further research recommended to see if changes are causal or effect and not just an association.</td>
</tr>
<tr>
<td>Farrell et al., 2006</td>
<td>2011</td>
<td>103%, and 97% of trochanteric height</td>
<td>90 RPM, data collected at 5 minute intervals</td>
<td>Differences in offset of the quadriceps activity not likely to be a causative factor in knee pain.</td>
<td></td>
</tr>
<tr>
<td>Thomas Jefferson University, Department of Physical Therapy</td>
<td>2015</td>
<td>75ms in impingement zone, large reductions in tibiofemoral anterior shear</td>
<td>Runners spent 75ms in impingement zone, large reductions in tibiofemoral anterior shear</td>
<td>Forces applied on the right and right lower leg decreased in the PFPS group.</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td>10 minute cycling trial conducted, measuring coronal and sagittal plane kinetics</td>
<td>Large reductions in coronal and sagittal plane knee moments and forces in the PFPS group.</td>
<td>Further research recommended to see if changes are causal or effect and not just an association.</td>
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</tr>
</tbody>
</table>

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Fig. 1: Cycle Diagram

Fig. 2: Algorithm for Allleviating Knee Pain during Cycling

Discussion

- Differences between cyclists with and without knee pain
  - Cyclists with prior history of injury may adopt a more medial knee position which reduces stress on the anterior knee mechanism.
  - Greater dislocation observed in cyclists with history of injury during phases of pedal cycle where a knee flexure moment is found.
- Effects of different saddle and foot position
  - Saddle
    - Backward saddle position increases tribofemoral anterior shear force
    - Compression forces are more sensitive to knee flexion angle
    - Compression forces relate to increased patellofemoral knee pain
  - Low saddle height may contribute to anterior knee pain
  - Knee flexion angle appears to be sensitive to changes in saddle height, low saddle height produces significantly higher knee flexion angle
- High saddle height relates to lateral knee pain (ITBS) due to increased time within the knee impingement zone.
- Foot position
  - Increased inversion may reduce patellofemoral knee syndrome
  - Due to changes in muscle activation and potential reduction in lateral patellar tracking
  - Increased pronation leads to increased iliotibial friction and increased forces values at the knee
  - Peak force decrease with to degrees of flexion of the foot
- A more neutral foot and knee position is beneficial for reducing overall knee injuries
- No ideal foot position noted in the literature to prevent most knee injuries
- Alterations in foot position may alleviate pain in cyclists with knee pain

Limitations

- Limited experimental studies comparing cyclists with and without knee pain. Studies containing data on cyclists with knee pain but limited research regarding preventative measures in those without knee pain.
- Few randomized control trials attempted in the literature on the topic
- Low to moderate evidence per Downes and Black grading scale
- Little research regarding effects of positioning in cyclists with posterior or medial knee pain

Conclusions

- “Optimal” bike fit inconsistent across the literature
- No single configuration shown to decrease or prevent knee pain
- Inconclusives data regarding biomechanical differences in cyclists with and without knee pain
- Recommendation for further experimental research in manipulating various bicycle components to determine an optimal configuration to prevent or alleviate knee pain in cyclists

References