Influence of Posterior Tibial Slope & Meniscal Tears on Preoperative Laxity in ACL-Deficient Knees

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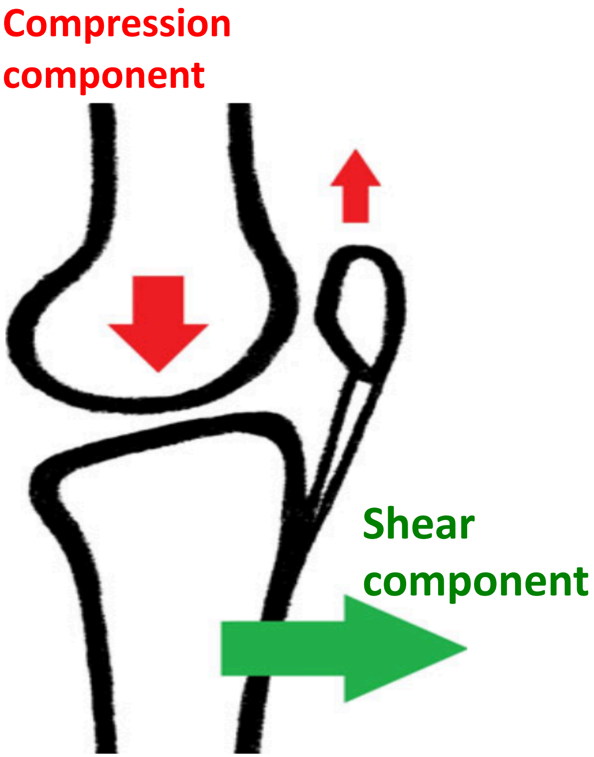
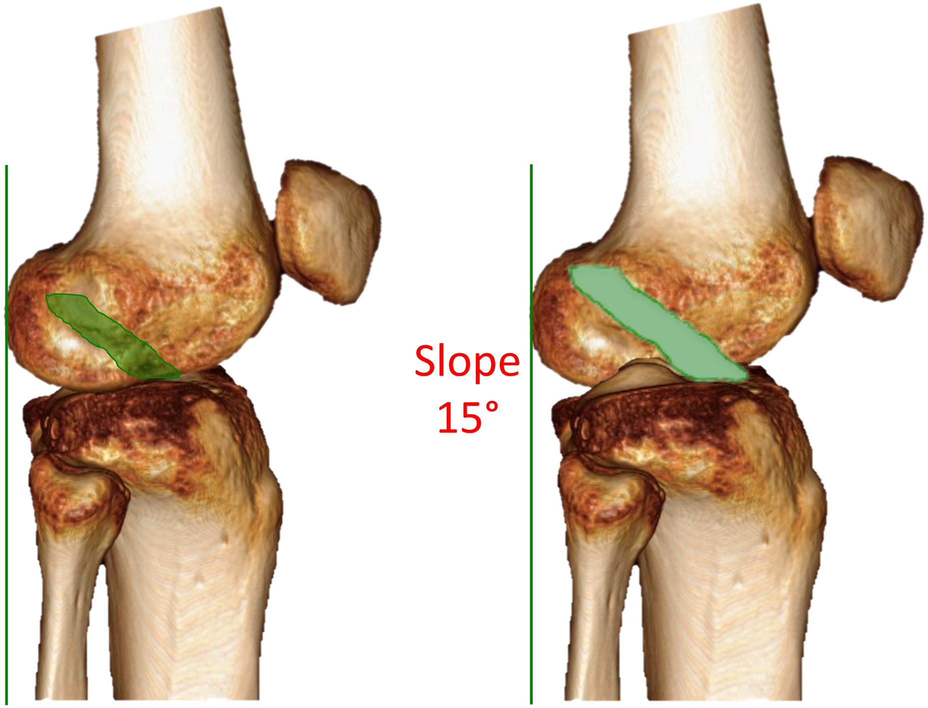
Posterior Tibial Slope

