

Serum hormone levels at the time of ACL injury

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ACL Study Group

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BACKGROUND AND SIGNIFICANCE

- Incidence of ACL Tears
 - 2 to 6 x higher in females compared to males

Stevenson Iowa Orthop J 1998

Ferretti AJSM 1992

Gray Int. JSM 1985

Myklebust Scand J Sports Med 1998

Lindenfeld AJSM 1994



BACKGROUND AND SIGNIFICANCE

- One in five female alpine ski racers have sustained an ACL disruption.
- Female racers are 3.1 times more likely to sustain an ACL disruption than her male counterpart.

Stevenson Iowa Orthop J 1998



Theoretical Possibilities

- Extrinsic factors
- Intrinsic factors



Extrinsic Factors

- Body movement
- Boot-binding interface
- Skill levels
- Conditioning
- Ski Conditions
- Cultural



Intrinsic Factors

- Joint laxity
- Limb alignment
- Femoral notch dimensions
- Ligament size
- Leg length
- Genu recurvatum
- Excessive foot pronation
- Muscular strength
- Muscle firing patterns
- Psychological
- Hormonal factors



Hormonal Factors

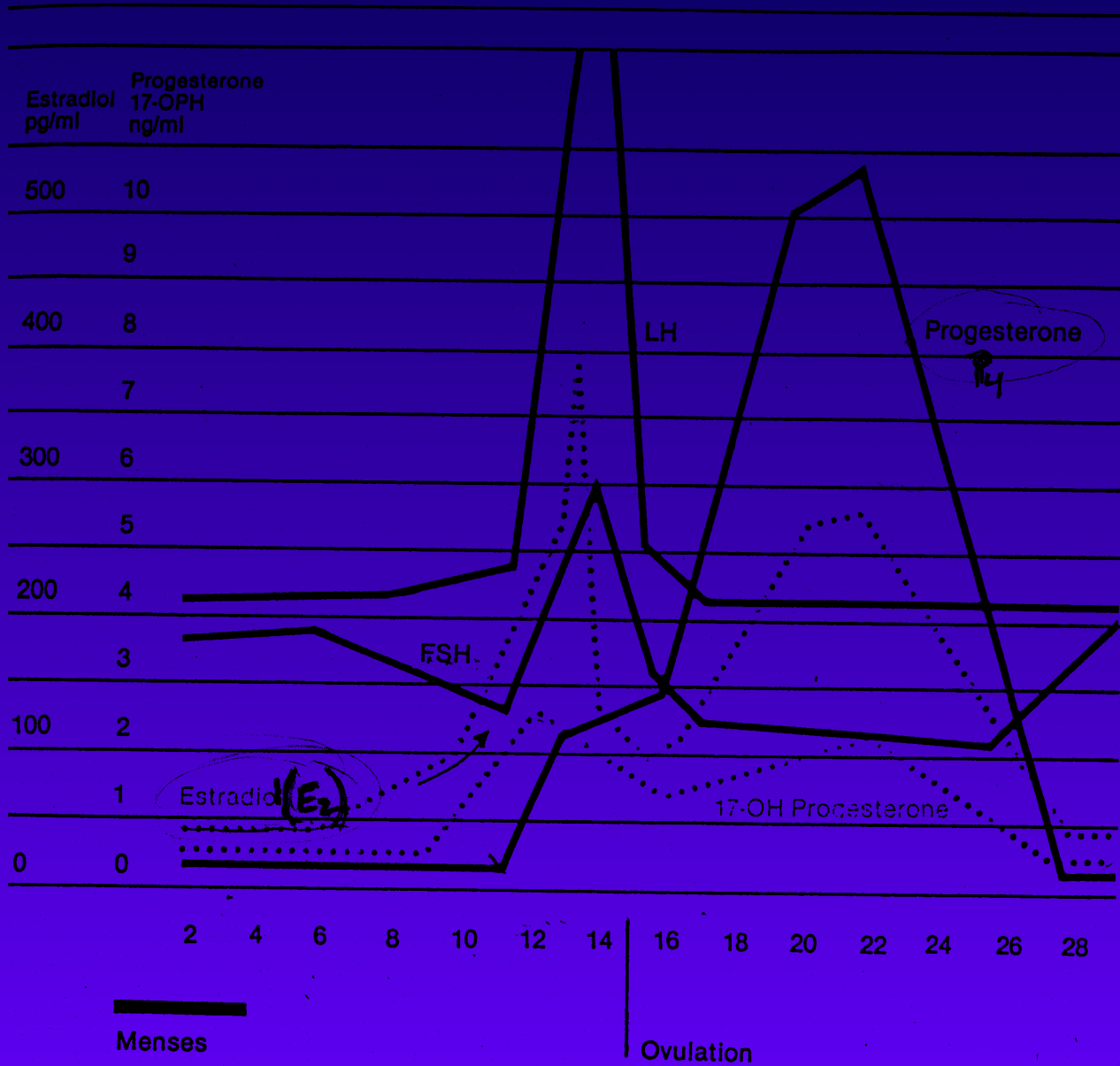
- Estrogen and Progesterone vary in concentration in rhythmic response to mid-brain signals.
- E2 and P4 have direct effects on most connective tissues and muscle.
 - Receptors have been identified on the ACL
 - Effect cellular metabolism and collagen proliferation
 - Increasing levels correlates with increases in knee laxity
 - Effect strength, relaxation and fatigability of muscle

