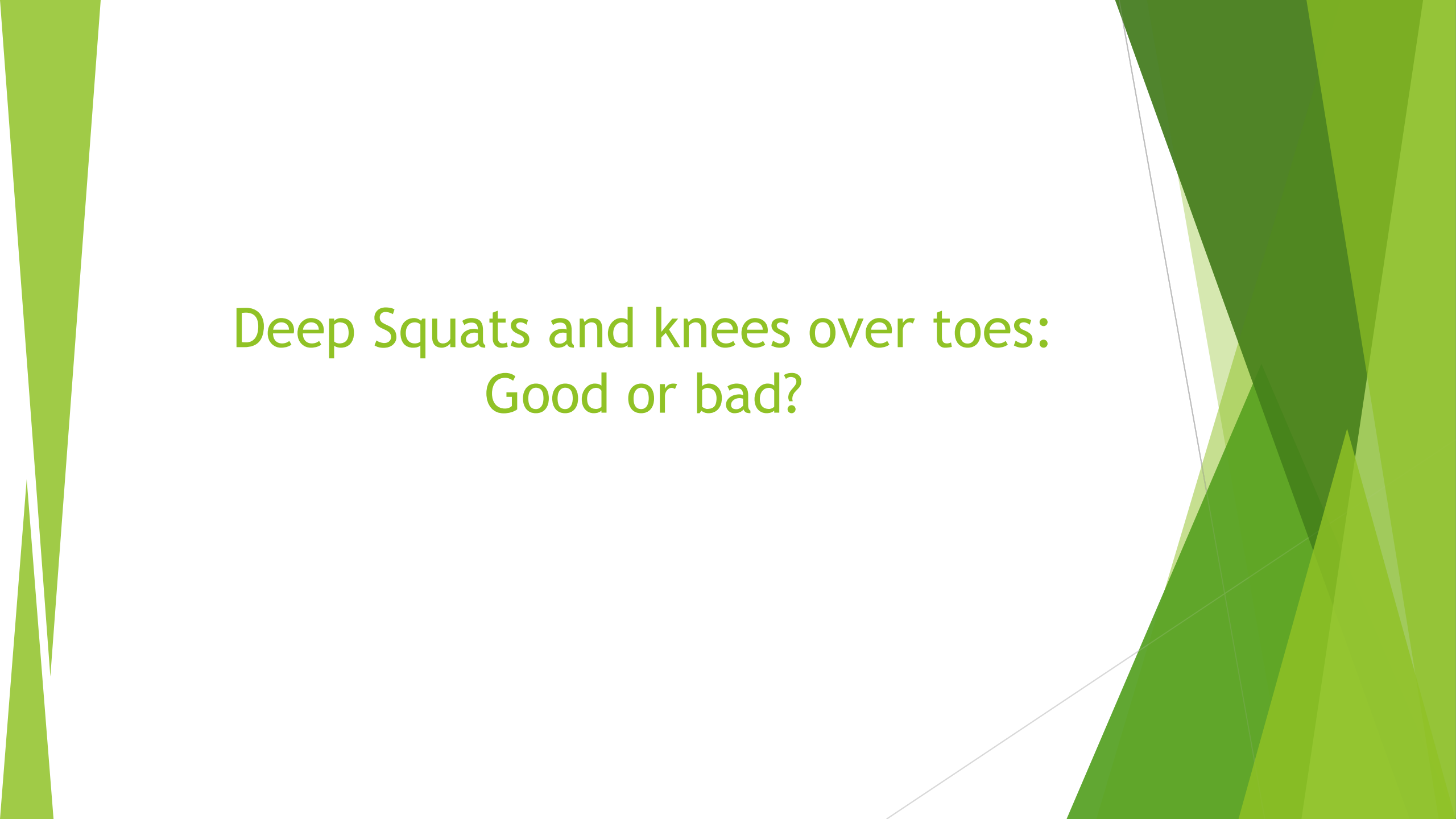


The background features abstract, overlapping green geometric shapes, primarily triangles and polygons, in various shades of green, creating a modern and dynamic visual effect.

Deep Squats and knees over toes: Good or bad?