Shearing/Compression Forces





Constraint on ACL

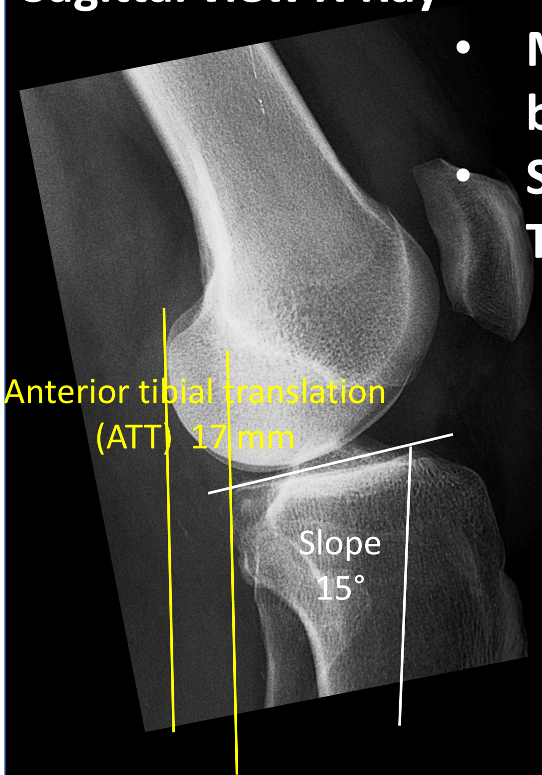
Feucht MJ et al. The role of tibial slope in sustaining and treating anterior cruciate ligament injuries. KSSTA 2013

Posterior Tibial Slope Measurement

Tibial Slope on x-rays (medial compartment)

Tibial Slope & Meniscal Slope on MRI (medial & lateral compartment)

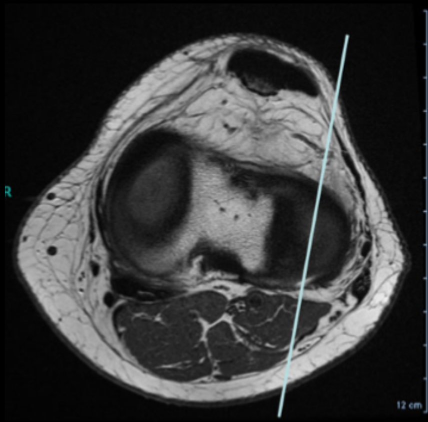
Sagittal view X-Ray

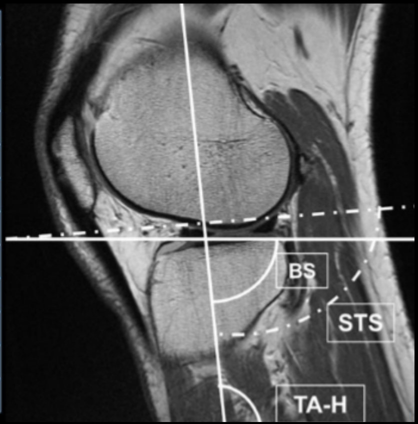


- **Monopodal weight bearing**
- **Stress x-ray by Telos™ device**

Tibial translation after anterior cruciate ligament rupture. Two radiological tests compared.
Dejour H, Bonnin M.
J Bone Joint Surg Br. (1994) Sep;76(5):745-9

MRI





Influence of soft tissues on the proximal bony tibial slope measured with two-dimensional MRI
Lustig S. et al.
Knee Surg Sports Traumatol Arthrosc (2013) 21:372–379

Factors of Laxity following ACL tear

Several *in vitro* studies investigated the factors that influence laxity following ACL (1-6) but none studied them in a clinical series of ACL-deficient knees

1) Ahn JH, Bae TS, Kang KS, Kang SY, Lee SH. Longitudinal tear of the medial meniscus posterior horn in the anterior cruciate ligament-deficient knee significantly influences anterior stability. *Am J Sports Med.* 2011;39(10):2187-2193

