ORIGINAL ARTICLE

Influence of Leg Dominance on Clinical Assessment of Knee Laxity in Anterior Cruciate Ligament (ACL) Injuries: A Systematic Review

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Abstract: Background: It remains unclear whether the leg dominance influences the side-to–side difference of knee laxity in healthy and anterior cruciate ligament reconstruction patients. Purpose: To perform a systematic review of clinical or other study types of evidence on the effect of leg dominance on side-to-side knee laxity. Study design: Systematic review; Methods: A systematic review was performed using the PubMed, Google Scholar and Ovid search engines. Inclusion criteria for the first part were any study except animal and cadaveric studies on healthy subjects comparing left to right knee laxity without any knee injury. For the second part, the inclusion criteria involved patients of after anterior cruciate ligament reconstruction, which compared the injured and contralateral side of knee laxity. Methodological quality of the final studies recorded leg dominance was assessed using Critical Appraisal Skill Program (CASP) tool. Conclusion: it is still confirmed of the influence of leg dominance on side-to-side difference of knee laxity by this systematic review.

1. Background

1.1 High Injury Rate of ACL and ACL Reconstruction Surgery

ACL injury is very common in sports, especially in high intensity and non-contact sports. The statistics of United States showed that there were 200,000 ACL reconstructions surgery performed each year[26]. Once the athletes injured their ACL, they preferred to do the ACL reconstruction surgery in order to restore the function of knee joint and go back to sports as soon as possible.

1.2 The Importance of Anterior Cruciate Ligament (ACL)

doi: 10.18686/jn.v6i1.98

Anterior cruciate ligament (ACL) is an important internal stabilizer of the knee joint and has 3 important restraints, anterior tibial translation, valgus rotation and internal tibial rotation[1]. It makes a great contribution to the anterior-posterior knee stability and rotational stability as well. In addition, knee joint has 6 degree of freedom in three axes, the sagittal axis, the coronal axis and traverse axis. There are 3 in translation, anterior tibia translation and posterior tibia translation (AP), compression, medio/lateral translation. The other 3 knee rotational movement is internal andexternal, valgus and varus, flexion and extention[21]. The function of anterior cruciate ligament is to restrain approximately 85% of passive anterior tibia translation[12].

1.3 Importance of Measuring Knee Laxity:

Measurement of anterior-posterior knee laxity is frequently used to record anterior cruciate ligament injury and more common in evaluating the success of different treatment of ACL construction surgery. The anterior-posterior laxity and rotational laxity of the knee joint are important parameters to evaluate ACL integrity.As for the rotational knee laxity, it is also an emerging problem in evaluating successful ACL reconstruction surgery no matter what treatments adopted.

1.4 Knee laxity and instability:

It is found in a prospective study that the increased anterior knee joint laxity has been identified as a risk factor for anterior cruciate ligament (ACL) injury among females.[14] The term of 'laxity' is defined as slackness in the ligament or a lack of tension, which is a lax ligament. When the term 'laxity' is applied to the intact knee joint, it means ligaments which can be slack by positioning the tibia to shorten the distance between the femoral and tibial attachments.[27] Laxity is used to describe both the normal and pathological status of knee joint ligament. However, the term 'instability' is defined as an episode of giving-way (symptom), and a condition of increased mobility of the joint. This indicated that when describe ACL, it is better not to use the term instability for anatomical structure. But laxity can be used to describe ACL both in healthy and deficient stages.[27] Clinical tests for the joint laxity involves determining the abnormality of displacement of tibia relative to femur and clinical signs are used to detect the abnormal laxity.

