Objective To estimate the incidence and proportion of non-contact to total ACL injuries by sex, age, sport, participation level, and exposure type.

Design Systematic review, meta-analysis and meta-regression

Setting Team ball-sports (soccer, rugby, basketball, volleyball, American and Australian football, floorball, lacrosse, hockey, baseball, softball)

Participants Athletes participating in team ball-sports regardless of sex, age, and participation level

Interventions Six electronic databases were searched from inception to July 2020. Cohort studies of team ball-sports reporting number of knee injuries as a function of exposure and injury mechanism were included.

Main Outcome Measurements Proportion of non-contact to total ACL injuries and non-contact ACL injury incidence by unit of exposure, sex, age group, sport, participation level, and exposure type.

Results Forty-three studies covering 12 sports were included. The overall proportion of non-contact to total ACL injuries was 54% (95% CI 47–60%, $I^2=90\%$; females: 62%, 95% CI 54–70%, $I^2=83\%$; males: 47%, 95% CI 39–54%, $I^2=86\%$). Injury incidence was higher in females (0.20 per 1000 player-hours, 95% CI 0.12–0.33, $I^2=92\%$; 0.07 per 1000 player-exposures, 95% CI 0.04–0.14, $I^2=98\%$) than males (0.08 per 1000 player-hours, 95% CI 0.04–0.14, $I^2=94\%$; 0.05 per 1000 player-exposures, 95% CI 0.03–0.08, $I^2=97\%$). Injury incidence during competition was much higher (0.53 per 1000 player-hours, 95% CI 0.35–0.81, $I^2=80\%$; 0.35 per 1000 player-exposures, 95% CI 0.17–0.71, $I^2=96\%$) than training (0.03 per 1000 player-hours (95% CI 0.02–0.05, $I^2=60\%$; 0.02 per 1000 player-exposures, 95% CI 0.01–0.05, $I^2=86\%$). Heterogeneity between studies was generally high.

Conclusions Non-contact ACL injuries represented over half of all ACL injuries sustained. The proportion of non-contact to total ACL injuries and injury incidence were higher in females than males. Injuries mostly occurred in competition settings. More research is required to fully understand the influence of sport, age group, and participation level on injury proportion and incidence. difficult.

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LONGITUDINAL CHANGES IN CUTTING KINEMATICS IN YOUNG FEMALE ATHLETES ACROSS PUBERTY

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Background Young female athletes involved in high-speed cutting and change-of-direction sports are particularly susceptible to anterior cruciate ligament (ACL) injuries. Little is known if maturational changes in cutting technique contribute to the increased injury risk.

Objective To examine longitudinal changes in cutting kinematics in female athletes as they matured through puberty.

Design Longitudinal cohort study

Setting Biomechanics laboratory

Patients (or Participants) One-hundred and seventy-two healthy high-school athletes were tested while in at least two different pubertal stages (pre-, mid-, post-pubertal).

Interventions (or Assessment of Risk Factors) Trunk, hip, and knee sagittal, frontal and transverse plane range-of-motion, peak angles, and angles at initial-contact during an unanticipated 45° cut measured with a laboratory-based optoelectronic motion capture system. Pubertal stages were defined by Tanner Stages.

Main Outcome Measurements Changes in trunk, hip, and knee kinematics as girls mature across puberty (pre-to-midpubertal, pre-to-postpubertal, mid-to-postpubertal).

Results As girls matured through puberty, they displayed a decrease in sagittal-plane hip (1.6–4.4°, $p\leq 0.01$) and knee range-of-motion (ROM) (2.7–2.9°, $p\leq 0.01$), and decreased peak hip (2.9–3.2°, $p\leq 0.02$) and knee flexion angles (2.5–2.9°, $p\leq 0.01$), which is indicative of greater quadriceps dominance. Peak knee abduction angles also increased as girls progressed through puberty (0.9–1.4°, $p\leq 0.006$), suggesting greater ligament dominance. In terms of trunk dominance, there were mixed findings with a decrease in trunk frontal- (2.5–5.7°, $p< 0.01$) and sagittal-plane ROM (1.4–2.0°, $p\leq 0.05$), but an increase in trunk transverse-plane ROM (2.8–3.6°, $p\leq 0.01$) observed as girls mature. Other significant changes in cutting technique were decreased peak trunk flexion (3.8–7.8°, $p\leq 0.01$), and decreased hip flexion (2.9–3.3°, $p\leq 0.01$) and knee flexion angles (2.0–3.0°, $p\leq 0.02$) at initial contact, suggesting a more upright and stiffer cutting posture.

Conclusions As girls mature through puberty, they display a change in cutting strategy characterized by greater quadriceps and ligament dominance. Ameliorating these kinematic changes throughout maturation may further reduce ACL injuries in this high-risk group.

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BONE BRUISE PATTERN AND MECHANISM OF ANTERIOR CRUCIATE LIGAMENT INJURY IN PROFESSIONAL FOOTBALL PLAYERS: CORRELATION BETWEEN MRI AND VIDEO ANALYSIS

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Background The presence of bone bruises (BB), especially in the lateral compartment of the knee, is a common finding in the context of anterior cruciate ligament (ACL) injury. However, different patterns have been described and a precise correlation with mechanism of ACL injury has never been determined.