2) Ali AA, Harris MD, Shalhoub S, Maletsky LP, Rullkoetter PJ, Shelburne KB. Combined measurement and modeling of specimen-specific knee mechanics for healthy and ACL- deficient conditions. *J Biomech.* 2017;57:117-124

3) Lorbach O, Kieb M, Herbort M, Weyers I, Raschke M, Engelhardt M. The influence of the medial meniscus in different conditions on anterior tibial translation in the anterior cruciate deficient knee. *Int Orthop.* 2015;39(4):681-687

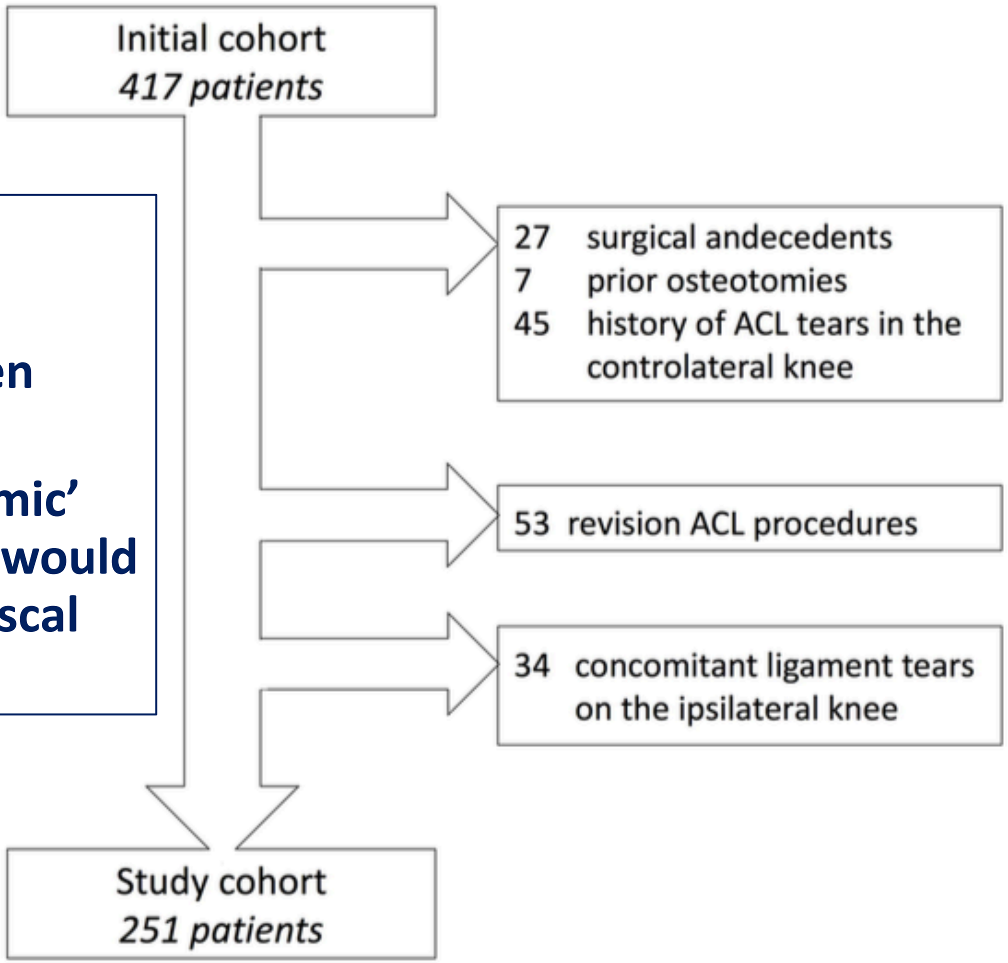
4) Peltier A, Lording T, Maubisson L, Ballis R, Neyret P, Lustig S. The role of the meniscotibial ligament in posteromedial rotational knee stability. *Knee Surg Sports Traumatol Arthrosc.* 2015;23(10):2967-2973

5) Stephen JM, Halewood C, Kittl C, Bollen SR, Williams A, Amis AA. Posteromedial Meniscocapsular Lesions Increase Tibiofemoral Joint Laxity With Anterior Cruciate Ligament Deficiency, and Their Repair Reduces Laxity. *Am J Sports Med.* 2016;44(2):400- 408