1.5 Diagnosis of ACL Injury:

Many examinations can be used to help to diagnose ACL rupture. There are 2 main types. One is for subjective measurements like Lachman's test: this is performed with the knee flexed in 20-30°with the femur stabilized. An anterior force is applied to the proximal tibia and the displacement is recorded. The pivot shift test: this test is to show the non-functional ACL, hold the patient's heel and internally rotate the foot and tibia and meanwhile applying valgus force at the knee. Fixing the knee from 0-30° while applying the force and holding the foot and tibia in internal rotation. The anterior drawer test with endpoint laxity can be diagnosed as ACL ruptured. These physical tests almost rely on the testers' experience and skills, which cause bias to some extent.[3]

1.6 Instrumented Knee Laxity Device:

To obtain more objective and non-invasive measuring method, many ligament-testing devices have been developed in order to establish quantitative measurements for ACL ruptures and compare preoperative and postoperative status of knee laxity.

These devices include the KT-1000 (MEDmetric, San Diego, CA), Stryker Knee Laxity Tester (Kalamazoo, MI), the

Genucom (FARO, Lke Mary,FL), KSS Acufex (Norwood, MA), and the Roliometer (Aircast,Boca Raton,FL)[4 11]. Among these, the KT-1000 is actually the most frequently used, reliable and accurate device for assessing ACL integrity[3 12].The Rotameter is a simple, noninvasive, and easy-to-control measurement device that to be used to identify the preoperative and postoperative rotational status of the knee with ACL injuries.[11]

1.7 Risk Factors:

Numbers of previous studies[13 14 15 18] have found that many risk factors contributing to the traumatic knee injury of sportsmen. As far as it is known, these factors include anthropometry, hormone differences, joint stiffness; lower limb alignment, lower leg characteristics, sports exposure and menstrual cycle characteristics.It is found that more sportswomen injured their non-dominant leg with 13 out of 20 sportswomen.[13] Another study emphasizd on the factor of leg dominance. They preferred that lower extremity had differences in muscle activation in kicking and supporting leg in soccer players.[2] Other studies also focused on the leg dominance to find out leg-to-leg difference of knee abduction moment. [28]

As Daniel et al[5] reported that side-to-side difference of knee laxity with 3mm or more may demonstrate a history of knee injury. It is found that the dominant side of lower limb is more lax than the contralateral side, so if not record which side is the dominant side, once the dominant side is injured, the side-to-side difference of knee laxity would be another story compared with the injury occurred in non-dominant side.

Based on previous studies, the parameter of side-to-side difference of knee laxity is always recorded in order to evaluate the outcome of ACL reconstruction between the lower limbs preoperatively and postoperatively. Clinical tests are difficult and may not be meaningful. The Lachman test, the anterior drawer test, and pivot shift test are subjective and less reliable, and it cannot quantify knee laxity because of the skills and experience of the testers[3].

1.8 Definition of Leg Dominance

In most studies, definition of the term leg dominance is not well described, especially in soccer, and the authors usually avoid suing the term dominance. In some previous studies, leg dominance was defined as: Hoffman et al.[7] deemed functional leg dominance as the leg that performed 3 tasks 2 out of 3 times with the same leg: ball kick, step-up, and balance recovery. Blackburn et al.[8] defined leg dominance as the leg each subject would use to kick a ball. Pincivero et al.[9] determined dominant leg by asking the subjects which leg they would preferentially use to kick a ball. However, in soccer, most of the cases deemed the dominance leg is the leg using to kick the ball.[2] Previous study[30] has found that differences that existed between contralateral limbs in relation to is kinetic strength, proprioception and knee flexion range of motion. To simplify it, dominant side had better muscle strength, proprioception and greater knee flexion range of motion.

It has been found that slightly more than half of the ACL injuries occurred in the dominant side of the lower extremity in previous study[2]. It has been also shown that there were more injuries in the dominant legs and the knee joint laxity is a possible contributing factor to the ACL injury[10]. Ergun M et al.[6] found that soccer players had significantly higher posterior knee laxity in their non-dominant side compare to the dominant side. All of these demonstrated that dominant side of lower extremity differs from non-dominant side in term of knee laxity and injury rate. Clinical studies of randomized controlled trials always reported side-to-side difference of knee laxity after ACL reconstruction with different treatments. However, they may not take leg dominance into consideration. Therefore, it would affect the detection of difference in side-to-side difference of knee laxity preoperatively and postoperatively, and misdiagnose the ACL injury as well.

