ALGORITHM IN EMERGENCIES

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CLINICA ORTOPEDICA II
LAB. di BIOMECCANICA e INNOVAZIONE TECNOLOGICA
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ISTITUTO ORTOPEDICO RIZZOLI
### Schenk classification

<table>
<thead>
<tr>
<th>Grade</th>
<th>Injured Structures</th>
<th>Intact Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Single cruciate + collateral</td>
<td>ACL + collateral PCL + collateral</td>
</tr>
<tr>
<td>II</td>
<td>ACL/PCL</td>
<td>Collaterals</td>
</tr>
<tr>
<td>III M</td>
<td>ACL/PCL/MCL/ LCL + PLC</td>
<td>LCL + PLC</td>
</tr>
<tr>
<td>III L</td>
<td>ACL/PCL/LCL + PLC</td>
<td>MCL</td>
</tr>
<tr>
<td>IV</td>
<td>ACL/PCL/MCL/ LCL + PLC</td>
<td>—</td>
</tr>
<tr>
<td>V</td>
<td>Fracture dislocation</td>
<td></td>
</tr>
</tbody>
</table>

### Moore classification

**Fracture-Dislocation of the Knee**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Split fractures through medial or lateral plateau</td>
</tr>
<tr>
<td>II</td>
<td>Complete fractures separating entire medial or lateral plateau</td>
</tr>
<tr>
<td>III</td>
<td>Rim avulsion fracture</td>
</tr>
<tr>
<td>IV</td>
<td>Rim compression fracture</td>
</tr>
<tr>
<td>V</td>
<td>4-Part fractures</td>
</tr>
</tbody>
</table>

### Anatomic Knee Dislocation Classification System

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KD I</td>
<td>KD with PCL intact. Collateral ligaments may be injured.</td>
</tr>
<tr>
<td>KD II</td>
<td>KD with both PCL and ACL injured and collateral ligaments intact.</td>
</tr>
<tr>
<td>KD IIIa</td>
<td>KD with both PCL and ACL injured and one collateral ligament injured, either medial or lateral.</td>
</tr>
<tr>
<td>KD IV</td>
<td>KD with ACL, PCL, and both collateral ligament injury.</td>
</tr>
<tr>
<td>KD V</td>
<td>KD with a periarticular fracture</td>
</tr>
</tbody>
</table>
ALGORITHM FOR CONCOMITANT VASCULAR INJURY

OVERALL INCIDENCE: 20%

EXAMINATION INCLUDES PALPATING DORSALIS PEDIS AND POSTERIOR TIBIAL PULSES

ABI: ANKLE-BRACHIAL-INDICES (sensitivity in detecting vascular injury ~ 100%)

ANGIOGRAPHY RECOMMENDED FOR PATIENTS WITH INSUFFICIENT PERFUSION OR ANY ASYMMETRY IN P.E.

Lachman et al., Ortop Clin N Am, 2015
Boyce et al., J Am Acad Orthop Surg, 2015
Nicandri et al., Clin J Sport Med, 2009
NEUROLOGIC EXAMINATION

- INCIDENCE 4.5% - 40%
- COMMON PERONEAL NERVE MOST COMMONLY INJURED
- MOTOR EXAMINATION INCLUDES FLEXOR AND EXTENSOR ALLUCIS LONGUS, TIBIALIS ANTERIOR AND GASTROCNEMIUS
- IN CASE OF NEUROLOGIC DEFICIT -> RECOVERY UNPREDICTABLE

Lachman et al., Ortop Clin N Am, 2015
REDUCTION & IMMOBILIZATION

- AFTER NEUROVASCULAR EXAMINATION
- ESSENTIAL TO REDUCE AS SOON AS POSSIBLE
- SKIN NECROSIS CAUSED BY DELAYED REDUCTION IS COMMON

ATTENTION TO «DIMPLE SIGN» (INCARCERATION OF MCL IN THE JOINT PREVENTING COMPLETE REDUCTION)
POSTREDUCTION IMMOBILIZATION

GROSSLY UNSTABLE KNEE:

**EXTERNAL FIXATOR** FOR STABILITY AND SOFT TISSUES HEALING AND GRAFT PROTECTION IN CASE OF VASCULAR OR RECONSTRUCTIVE SURGERY

NOT GROSSLY UNSTABLE:

**KNEE IMMOBILIZER IS RECOMMENDED**

CIRCUMFERENTIAL SPLINTING OR CASTING INCREASE THE CHANCE OF COMPARTMENT SYNDROME SECONDARY TO LIMITED MATERIAL COMPLIANCE

Engebretsen et al, KSSTA 2009
RADIOGRAPHIC EVALUATION

IMMEDIATE

AFTER REDUCTION:

- TO CONFIRM REDUCTION
- FRACTURE EVALUATION
- OVERALL KNEE ALIGNMENT

ASSOCIATED FRACTURES INCIDENCE: 10-20%

SECONDARY

AFTER NEUROVASCULAR EXAMINATION AND STABILIZATION:

- CT
- MRI
- BOTH

SURGICAL TIMING

EARLY OPERATIVE INTERVENTION (WITHIN 3 WEEKS): OPEN SURGERY DUE TO CAPSULAR DISRUPTION PRECLUDING ARTHROSCOPIC ASSISTANCE (RISK OF FLUID EXTRAVASION AND COMPARTMENTAL SYNDROME)

SEQUENCE:
1. PCL
2. ACL
3. COLLATERAL LIGAMENTS AND PLC PMC REPAIR/RECONSTRUCTION

DELAYED INTERVENTION (AFTER 3 WEEKS): DIRECT REPAIR OF THE COLLATERALS IS NO LONGER POSSIBLE AND RECONSTRUCTION WITH AUTOGRRAFT OR ALLOGRAFT IS NECESSARY

CONTROVERSIAL RESULTS
EARLY OPERATIVE TREATMENT OF THE MULTILIGAMENT-INJURED KNEE YIELDS IMPROVED FUNCTIONAL AND CLINICAL OUTCOMES COMPARED WITH NONOPERATIVE MANAGEMENT OR DELAYED SURGERY

REPAIR OF THE POSTEROLATERAL CORNER MAY YIELD HIGHER REVISION RATES COMPARED WITH RECONSTRUCTION
SURGICAL TIMING

Acute surgical management of traumatic knee dislocations – Average follow-up of 10 years

R.S. Khakha\textsuperscript{a,b}, A.C. Day\textsuperscript{a,*}, J. Gibbs\textsuperscript{a}, S. Allen\textsuperscript{a}, P. Hill\textsuperscript{b}, J. Hull\textsuperscript{b}, A. Perry\textsuperscript{b}, H. Chissell\textsuperscript{b}

\textsuperscript{a} St George’s University Hospitals NHS Foundation Trust, Blackshaw Road, London SW17 0QT, United Kingdom
\textsuperscript{b} Frimley Park Hospital NHS Foundation Trust, Portsmouth Road, Frimley, Surrey GU16 7UJ, United Kingdom

- 56\% ASSOCIATED INJURIES
- 22\% CPN PALSY
- 11\% POPLITEAL ARTERY INJURY
- 56\% IKDC A-B
- 53\% GOOD – EXCELLENT OUTCOME
- HIGH LEVEL OF OVERALL KNEE FUNCTION FOLLOWING ACUTE SURGICAL RECONSTRUCTION

The Knee, 2016
SURGICAL TIMING

Review
Early or delayed reconstruction in multi-ligament knee injuries: A systematic review and meta-analysis

Erik Hohmann a,b,* Vaida Glatt c Kevin Tetsworth d,e,f,g

a Medical School, University of Queensland, Australia
b Medical School, University of Pretoria, South Africa
c Department of Orthopaedic Surgery, University of Texas Health Center, San Antonio, TX, USA
d Department of Orthopaedic Surgery, Royal Brisbane Hospital, Herston, Australia
e Department of Surgery, School of Medicine, University of Queensland, Australia
f Queensland University of Technology, Australia
g Orthopaedic Research Institute of Australia, Australia

► SIGNIFICANTLY HIGHER LYSHOLM SCORE IN EARLY GROUP

► 31% OF PT. WITH EARLY SURGERY NORMAL OR NEAR-NORMAL KNEE VS. 15% OF PT. WITH LATE SURGERY

► TREND OF IMPROVED ROM

The Knee, 2017
SURGICAL TIMING

- Complications higher in patients with >3 ligaments and in early treatment (<3 weeks)
- Knee stiffness more common in patients who had >3 ligaments and acute
- Knees with all 4 ligaments more revision surgery cases
- Infection more common in the obese group

Cook, Amendola, KSSTA, 2015
COMPLEX KNEE DISLOCATION NEED DIFFERENT MANAGEMENT
PROPOSED SURGICAL APPROACH

STAGED SURGERY WITH APPLICATION OF DYNAMIC EXTERNAL FIXATOR PLUS:

- PCL RECONSTRUCTION
- TREATMENT OF ASSOCIATED LESIONS (FRACTURE, VASCULAR INJURY)
## KNEE DISLOCATIONS GROUP DEMOGRAPHYCS
(F.U. 1-4 YEARS)