6) Yang C, Tashiro Y, Lynch A, Fu F, Anderst W. Kinematics and arthrokinematics in the chronic ACL-deficient knee are altered even in the absence of instability symptoms. *Knee Surg Sports Traumatol Arthrosc.* 2017

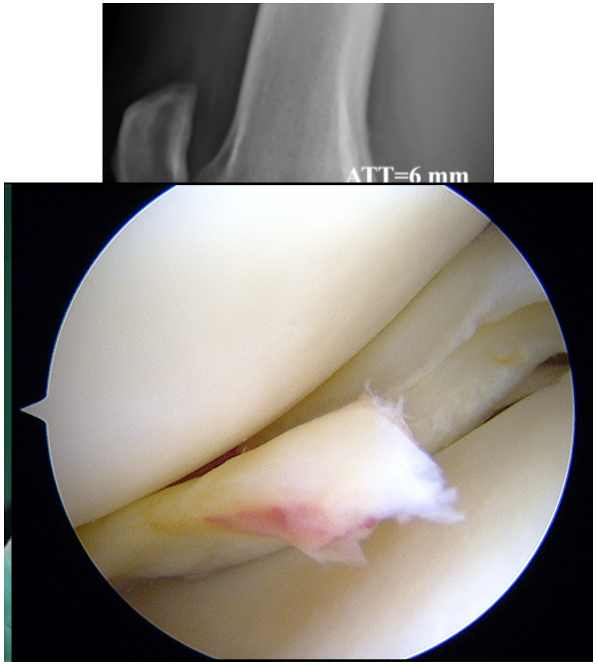
Study Design

- **Cohort study**
- **Level of evidence: 4**
- **Data prospective collection between January 2013 and April 2015**
- **Hypothesis: both 'static' and 'dynamic' ATT as well as pivot shift test (PST) would increase with tibial slope and meniscal lesions**