Liu AJSM 1997

Rozzi AJSM 1999

Sarwar J Physio 1996





Hypothesis

The phase of the menstrual cycle has no effect on the risk of ACL injury.



Specific Aims

1. To identify female athletes with ACL disruptions.
2. To obtain serum estrogen and progesterone level from female athletes at the time of ACL disruption.
3. To correlate serum estrogen and progesterone level with menstrual cycle.
4. To determine if incidence of ACL injury is affected by phase of menstrual cycle



Study Design

- Cohort investigation
 - Performed at a Vermont ski area during the 2000-2002 seasons
- Female alpine skiers
 - Ages 16-50



Inclusion / Exclusion Criteria

- All subjects admitted to Ski Clinic with grade II-III ACL sprains
- Subjects were excluded for the following:
 - History of Grade 2 or Grade 3 ACL sprain
 - Previous surgical procedure involving the knee
 - Sustain a knee dislocation
 - History of metabolic disease (ex. diabetes)
 - Presence of a degenerative joint disease (ex. JRA)
 - Currently pregnant.



Outcome Measures

- ACL disruption
 - Clinical evaluation verified at follow-up by arthroscopy
- At the time of injury
 - Serum estrogen (E_2) and progesterone (P_4) concentrations
- Injury history
- Menstrual history and use of OCP
- IKDC



Statistical Methods

- Pearson Chi-Square test used to compare expected and observed rates of ACL injury
- Power study:
 - a sample size of 41 is needed for 80% power to detect a significant increase



Results

- 25 women with ACL disruptions
 - 13 No-OCP
 - 12 OCP
- Age 16 to 48
- Skiing ability;
 - Beginner (5)
 - Intermediate (13)
 - Expert (7)