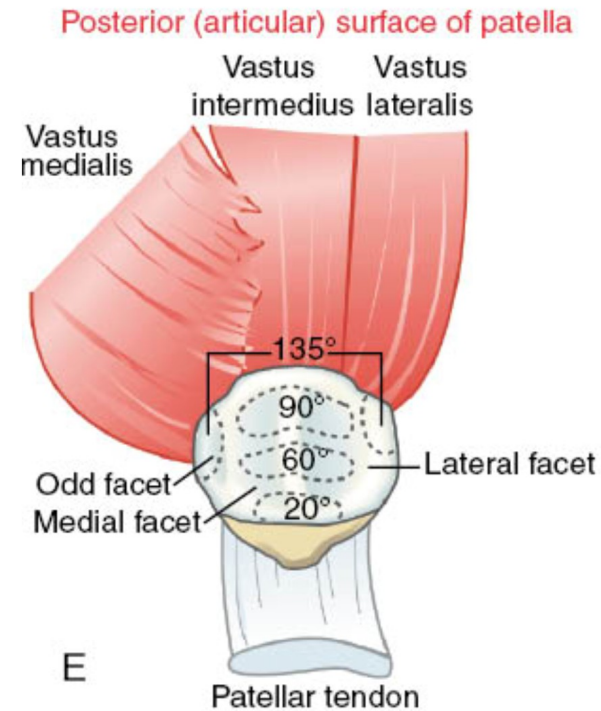
Squat Warnings!

- ▶ Don't let knees go beyond your toes.
Only go down to parallel (ACSM)

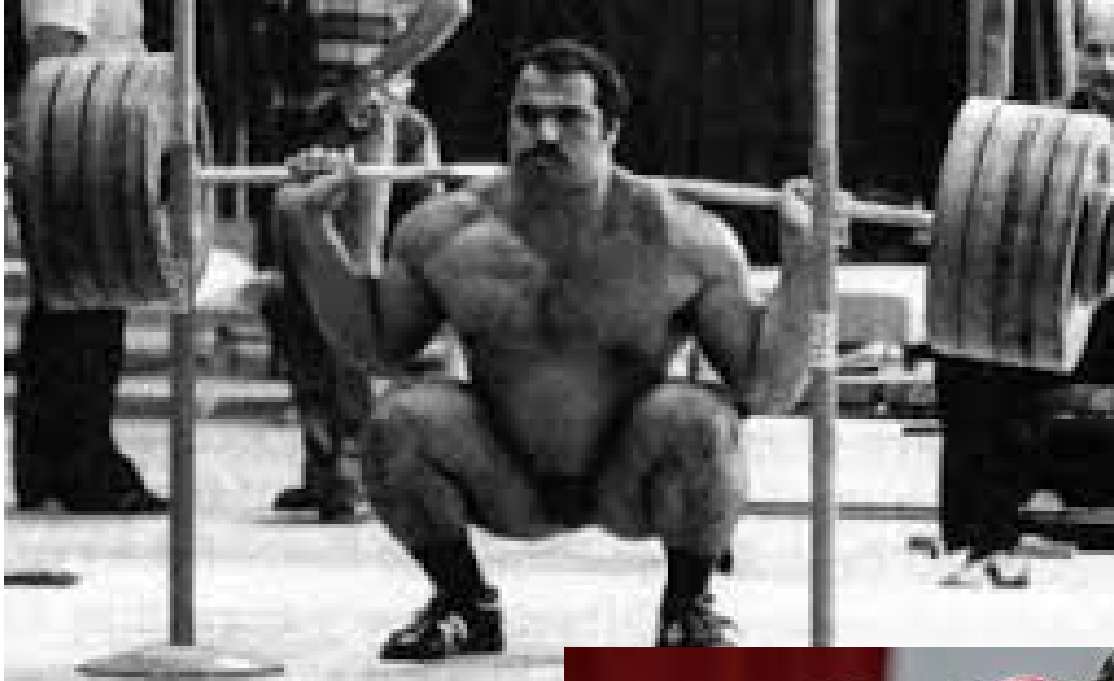
Squatting is bad for your knees/back/etc