Methods

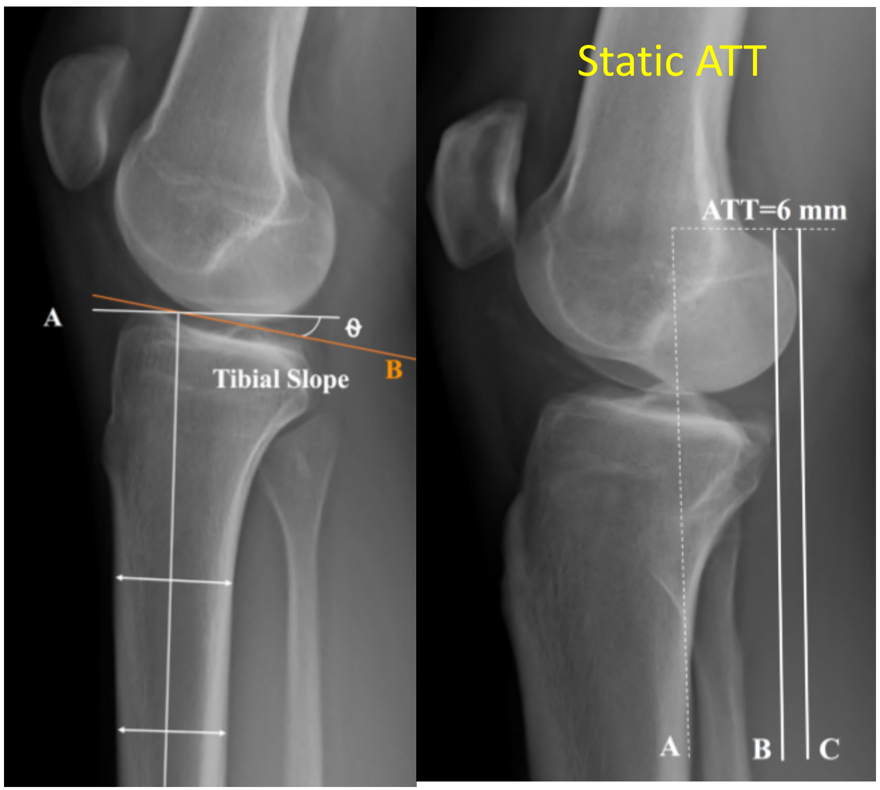
Preoperative/Perioperative Assessments



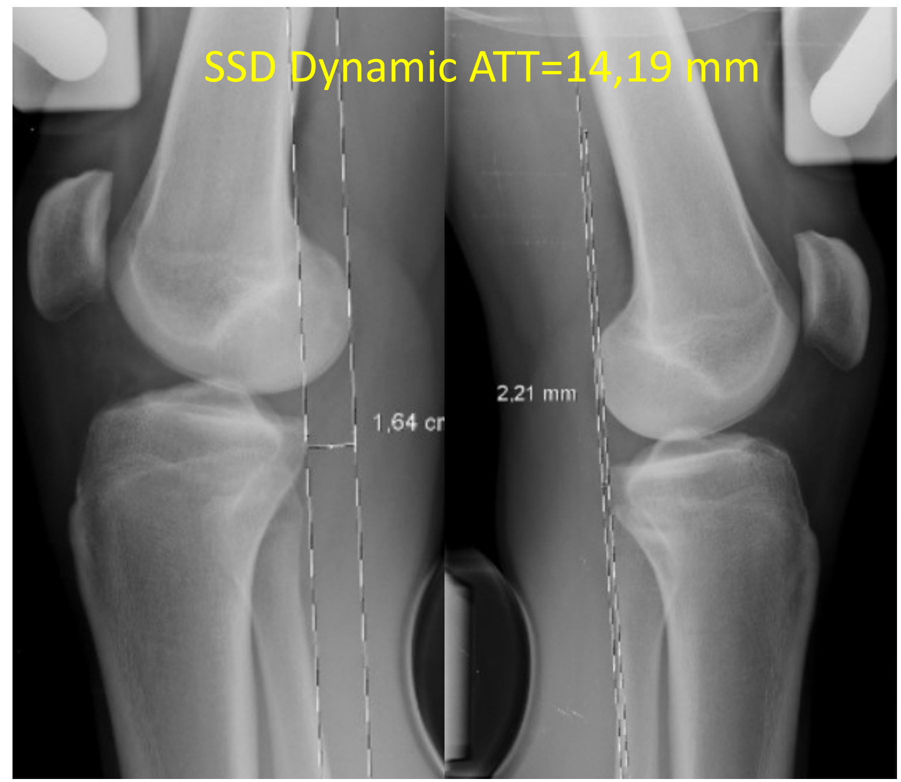
- **Anteroposterior knee laxity**
  - Clinical exam: Lachman test
  - Monopodal weight-bearing x-rays sagittal view
  - Stress x-rays sagittal view (Telos™ device)
- **Rotational laxity**
  - Pivot Shift Test (PST)
- **Meniscal and ACL**
  - MRI and confirmed by Arthroscopy
  - **Meniscal** status was classified in **'no lesion'** or **'presence of lesion'** for each compartment
  - **ACL** status was classified in **'complete tear'** or **'partial tear'**

Methods

Monopodal weight bearing X-Rays



Telos™ stress radiography device
Side-to-side difference (SSD)