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age at injury (years)</th>
<th>Followup (months)</th>
<th>Body mass index (kg/m²)</th>
<th>Open dislocation</th>
<th>Injured ligaments</th>
<th>Associated fractures</th>
<th>Neurovascular status</th>
<th>Surgery associated with EF implant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male</td>
<td>47</td>
<td>45</td>
<td>32.2</td>
<td>No</td>
<td>ACL + PCL + MCL + LCL</td>
<td>No</td>
<td>No</td>
<td>PCL + MCL repair</td>
</tr>
<tr>
<td>2</td>
<td>Male</td>
<td>42</td>
<td>33</td>
<td>41.9</td>
<td>No</td>
<td>ACL + PCL + MCL + LCL</td>
<td>Tibial plateau</td>
<td>No</td>
<td>PCL + PLC repair + internal fixation</td>
</tr>
<tr>
<td>3</td>
<td>Male</td>
<td>20</td>
<td>10</td>
<td>22.4</td>
<td>Yes</td>
<td>ACL + PCL + MCL + LCL</td>
<td>No</td>
<td>No</td>
<td>PCL + MCL repair</td>
</tr>
<tr>
<td>4</td>
<td>Male</td>
<td>18</td>
<td>18</td>
<td>20.9</td>
<td>No</td>
<td>ACL + PCL + MCL + LCL</td>
<td>No</td>
<td>Popliteal artery</td>
<td>Popliteal artery bypass</td>
</tr>
<tr>
<td>5</td>
<td>Male</td>
<td>18</td>
<td>26</td>
<td>21.3</td>
<td>No</td>
<td>ACL + PCL</td>
<td>Tibial plateau</td>
<td>No</td>
<td>PCL + internal fixation</td>
</tr>
<tr>
<td>6</td>
<td>Male</td>
<td>27</td>
<td>22</td>
<td>28.8</td>
<td>Yes</td>
<td>ACL + PCL + MCL + LCL</td>
<td>No</td>
<td>No</td>
<td>Wound suture</td>
</tr>
<tr>
<td>7</td>
<td>Female</td>
<td>45</td>
<td>20</td>
<td>27.5</td>
<td>No</td>
<td>ACL + PCL + MCL + LCL</td>
<td>Tibial plateau</td>
<td>No</td>
<td>Internal fixation</td>
</tr>
<tr>
<td>8</td>
<td>Male</td>
<td>20</td>
<td>34</td>
<td>21.5</td>
<td>Yes</td>
<td>ACL + PCL + MCL</td>
<td>Patella</td>
<td>No</td>
<td>Patella TBW</td>
</tr>
</tbody>
</table>

EF = external fixator; MCL = medial collateral ligament; LCL = lateral collateral ligament; PLC = posterolateral corner; TBW = tension band wiring.

M. Marcacci, S. Zaffagnini, T. Bonanzinga CORR 2012
CLINICAL RESULTS

>60% NORMAL OR NEAR-NORMAL KNEES

Table 2. Clinical results

<table>
<thead>
<tr>
<th>Patient</th>
<th>Lysholm score</th>
<th>IKDC (subjective) score</th>
<th>Tegner level</th>
<th>IKDC (objective) score</th>
<th>ROM</th>
<th>Loss of flexion</th>
<th>KT-1000™ at MMT (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>68</td>
<td>67</td>
<td>3</td>
<td>B</td>
<td>0°–100°</td>
<td>20°</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>71</td>
<td>68</td>
<td>3</td>
<td>C</td>
<td>0°–110°</td>
<td>15°</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>62</td>
<td>61</td>
<td>3</td>
<td>C</td>
<td>0°–120°</td>
<td>15°</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>96</td>
<td>92</td>
<td>7</td>
<td>C</td>
<td>0°–140°</td>
<td>0°</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>82</td>
<td>78</td>
<td>4</td>
<td>A</td>
<td>0°–120°</td>
<td>5°</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>76</td>
<td>69</td>
<td>4</td>
<td>B</td>
<td>0°–115°</td>
<td>20°</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>75</td>
<td>73</td>
<td>4</td>
<td>B</td>
<td>0°–120°</td>
<td>10°</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>82</td>
<td>78</td>
<td>5</td>
<td>B</td>
<td>0°–130°</td>
<td>10°</td>
<td>3</td>
</tr>
</tbody>
</table>

IKDC = International Knee Documentation Committee; MMT = manual maximum test (side-to-side difference).

- STAGED SURGERY
- SOFT TISSUE PROTECTION
- KNEE STIFFNESS AVOIDANCE
- EARLY MOBILIZATION TO AVOID ARTHROFIBROSIS

M. Marcacci, S. Zaffagnini, CORR, 2012
Male, 21 Years Old
FEMALE 21 Y.

KNEE LUXATION

POPLITEAL ARTERY ISCHEMIA

FEMORO POLITEAL BY PASS

COMPARTIMENTAL SYNDROME

FASCIOTOMY

TEMPORARY KNEE FIXATION WITH EXTERNAL FIXATOR
28-2-2014

✓ EXTERNAL FIXATOR REMOVAL

✓ NEXT SURGERY SCHEDULED:

LATERAL MENISCECTOMY (BUCKET HANDLE TEAR)
PCL REC. (G\ST)
MCL REC. (ALLOGRAFT)

25-3-2014 SURGICAL PROCEDURE
CONCLUSION

- ACCURATE PRE-OPERATIVE EVALUATION
- ACUTE (3 WEEKS) OR STAGED SURGERY ACCORDING TO DISLOCATION DEGREE (CUSTOMIZED TO PATIENT COMPLICATION)
- RECONSTRUCTION OR REPAIR OF ALL SOFT TISSUE STRUCTURE
- IN SEVERE CASE APPLICATION OF DYNAMIC EXTERNAL FIXATOR ALLOW:
  
  STAGED LIGAMENT RECONSTRUCTION (EASIER)
  
  EARLY ROM PROTECTING GRAFT TISSUES
thank you!

Prof. Stefano Zaffagnini

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