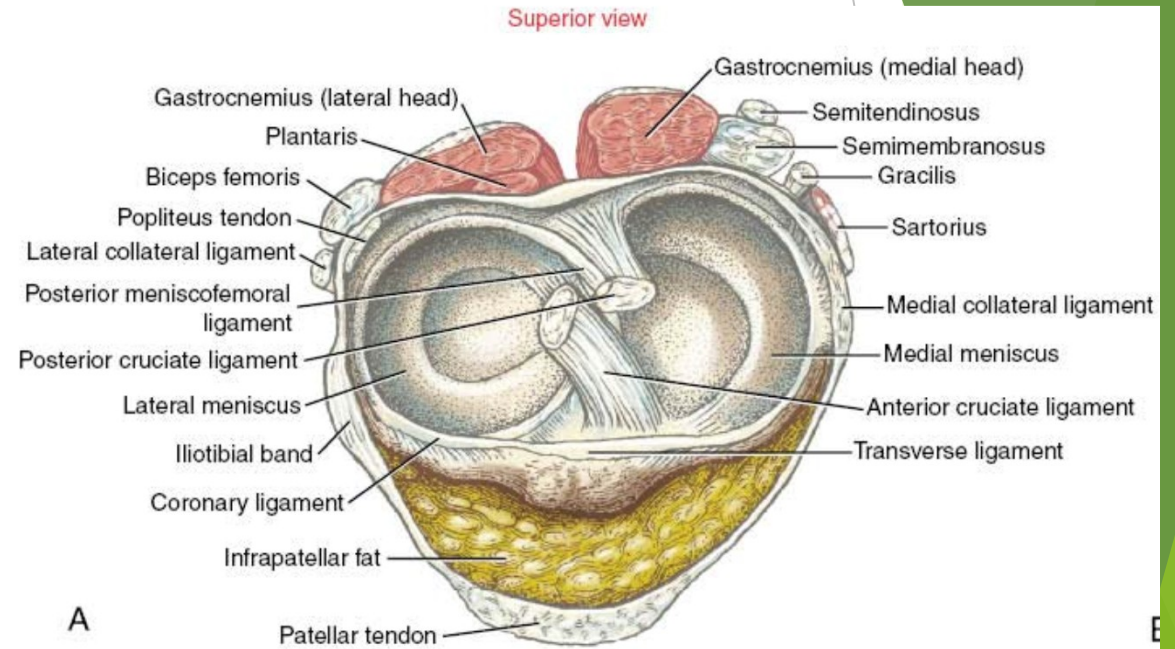
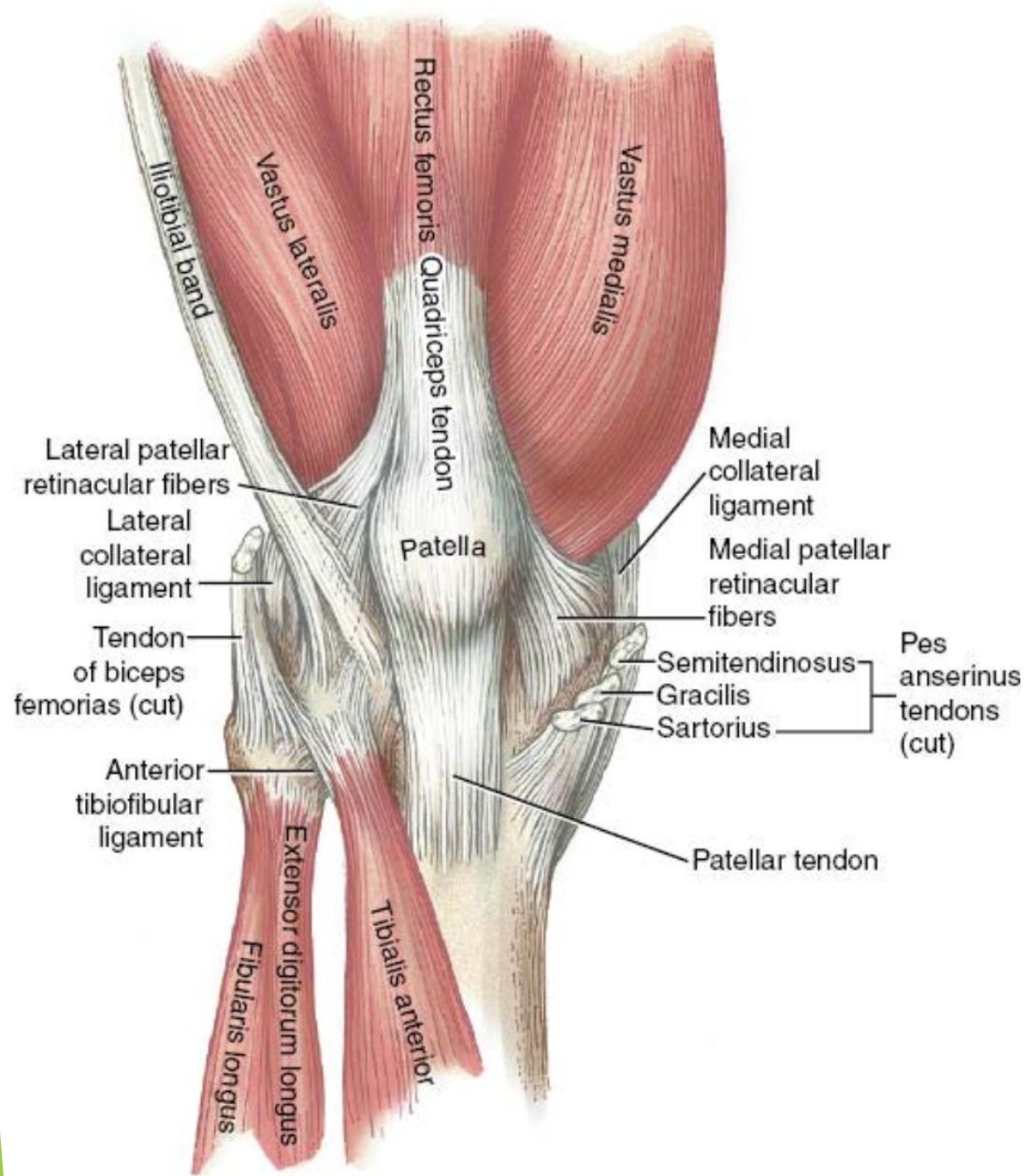
Decreased area on back of patella when deep squatting