Results

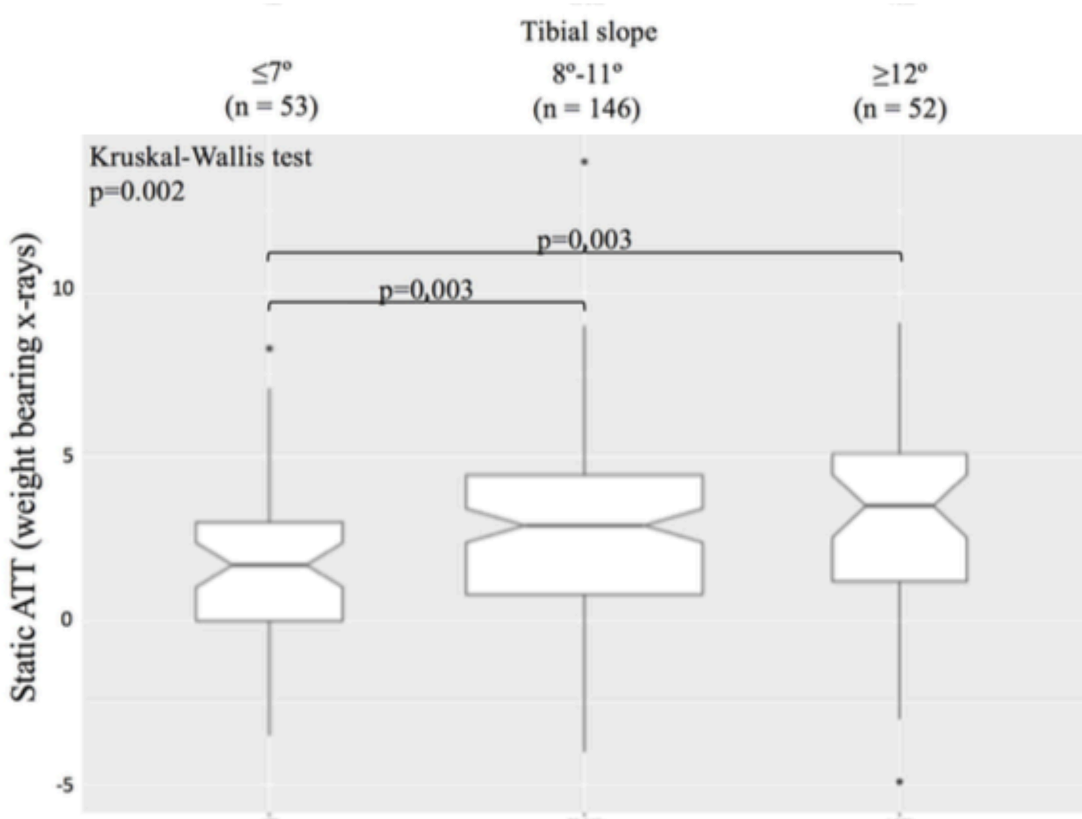
n=251

Table 1: Patient demographics (n=251)

	Entire cohort	n = 251		Male	n = 173		Female	n = 78		
	mean	*± SD*	*(range)*	*mean*	*± SD*	*(range)*	*mean*	*± SD*	*(range)*	*p-value**
Age (years)	29.8	± 10.5	(16.1 – 61.9)	29.1	± 10.0	(16.1 – 56.7)	31.3	± 11.5	(16.9 – 61.9)	0.190
Men	173	(69%)								
BMI (kg/m2)	23.8	± 3.5	(16.0 – 35.3)	24.3	± 3.3	(16.0 – 35.3)	22.9	± 3.7	(18.6 – 34.5)	<0.001
Type of tear										0.316
Partial	87	(35%)		56	(32%)		31	(40%)		
Complete	164	(65%)		117	(68%)		47	(60%)		
Tibial slope (°)	9.5	± 2.4	(3.0 – 16.0)	9.5	± 2.6	(3.0 – 16.0)	9.6	± 1.9	(6.0 – 14.0)	0.626
Meniscal lesion										0.015
None	99	(39%)		57	(33%)		42	(54%)		
Medial	70	(28%)		51	(29%)		19	(24%)		
Lateral	47	(19%)		38	(22%)		9	(12%)		
Both compartments	35	(14%)		27	(16%)		8	(10%)		
Static ATT (Monopodal weight bearing)	2.6	± 3.0	(-4.9 – 14.0)	2.6	± 3.1	(-4.9 – 14.0)	2.8	± 2.6	(-4.0 – 8.8)	0.404
Dynamic ATT (Telos stress x-ray SSD)	6.1	± 3.7	(-5.7 – 16.8)	6.4	± 3.9	(-5.7 – 16.8)	5.6	± 3.3	(-0.5 – 16.3)	0.079
Pivot shift Test										<0.001
Glide	170	(68%)		103	(60%)		67	(86%)		
Clunk / Severe	81	(32%)		70	(40%)		11	(14%)		