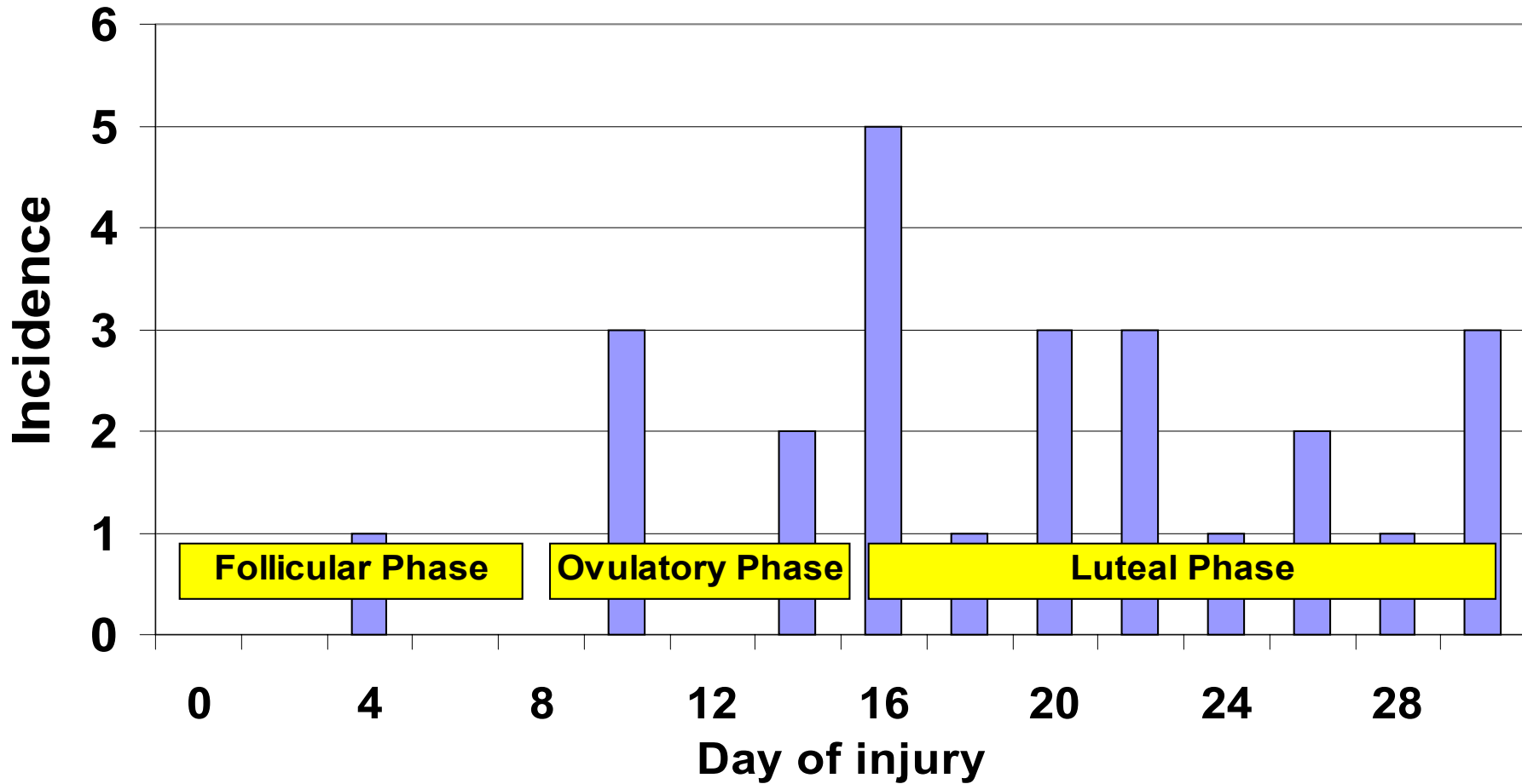
Results

- When all subjects were examined, there were significant differences in the incidence of ACL tears based on cycle phase.

($p=0.007$)