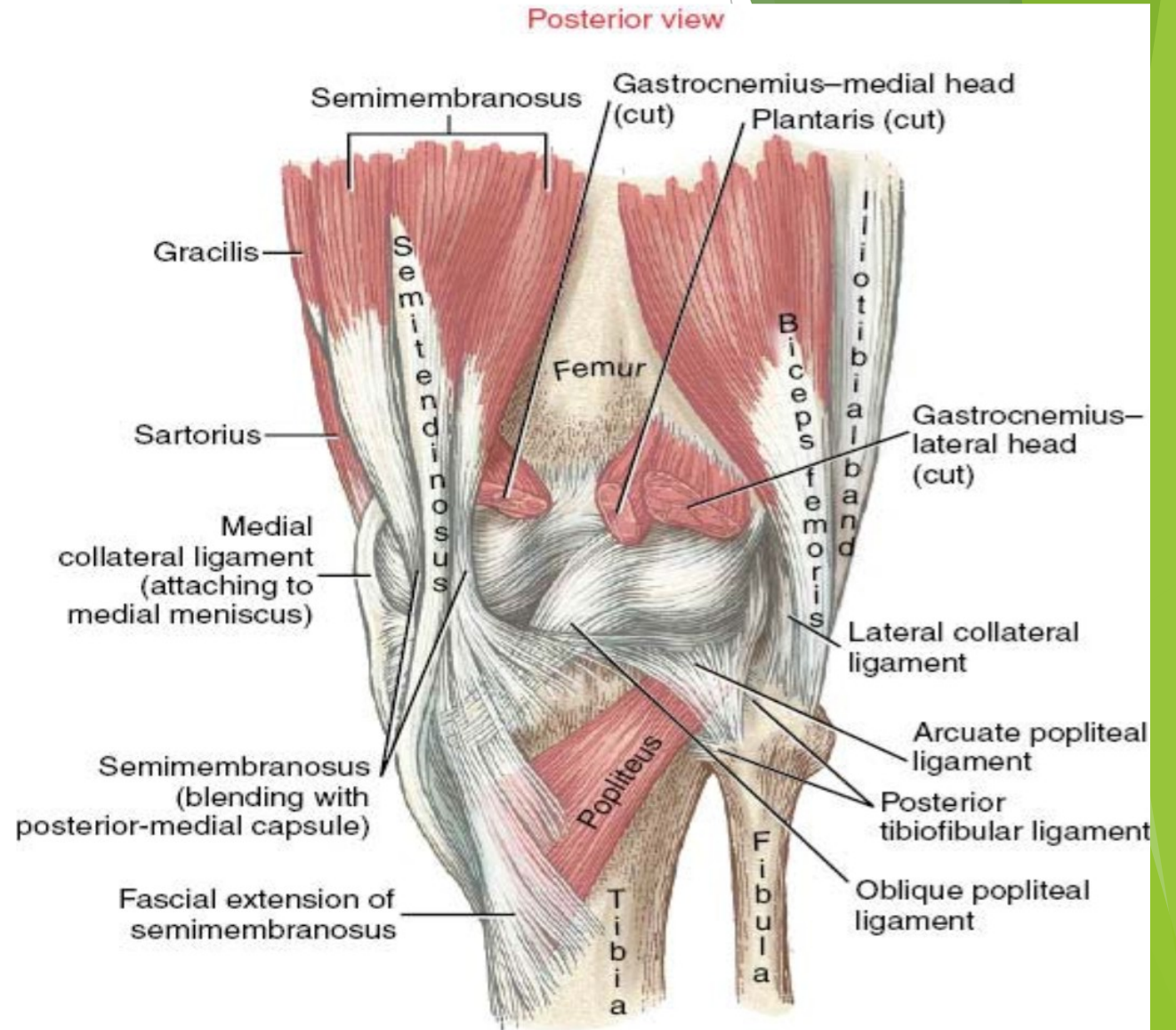