1.9 Research Questions

There are two research questions to ask. The first is are there any evidence about if leg dominance affect side-to-side difference of knee laxity in normal healthy subjects? The second research question is that are there evidence about whether leg dominance influence the side-to-side difference of knee laxity in ACL injured patients with ACL reconstructed surgery?

1.10 Hypothesis

The hypothesis is the factor of leg dominance influence the side-to-side difference of knee laxity in normal healthy subjects, and there are differences in side-to-side knee laxity between ACL injured in dominant side and non-dominant side.

2. Purpose

The study was divided into two parts. The purposes of the part1 is to perform a systematic review to justify the difference of left to right of knee laxity (anterior-posterior laxity or rotational laxity) in healthy subjects, and summarize the studies recorded leg dominance. Part2 is to find out whether the factor of leg dominance is recorded in the ACL reconstructed-side to normal side of difference of knee laxity preoperatively and postoperatively.

3. Method

3.1 Search Strategy for Part 1

A literature search will be completed using MED-LINE accessed through PubMed, OVID and Google scholar search engines. For the first part, the key words are as follows: (knee laxity measurement OR KT-1000/2000 OR Genucom OR Stryker knee laxity tester OR Roliometer OR Acufex knee signature system OR UCLA instrumented clinical testing apparatus OR Dyonics dynamic cruciate tester). For the second part, we also use the key word (knee laxity measurement OR KT-1000/2000 OR Genucom OR Stryker knee laxity tester OR Roliometer OR Acufex knee signature system OR UCLA instrumented clinical testing apparatus OR Dyonics dynamic cruciate tester) to search for suitable studies.

3.2 Study Selection for Part 1

3.2.1 The inclusion criteria for this systematic review included the following:

- Study types: the first part includes all types of studies except animal studies and cadaveric studies. Review articles were not included. The second part only includes clinical study of randomized control trials.
- Study group: subjects in the first part only included healthy, normal adults (not focus on children and adolescence)
- without any knee injuries, and the knee laxity was measured by static instrumented knee arthrometer. For the second part, patients who injured the unilateral ACL and received ACL reconstruction surgery, no matter the

- treatment they used were included.
- Language: limited in English and Chinese.

3.2.2 The exclusion criteria for this systematic review included the following:

- Study types: for the first part, studies of animals and cadavers were excluded. Review articles and meta-analysis were excluded. For the second part, only RCTs were included.
- Article type: articles other than original research articles.

3.3 Search Strategy for Part 2

A literature search will be completed using MED-LINE accessed through PubMed, OVID search engines. For the second part, the key words are as follows: (knee laxity measurement OR KT-1000/2000 OR Genucom OR Stryker knee laxity tester OR Roliometer OR Acufex knee signature system OR UCLA instrumented clinical testing apparatus OR Dyonics dynamic cruciate tester). For the second part, we also use the key word (knee laxity measurement OR KT-1000/2000 OR Genucom OR Stryker knee laxity tester OR Roliometer OR Acufex knee signature system OR UCLA instrumented clinical testing apparatus OR Dyonics dynamic cruciate tester) to search for suitable studies.

3.4 Study Selection for Part 2

3.4.1 The inclusion criteria for this part included the following:

- Study group: subjects in the second part include the patients who injured the unilateral ACL and received ACL reconstructionsurgerywith minimum of 1-year follow-up. Knee laxity was measured by static instrumented knee arthrometer pre-op and post-op. no matter the treatment they used was included.
- Language: limited in English and Chinese.

3.4.2 The exclusion criteria for this systematic review included the following:

- Study types: animal and cadaveric studies were not included.
- Article type: review articles and meta-analysis were not included.
- Children and adolescence were not included.