- 69% male / 31% female
- Mean age = 30y ±10 (range 16 – 62)
- Mean BMI = 24
- ACL : 35% Partial Tears / 65% Complete tears
- Mean Tibial Slope = 9.5° ±2.4° (range 3°–16°)
- Meniscal Lesions (n152) : Medial (28%), Lateral (19%), Both (14%)

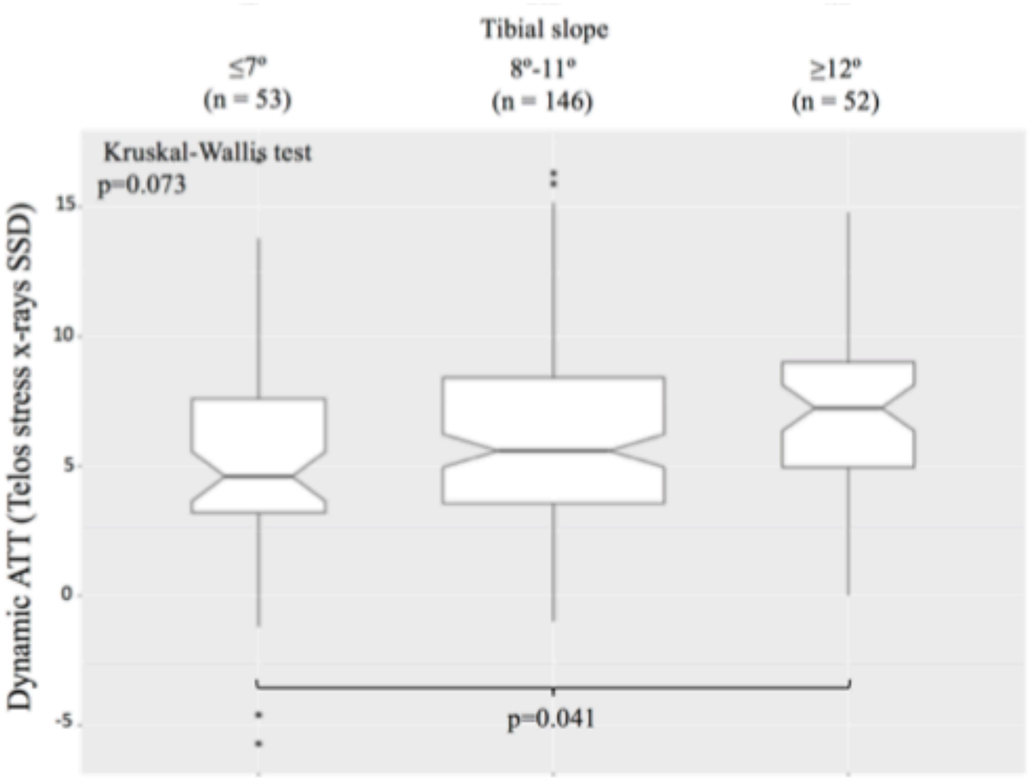
Results



Tibial Slope strongly influence 'static' ATT

- Static ATT = 2.6±3.0mm (range -4.9 – 14.0)
- Only significantly associated with tibial slope
- Increase significantly in knees with Tibial slope >7° (p=0.002)
- by approximately 0.3mm per degree

Results



Tibial Slope strongly influence 'dynamic' ATT

- **Dynamic ATT = 6.1±4mm (range -5 – 17)**
- **significantly associated with tibial slope**
- **Increase significantly in knees with Tibial slope ≥ 12° (p=0.04)**
- **by approximately 0.2mm per degree**

Results

Table 3: Uni- and Multi-variable regression to identify factors associated with dynamic ATT (Telos stress x-ray SSD)