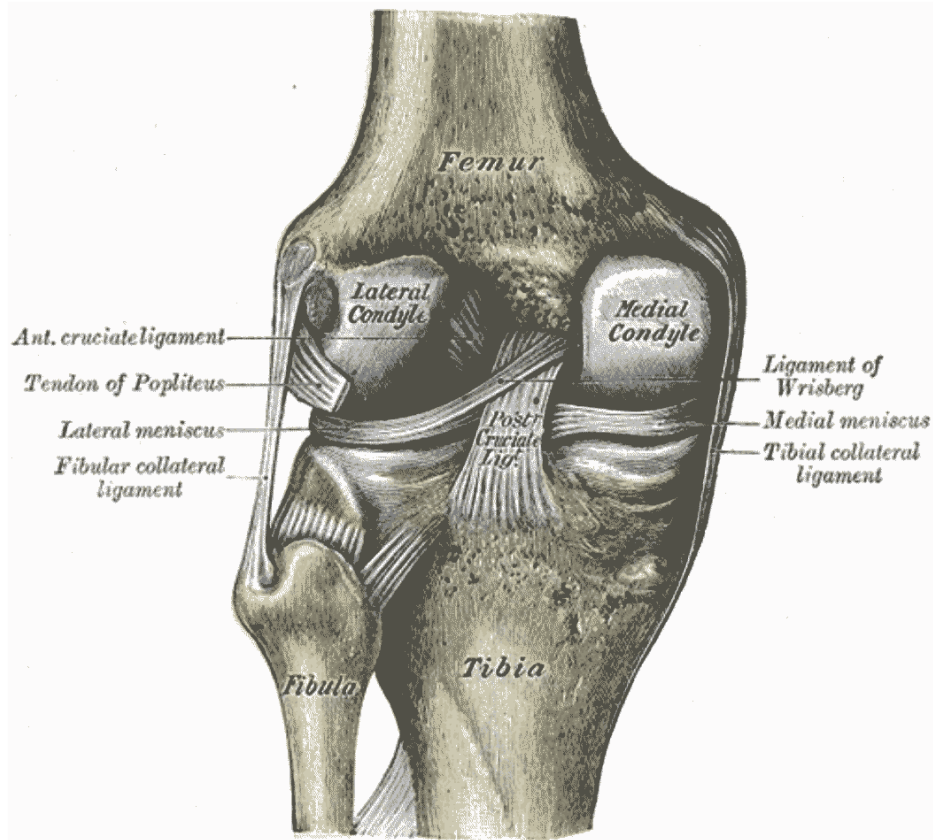
Increased risk of arthritis