Objective To correlate the MRI features of ACL injuries with the exact injury mechanism obtained from video-analysis. Such investigation, which has never been performed up to now, provides relevant insights in the understanding ACL injury mechanism and in the genesis of intra-articular lesions such as bone bruises.

Design Fifteen professional football players sustaining an ACL injury (while playing during an official match of First League Championship) were included in the study. The video of injury was obtained from the Television broadcast. Knee Magnetic Resonance Imaging (MRI) was obtained within 7 days

from the injury. BB and meniscal/cartilage lesions were analyzed on MRI, while a video analysis of mechanisms of ACL injury and injury dynamics were assessed from the videos.

Results The most common pattern of BB present in 8 cases (53%) was a femoral BB >5 mm in the central portion of the lateral femoral condyle and in the posterior portion of the lateral tibial plateau. In all these cases, the injury occurred with single-leg load during a pivoting maneuver while changing direction during pressing (33%), dribbling (7%), goalkeeping (7%) or in response of being being tackled on the upper body (7%). All these injuries occurred without direct contact, high horizontal speed and with an abducted hip.

Other patterns included BB only in tibia (20%), tibia and femur BB <5 mm (7%) or no BB (20%). In these cases, injury occurred due to direct contact (20%), recovery balance after kicking (13%) or jumping (7%), and while tackling (7%).

Conclusions A characteristic and well-defined BB pattern, with BB in both tibia and femur, was identified in ACL injuries without direct contact and while the football players had single-leg loading while pivoting trying to perform a sudden change of direction.

402 LATERAL-HEEL RELEASE-SETTINGS FOR SPECIAL SKI-BINDINGS

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Background Lateral-heel ski-binding release is favorably associated with the attenuation of combined abduction-moment/torsional-tibia-torque developed during Slip-Catch trauma on skis - which combined-loading is associated, biomechanically, with ACL injury.

Objective Derive a range of lateral-heel release-settings indexed to a range of 'torsional-tibia-torque release-settings' (torsional-settings). Hypotheses: a range of torsional-settings can be indexed to a range of lateral-heel release-settings to mitigate ACL injuries on skis.

Design, Setting

Biomechanical, Observational. International alpine skiing-binding test-method standards were expanded to include measurement of lateral-heel release. The toe-piece of the binding was calibrated to produce a range of torsional-settings as a function of a range of body-weights. A range of lower-leg lengths (denoted between the distal-heel and the centre of the knee) were culled from gender-specific biometric data, matched to body weights. Adding lower-leg length to boot-sole thickness, binding and ski-thickness - a range of 'total-length abduction-lever-arms' (TLALA) were matched to the range of body-weights. Lateral-heel release was hunted by adjusting the lateral-heel release-mechanism such that when (a) abduction-force was applied 5cm aft ward of a range of 'transition points' ('transition-point' = TLALA transposed horizontally to rear-portion of ski), lateral-toe release occurred; and when (b) abduction-force was applied 5cm forward of the transition-points, lateral-heel release occurred. Lateral-heel release-force was measured by a transducer positioned on the ski at the projected interface of the boot-sole/ski-binding heel.

Patients None.

Interventions Additional lateral-heel release-settings.

Main Outcome Measurements Lateral-heel release-force.

Results

Abstract 402 Table 1

Torsional-tibia | Lateral-heel release
release-torque | (force) setting [daN]
[daNm] | Females - Males

3.0 | 12 - 18
4.0 | 20 - 24
5.0 | 25 - 28
6.0 | 30 - 32
7.0 | 35 - 37
8.0 | 40 - 40

Conclusions A range of lateral-heel release (force) settings were indexed to a range of standardized torsional-settings. A prospective intervention study is needed to correlate lateral-heel release to a mitigation of ACL injuries.

403 INCIDENCE OF PEDIATRIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTIONS IN NORWAY FROM 2005 TO 2019

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Background The incidence of paediatric anterior cruciate ligament (ACL) reconstructions is increasing in the USA and Australia, but the incidence in Norway is unknown. The health burden regarding short- and long-term complications from ACL injury is high, and there are also risks of complications associated with reconstructions.

Objective The primary aims were to determine the incidence of paediatric ACL reconstructions in Norway and to detect changes in incidence during the past 14 years.

Design Retrospective observational register study.

Setting Data were retrieved from the nationwide Norwegian Knee Ligament Register (NKLR) which collects data on all cases of ACL reconstructions in Norway.

Patients (or Participants) Girls aged 14 years or younger, and boys aged 16 years or younger, with primary ACL reconstruction registered between January 2005 and December 2019.

Main Outcome Measurements Annual incidence of paediatric ACL reconstructions, stratified by age and sex.

Results For boys, the annual incidence increased from 21 per 100,000 in 2005 (95% CI, 15–27) to 30 in 2019 (95% CI, 23–37). For girls, the incidence increased from 14 (95% CI, 9–19) to 28 (95% CI, 20–36). A total of 26,106 patients (all ages) underwent ACL reconstruction between 2005–2019. Of these, 818 (3.1%) were boys, and 470 (1.8%) were girls. The mean age at time of surgery was 15.3 years (SD 0.94) for boys, and 13.7 years (SD 0.57) for girls. Of the surgically treated patients, 55.6% (455) of the boys were 16 years of age, and 77.4% (364) of the girls were 14 years of age. The sports where most injuries occurred were football, handball and alpine.