Incidence of injury based on 28 day cycle

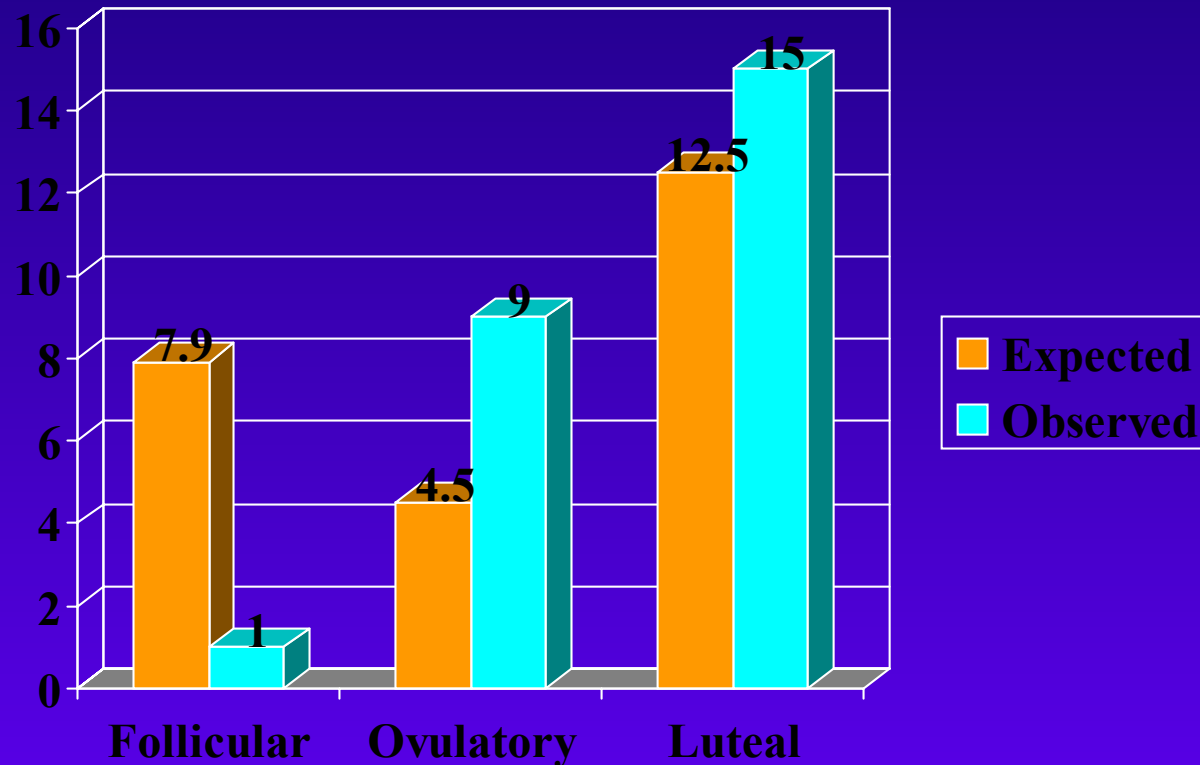


Results

- A disproportionately large number of ACL injuries occurred in the ovulatory and luteal phases compared to the follicular phase.



Observed vs. Expected injuries



Subjects not on OCP

	Expected	Observed
Follicular	4.1	1
Ovulatory	2.3	5
Luteal	6.5	7

($\chi^2=5.462$, $p=0.06$)



Subjects on OCP

	Expected	Observed
Follicular	3.8	0
Ovulatory	2.2	4
Luteal	6	8

($\chi^2=6.074$, $p=0.05$)



Results

E_2 and P_4 were significantly elevated for the non-OCP group

	OCP	Non-OCP	
E_2 (pg/ml)	56.0	125.6	P=0.02
P_4 (ng/ml)	0.68	3.35	P=0.01



Conclusion

- We were able to identify female athletes with ACL injuries, and obtain serum on the day of injury for hormonal analysis.
- Serum estradiol and progesterone levels were correlated with self-report menstrual histories.
 - No significant difference between cycle phase determination based on serum analysis as compared with self-report ($\chi^2=0.343$, $p=0.84$).



Conclusion

- A variation in incidence of injury was identified.
 - More injuries occurred during the ovulatory and luteal phase than expected.
 - Similar patterns were observed in both OCP and non-OCP subjects.
 - This was demonstrated by both self-report and serum determination of menstrual cycle phase.



Conclusion

- Elevations in progesterone and estrogen were noted in the group not taking OCP.
 - This study was not designed to evaluate the effects of concentration of E2 and P4 on the risk of injury, however our data suggests that concentration may not be an effect.



Conclusion

- Menstrual cycle phase does have an effect on the risk of suffering an ACL injury in alpine skiers



Future Directions

- Currently in second season of recruitment
 - Obtaining control data from non-injured female alpine skiers
 - Population at risk
 - Absolute hormone levels



Thank You

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