But wait...







The idea deep squats are bad for you

- ▶ Dr. Karl Klein: Study found that weightlifters had greater knee laxity when comparing 128 weightlifters to 360 college students.

One, the applying of the pressure was far too subjective. The tester could push harder and harder on the knee joint and secure a pre-determined reading. Many athletes complained that the tester actually hurt their knees because he pushed so hard. Did he push equally hard on each subject? Two, the tester always had the subject classified as a squatter or non-squatter before he tested him, rather than after. This certainly gave the tester the opportunity to have a built-in prejudice... By applying the same testing procedure, another researcher, with an eye to reversing the findings, could quite easily do so. A pure piece of research should not have this wide margin of testing subjectivity unless it is specifically spelled out in the conclusion, which it definitely was not in this case.” (Bill Star, The Strong Shall Survive: Strength Training for Football. 1976 pg 39-40)

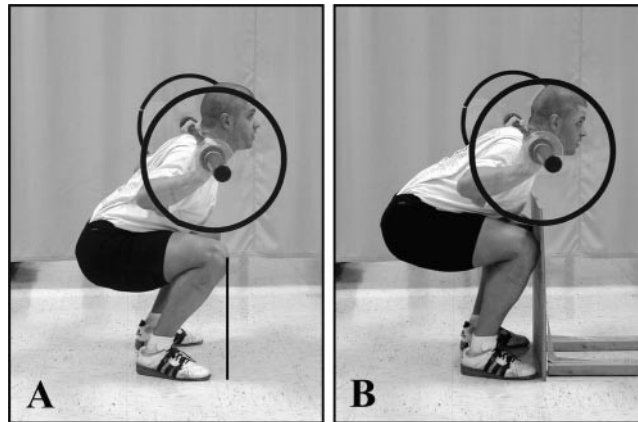
- ▶ “Dr. Karl Klein’s study at the University of Texas in 1961 is a poorly designed and badly conducted mess that has never been replicated and has been successfully



The idea deep squats and squatting with knees over toes are bad for you.

- Duke study “keeping lower leg more vertical reduced shear forces.”

2003 Memphis study **Effect of Knee Position on Hip and Knee Torques During the Barbell Squat.** ANDREW C. FRY et al. Journal of Strength and Conditioning Research, 2003, 17(4), 629±633



Why deep squats/knees over toes isn't bad.

- Schoenfield, Squatting Kinematics and Kinetics and their Application to Exercise Performance, *J Strength Cond Res* 24 (12): 3497-3506, 2010.

When squatting with 2.5 times bodyweight peak tibiofemoral compression forces measured at 8000 N at 130 degrees. Patellofemoral ligament is capable of resisting 10-15K Newtons. (This does not take into account the wrapping effect discussed later.)

Weightlifters lifting 2x body weight reached 25% of ACL strain, 50% of PCL strain. (Not factoring in assistance from hamstring, quad.)

Knee structures are highly constrained above 120 degrees flexion, which means increased stability and greater load tolerance.

Forces at knee

- ▶ Hamstrings alleviate ACL stress, especially as you squat deeper. They alleviate shear force by pulling superior tibia posteriorly.

Peak anterior shear force is from 0-60 degrees, highest around 30 degrees.

Peak posterior force is at 90 degrees, decreases as you squat deeper. Quads alleviate PCL stress by pulling superior tibia anteriorly.

Highest ACL force when squatting without weights was 95 N, which is 6% of that of a young person.

Highest PCL force was 73.2 N at 90. Decreases as you squat past 90.

Forces at knee

- Analysis of the Load on the Knee Joint and Vertebral Column with Changes in Squatting Depth and Weight Load, Hartmann, Sports Med (2013) 43: 993-1008.

164 Article Review on Pubmed

As of Jan 2013, no studies take into account the wrapping effect which enhances load distribution and force transfer. This means decreased retropatellar force. Argues there is no true measurement of forces below 50 degrees flexion because they don't account for wrapping effect, or hamstring/calf contact.

Decreased surface area on meniscus at 90 degrees, but compressive forces increase surface area. (ex vivo) Don't know how much it has exactly.

MRI has shown increasing surface area of meniscus at 60 in vivo with increased loading.