3.5 Quality Assessment

Clinical Appraisal Skills Program (CASP) was used to evaluate studies that recorded leg dominance.

Table 1. Study quality assessment using CASP

Author	Year	Quality (answering yes)
Cinar-Medeni O et al.	2014	7 of 10
Eric L Smith et al.	2011	6 of 10
PaoloAglietti et al.	2010	6 of 10

2003	5 of 10

3.6 Data Extraction

Data extracted from the first part of papers consist of the author, published year, type of study, sample size, sex ratio, average age, tool of measurement, type of laxity recorded, side-to-side difference of knee laxity and whether record dominant leg. Data extracted form the second part of papers consist of the author, published year, sample size, sex ratio, average age, too l of measurement, whether record dominant leg, length of follow-up, type of laxity recorded and reconstructed-normal difference of knee laxity.

4. Searching result

4.1 Searching result of part 1

For the first part after searching, there are 11 papers in the inclusion criteria. However, there is only 2 papers recorded leg dominance.

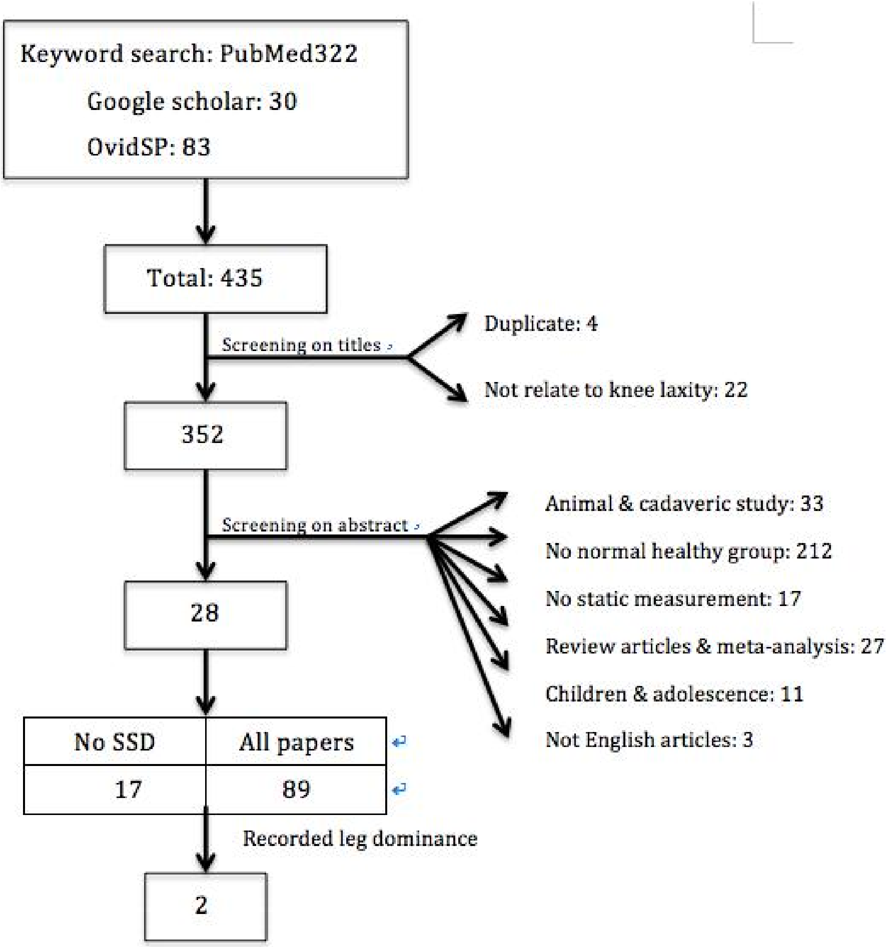

Fig.1 Searching result of part1

The table 1 shows the demographic of the normal healthy subjects and table 2 shows the data collected from all studies.