	Univariable			Multivariable (n=251)		
	regression coefficient [a]	95% C.I. (range)	*p-value*	regression coefficient [a]	95% C.I. (range)	*p-value*
Age at surgery	-0.07	(-0.11 – -0.03)	*0.002*	-0.09	(-0.13 – -0.05)	*<0.001*
Female gender	-0.76	(-1.76 – 0.24)	*0.136*	-0.35	(-1.31 – 0.62)	*0.482*
BMI	-0.03	(-0.16 – 0.11)	*0.685*	0.02	(-0.11 – 0.15)	*0.805*
Complete ACL tear	2.16	(1.22 – 3.10)	*<0.001*	2.06	(1.12 – 2.99)	*<0.001*
Tibial slope	0.20	(0.01 – 0.39)	*0.039*	0.19	(0.01 – 0.37)	*0.041*
Medial meniscal lesion	1.22	(0.29 – 2.15)	*0.010*	1.27	(0.35 – 2.19)	*0.007*
Lateral meniscal lesion	0.00	(-0.99 – 0.99)	*0.995*	-0.41	(-1.34 – 0.53)	*0.392*

Abbreviations: SSD, Side-to-side differential laxity; ATT, Anterior Tibial Translation

[a] Expected difference

Table 2: Uni- and Multi-variable regression to identify factors associated with static ATT (in monopodal weight bearing)

	Univariable			Multivariable (n=217)		
	regression coefficient [a]	95% C.I. (range)	*p-value*	regression coefficient [a]	95% C.I. (range)	*p-value*
Age at surgery	0.00	(-0.04 – 0.04)	*0.914*	0.00	(-0.04 – 0.04)	*0.939*
Female gender	0.02	(-0.64 – 1.05)	*0.635*	0.34	(-0.52 – 1.21)	*0.436*
BMI	0.07	(-0.05 – 0.18)	*0.265*	0.07	(-0.05 – 0.19)	*0.225*
Complete ACL tears	0.24	(-0.58 – 1.07)	*0.561*	0.21	(-0.63 – 1.06)	*0.617*
Tibial slope	0.30	(0.14 – 0.46)	*<0.001*	0.30	(0.14 – 0.47)	*<0.001*
Medial meniscal lesion	0.24	(-0.56 – 1.05)	*0.553*	0.25	(-0.58 – 1.08)	*0.553*
Lateral meniscal lesion	0.37	(-0.48 – 1.21)	*0.390*	0.41	(-0.44 – 1.26)	*0.342*

Abbreviations: SSD, Side-to-side differential laxity; ATT, Anterior Tibial Translation

[a] Expected difference

Medial Meniscus tear strongly influence 'dynamic' ATT

(but not 'static' ATT)

Other Findings

- **Age correlated negatively with dynamic ATT and high-grade pivot shift**, in agreement with other published studies (Myer et al BJSM 2011, Quatman JSMS 2008)
- **Women were less likely to exhibit high-grade pivot shift**, contrary to recent findings (Pfeiffer KSSTA 2017, Sundemo KSSTA 2017). The contradiction could be related to our higher average age, and to a lower prevalence of anterolateral ligament injuries in women, which we did take into consideration
- **Complete ACL tears** did not influence static ATT but **were associated with greater dynamic ATT and high-grade pivot shift**, as reported by other authors (Colombet OTSR 2010, Dejour KSSTA 2012)

Conclusion

- **Tibial slope** increases both static and dynamic anteroposterior laxity
(Static ATT : slope >7° / Dynamic ATT : slope ≥12°)

- **Medial meniscal lesions** increase dynamic anteroposterior laxity as well as pivot shift

- These findings are relevant to guide surgeons in **optimizing** their **surgical procedures** and **rehabilitation protocols** to patients with different anatomic and lesional characteristics

➡ "Menu à la carte"

- *Primary ACLr + high tibial slope and meniscal lesions : **Non-Weight Bearing period***
- *Revision of ACLr + Slope **≥12°,** especially in the presence of meniscal lesions: **Correction of excessive Tibial Slope with Deflexion Osteotomy***