Injury risk?

- ▶ Former pro weightlifters and former pro soccer players had similar amounts of knee arthritis (29 and 31%) though weightlifters had more patellofemoral. Soccer players had more tibiofemoral. Misdiagnosis must be noted.

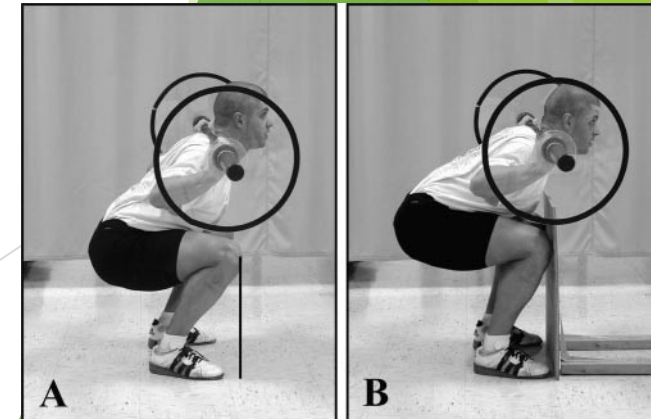
27 Olympian weightlifting athletes from different training centers averaged 3.3 injuries per 1000 training hours. 95% of these injuries resulted in a day or less of missed training time. Remaining cases lost less than a week's training time. Largely tendinitis and overuse injuries.

4 year retrospective study of 1,109 weightlifters age 12-20 competing and national and international level showed no injury that required surgery or hospitalization

Weightlifter survey had .0017 injuries per 100 hours of training. Basketball was .03, track and field .57, American football .1, gymnasts .04.

Why NOT putting knees over toes is bad

- ▶ Descend to thighs below parallel?
 - It can be argued that not squatting deep has higher risk for injury
 - Animal studies have shown that partial squats increase risk for degeneration and atrophy of tissue due to lack of use.
- ▶ Highest knee shear forces at depths from 30-90 degrees. If weightlifting and not squatting deep you may be loading up too much weight too fast.
- ▶ Knee's past the toes increases stress knee stress 28%. However a wooden barrier preventing knees from going past toes increase stress on hips 1000%, increased lower back stress via greater anterior lean of upper body to maintain balance while squatting.



Adaptions

- ▶ Knee joints of weightlifters (who began lifting at ages 7-13 years old) had 14% higher thickness at patella contact points during deep squat than control. Increased thickness equals increased stiffness and greater resistance to loads.

Cartilage thickness at tibial plateau and femoral condyles did not show a difference. Other studies have shown increased activity can lead to adaptations of cartilage tissue.

Active weightlifters at national and international level with average experience of 17 years showed no difference degenerative changes of cartilage at patellofemoral and tibiofemoral joints.

Conclusion

- ▶ Deep squatting is not bad for you. It's likely better for you than shallow squatting. It increases strength, range of motion, and decreases decay from lack of use. Our body will adapt to stresses placed upon it.

Knees over toes does not increase stress on knee structures in a dangerous way. This is especially true with body weight only squats, which is generally what our patient population will be. It does significantly affect hip and lower back to not put knees over toes or past.

There are very few times you wouldn't want to do deep squats.

More questions

- Effect on meniscus (measured 3.45K newtons in vivo at 66 degrees knee flexion.)

Difficult to measure, differences in different species and different parts of the body.

Are tendon strength measurement obtained from cadaver's? How much stronger are ligaments when in the body?

Sources

- ▶ Klein K. The deep squat exercise as utilized in weight training for athletes and its effects on the ligaments of the knee. J Assoc Phys Ment Rehabil. 15; Pp 6-11. 1961.

Deep Squats By Jason Shea PICP III, MS, C.S.C.S,
<http://www.apec-s.com/wp-content/uploads/2011/12/Deep-Squats.pdf>

Schoenfeld, BJ. Squatting kinematics and kinetics and their application to exercise performance. J Strength Cond Res 24(12): 3497-3506, 2010

Analysis of the Load on the Knee Joint and Vertebral Column with Changes in Squatting Depth and Weight Load, Hartmann, Sports Med (2013) 43: 993-1008

Effect of Knee Position on Hip and Knee Torques During the Barbell Squat.
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