Author/ Year	TYPE OF STUDY	SAMPLE SIZE	SEX RATIO (M/F)	AVERAGE AGE
Mahbub Alam et al./2013	Cohort study	46	25/21	27 years (range 21-34)
Michel Collette et al./2012	Diagnostic study	15	Not record	19-27 years
Bryan D et al.2012	Retrospectiv e case-control	16	8/8	Men: 26.8±6.4 women: 26.9±3.8
H.Robert et al.2009	Prospective comparative study	20	17/3	Not recorded
Sandra J et al.2007	Descriptive	100	50/50	22.8+/-3.3 years
Sandra J et al.2007	Not RCT	20	10/10	Men: 27.3+/-3.4yrswome n: 22.9+/-1.5yrs
Bonnie L et al.2003	Cohort study	12	Only female	24.3+/-4.9 years
Matthew J et al.2000	Single-factor , posttest-only control group design	55	Only female	20-25 years old
Carl L et al.1990	Not RCT	218	97/121	Men: 31.03+/-13.98

				women: 29.71+/-13.12
J.Iwasa et al.2006	Comparative study	8	4/4	27.9+/-7.5
Louis C.Almekinders et al.2004	Therapeutic study	25	Not record	30.1 years (range 20-41)

Demographic of subjects (part 1)

Author/Year	TOOL OF MEASUREMENT	TYPE OF LAXITY RECORDED	SSD DEG/mm	REPORT DOMINANT SIDE (Y/N)
Mahbub Alam et al.2013[16]	Nest Of Bird, Rotational Measurement Device, Boot Inclinometer	Rotational laxity	NOB: 90deg 4Nm IR 0.5 ER 1.0 RMD: 90deg 4Nm IR 0.9 ER 0.9 BI: 90deg 4Nm IR 5.1 ER 5.5	N
Michel Collette et al.2012[17]	KT-1000, GNRB	Anterior laxity	Inferior to 3mm	N
Bryan D et al.2012[18]	MRI-based rotational device	Rotational laxity (TR)	3.6+/-2.4deg	N
H.Robert et al.2009[19]	GNRB, KT-1000	Anterior laxity	GNRB:0. 8mm(0.7-0.94) at 134N. KT-1000: 1.34mm(1.1-1.56) at 134N	N
Sandra J et al.2007[20]	NOT MENTIONED	Anterior laxity	Less than 2mm.95% LOA	N

Sandra J et al.2007[21]	Vermont Knee Laxity Device	Rotational laxity	Total INT-EXT (NWB):0. 7deg totalINT-EXT (WB):0. 6deg	N
Bonnie L et al.2003[22]	KT-2000, radiographic measurement	Knee laxity	Have difference but no data	Y (right dominance)
Matthew J et al.2000[23]	KT-1000	Anterior laxity	CONTROL GROUP:89N:Dominant5.7±2.15 Nondominant6.2±2.26 TEST GROUP:89N:Dominant5.8±2.59 Dondominant6.4±2.47	Y
Carl L et al.1990[24]	Genucom Knee Analysis System	Anterior laxity	2mm	N
J.Iwasa et al.2006[25]	KT-2000	Anterior laxity	0.1mm	N
	KT-1000	AP laxity	0.8mm	N

Table 3. SSD of knee laxity in normal healthy subjects (part 1)

We can make a conclusion that only 2 (18.2%) papers recorded leg dominance among all included 11 studies. Very little attention has taken on the effects of leg dominance. Many papers compare the side-to-side difference of knee laxity between healthy lower limbs showing a minor difference. This minor difference may due to the factor that we are interested in, the leg dominance. The searching result of side-to-side difference of knee laxity is accordance with the previous study, Daniel et al.[5] reported that 92% of the normal subjects had a left-to-right difference in anterior displacement of no more than 2 mm. For those who have unilateral disruption of anterior cruciate ligament patients had injured-knee to normal-knee difference in anterior displacement of more than 2 mm.

4.2 Searching result of part 2

There are 44 papers fit for the inclusion criteria, but when it comes for leg dominance, there is only 2 papers recorded leg dominance. The table 3 and table 4 show the demographic and SSD of knee laxity ACL reconstructed patients.

Fig. 2. Searching result of part2

Table4 demographic of ACL reconstructed patients (part 2)

Author/Year	SAMPLE SIZE	SEX RATIO (M/F)	AVERAGE AGE	INJURED SIDE
StephanFroschet al.2012[31]	Cross pin group: 28 milagro group: 31	Crosspin group: 18/10 milagro group: 19/12	Cross pin group: 28.2yrs milagro group: 24.6yrs	Not recorded
Alberto Gobbi et al.2011[26]	SB: 30 DB: 30	SB: 15/15 DB: 18/12	SB: 31.9+/-1.92 DB: 28.9+/-1.89	SB group: R12 L18 DB group: R18 L12
S.A.R.Ibrahim et al.2009[32]	200	Not recorded	28yrs	Not recorded
Paolo Aglietti et al.2010[33]	SB: 35 DB: 35	SB: 25/10 DB: 28/7	SB: 28yrs DB: 28yrs	SB group: R19 L16 DB group: R16 L19
Anna-Stina Moisala et al.2008[34]	B-group:31 M-group: 31	B-group: 22/9 M-group:19/12	B-group: 30yrs M-group: 34yrs	B-group: R16 L15 M-group: R12 L19
Luca Capuano et al.2008[35]	Group1: 15 Group2: 15	Bothgroups: 10/5	Group1: 32.3+/-9.5yrs Group2: 30.6+/-9.8yrs	Both groups: R7 L5
Nikolaus A.Streich et al.2008[36]	SB: 25 DB: 24	ALL MALE	SB: 29.2+/-6.3yrs DB: 30.0+/-6.5yrs	Not recorded

Continued

Author/Year	SAMPLE SIZE	SEX RATIO (M/F)	AVERAGE AGE	INJURED SIDE

Arsi Harilainen et al.2006[37]	BPTB: 51 STG: 48	Not recorded	Not recorded	Not recorded
Tim Rose et al.2006[38]	TF group: 38 BS group: 30	TF group: 22/18 BS group: 20/10	TF group: 28.5yrs BS group: 25.5yrs	Not recorded
Michael Svensson et al.2006[39]	BTB: 28 STG: 31	ALL FEMALE	BPB: 28yrs STG: 25yrs	BPB: R15 L13 STG: R16 L15
BPB Tow et al.2005[40]	BPB: 34 STG: 34	64/4	27.3yrs	Not recorded
Julian A.et al.2003[41]	PT: 31 HS: 34	PT: 23/8 HS: 24/10	PT: 25.8yrs BS: 26.3yrs	Not recorded
Lars Ejerhed et al.2003[42]	BTB: 32 ST: 34	BTB: 21/11 ST: 25/9	BTB: 26 ST: 29	Not recorded
Cinar-Medeni O et al.2014[43]	28	Not recorded	28.03yrs	Dominant side: 21 non-dominant side: 7
H.E.Bourke et al.2012[44]	200(objective review114)	100/100	25.8yrs	R101 L99
Eric L Smith et al.2011[45]	21	17/4	28yrs	Recorded
Sung-Jae Kim et al.2009[46]	SB: 32 DB: 29	SB: 18/14 DB: 18/11	SB: 28.9yrs DB: 25.3yrs	Not recorded
J.M.Scarvell et al.2005[47]	20	8/12	33yrs	R12 L8
Mario Bizzini et al.2006[48]	BPTP: 87 QSGT: 66	BPTP: 54/33 QSGT: 45/21	BPTP: 33.7yrs QSGT: 31.3yrs	Not recorded

Louis C.Almekinders et al.2004[49]	19	Not recorded	26.3yrs	Not recorded
Bruce D.Beynnon et al.2002[50]	56	BPB: 18/10 STG: 13/15	BPB: 28.5yrs STG: 29.9yrs	BPB: R11 L17 STG: R13 L15
Kevin D.Plancher et al.1998[51]	75	42/30	45yrs	R41 L34
B. Sonnery-Cottet et al.2012[52]	168	105/63	30yrs (range 14-58)	Not recorded
N. Pujol et al.2012[53]	Group1: 29 group2: 25	Group1: 16/13 group2: 17/8	30yrs (14-46)	Group1: R15 L14Group2: R13 L12
S. Plaweski et al.2012[54]	Control: 100 CANS: 114	Control: 95/5 CANS: 104/10	Control: 28.9+/-9.0 CANS: 31.0+/-9.5	Not recorded

Table5.SSD of knee laxity in ACL injured patients (part 2)

Author/Year	TOOL OF MEASUREMENT	REPORT DOMINANT SIDE (Y/N)	TYPE OF LAXITY RECORDED
Stephan Frosch et al.2012	KT-1000	N	AP laxity
Alberto Gobbi et al.2011	Roliometer	N	AP laxity
S.A.R.Ibrahim et al.2009	KT-1000	N	Anterior knee laxity

Paolo Aglietti et al.2010	KT-1000	N	Anterior knee laxity B-group: pre-op: 3.7mmpost-op: 1.7mm M-group: pre-op: 4.4mm post-op: 1.9mm
Anna-Stina Moisala et al.2008	KT-1000	N	
Luca Capuano et al.2008	Rolimeter	N	Group1: 1.5mm group2: 2mm
Nikolaus A.Streich et al.2008	KT-1000	N	SB: pre-op: 9.1mmpost-op:0. 94mm DB: pre-op: 9.0mmpost-op: 1.10mm
Arsi Harilainen et al.2006	CA 4000 arthrometer	N	BPTB: 1.5mmSTG: 1.2mm
Tim Rose et al.2006	Rolimeter	N	TF group: 12-month:0. 8mm BS group: 12-month: 1.2mm
Micheal Svensson et al.2006	KT-1000	N	BPB:anterior laxity: pre-op: 3.0mm2-year: 2.0mm; AP laxity: pre-op: 3.5mm2-year: 2.8mm STG:anterior laxity: pre-op: 4.0mm2-year: 3.5mm; AP laxity: pre-op: 4.0mm2-year: 3.0mm
BPB Tow et al.2005	KT-1000	N	Pre-op: All patients:>5mm. BPB: 2.52mm STG: 3.26mm
Julian A.et al.2003	KT-1000	N	HS (67N) 3y: 1.1mm (134N) 3y: 1.6mm PT (67N) 3y:0. 5mm (134N) 3y:0. 5mm
Lars Ejerhed et al.2003	KT-1000	N	BTB: pre-op: 3.75mm(two missing) postop: 2.0mm ST: pre-op: 3.75mmpostop: 2.25mm

Cinar-Medeni O et al.2014	Kneelax 3 arthrometer	Y (21 dominant legs; 7non-dominant legs)	89N: 2.46mm 132N: 3.10mm
H.E.Bourke et al.2012	KT-1000	N	Male 1.6mm Female 1.9mm
Eric L Smith et al.2011	KT-1000	Y	Pre-op: 7.5mmpostop: 1.4mm
Sung-Jae Kim et al.2009	KT-2000	N	SB: 3.37mm DB: 2.03mm
J.M.Scarvell et al.2005	KT-1000	N	Pre-op: 3.9mm Post-op: 2.2mm
Mario Bizzini et al.2006	Kneelax 3 arthrometer	N	BPTP: 1.9mm QSGT: 2.7mm
Louis C.Almekinders et al.2004	KT-1000	N	ACLD 5.8 ACLR 2.7
Bruce D.Beynnon et al.2002	KT-1000	N	BPB: 1.1mm STG: 4.4mm
Kevin D.Plancher et al.1998	KT-1000	N	Pre-op: 6.4mm Postop: 1.4mm
B. Sonnery-Cottet et al.2012	Goniometry or Telos stress radiography	N	Pre-op: 5.5mmpost-op: 1.1mm
N. Pujol et al.2012	Rolimeter	N	Group1: pre-op: 5.03mm Post-op: 1.24mm. Group2: pre-op: 5.12mmpost-op: 1.87mm
S. Plaweski et al.2012	Telos stress radiography	N	Control: 1.38mm CANS: 1.77mm

S. Zaffagnini et al.2011	KT-2000 and Telos valgus stress radiography	N	Group A: 1.3mm Group AM: 2.4mm

Table 6. Comparison of SSD of knee laxity in ACLD group pre-op and post-op

Author/Year	CG (SSD mean)	TG (SSD mean)	Position & force	Device	Max.FU
Eric L Smith et al.2011	ACLD 7.5	ACLR 1.4	-	KT-1000	62mon
J.M.Scarvellet al.2005	ACLD 3.9	ACLR 2.2	134N	KT-1000	24mon
Louis C.Almekinders et al.2004	ACLD 5.8	ACLR 2.7	67N	KT-1000	52mon
Kevin D.Plancher et al.1998	ACLD 6.4	ACLR 1.4	-	KT-1000	117mon
B. Sonnery-Cottet et al.2012	ACLD 5.5	ACLR 1.1	-	Goniometry orTelos stress radiography	59mon

CG: control group TG: treatment group SSD: reconstructed-to-normal difference

FU: follow-up ACLD: ACL deficient ACLR: ACL reconstructed

These studies have many variables, so it made difficult to make comparison. The table 5, showing the comparable results. We can see from the table 5, When compared the studies having one group but recording SSD of knee laxity pre-op and post-op, the study (Eric et al) recorded leg dominance have biggest difference among all studies after ACLR than those without taking leg dominance into consideration. This may demonstrate that leg dominance have effect on evaluating restoration of knee joint after ACLR.

5. Discussion

It is clearly defined of the terminology of dominance in upper limbs, like right-handed and left-handed. The concept of dominance is based on the fact that the two hemispheres of the brain have different functions and some preferential use for certain activities[29]. However, the leg dominance in lower limbs is difficult to define since different sports involved different limbs and it may keep changing in the whole duration. Children and adolescence are not mature enough, so they haven'tdeveloped the dominancy yet. Determining the leg dominance, it is important to consider the role of legs in different tasks, such as mobility and stability[29]. Like the soccer players, they use the leg to manipulate the ball, while the other leg is significant to postural control and stability. Jessica et al[29] and S. Spry et al[30] found that the dominant leg in left and right dominant subjects have to be determined by manipulative and weight-bearing performance.

As for the evidence of side-to-side difference of knee laxity in normal healthy subjects, we found that dominant leg and non-dominant leg do exist the different muscle strength and knee laxity as well, but very limited study pay attention to the factor of leg dominance. For instance, like the Eric et al study that reported the significant difference of side-to-side knee laxity in ACLD (17.5mm) andACLR (1.4mm), we may make assumption that all of the patients injured the dominant leg so that after the injury, the side-to-side difference of knee laxity will be larger than all injured in non-dominant leg. From above, recording which side is dominance is very useful to evaluate the restoration of knee joint.

Leg dominance is also depended on different kinds of sports. And different sports cause different knee laxity in athletes. Soccer players have significantly higher posterior knee laxity in non-dominant side.In addition, one of a literature review agreed that regular training have effects on the change of knee laxity. As for the normal healthy subjects, they have higher anterior and AP laxity than soccer players.[6]

6. Conclusion

The side-to-side difference of knee laxity exists in normal healthy subjects, and the dominant leg is different from non-dominant side in lower limbs. However, the recording of leg dominance in clinical studies is very limited, and the influence of leg dominance on side-to-side difference of knee laxity is still unclear.

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