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Iliotibial Band Syndrome in Runners

A Systematic Review

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Abstract

Background: The popularity of running is still growing and, as participation increases, the incidence of running-related injuries will also rise. Iliotibial band syndrome (ITBS) is the most common injury of the lateral side of the knee in runners, with an incidence estimated to be between 5% and 14%. In order to facilitate the evidence-based management of ITBS in runners, more needs to be learned about the aetiology, diagnosis and treatment of this injury.
Objective: This article provides a systematic review of the literature on the aetiology, diagnosis and treatment of ITBS in runners.
Search strategy: The Cochrane Library, MEDLINE, EMBASE, CINAHL, Web of Science, and reference lists were searched for relevant articles.
Selection criteria: Systematic reviews, clinical trials or observational studies involving adult runners (>18 years) that focused on the aetiology, diagnosis and/or treatment of ITBS were included and articles not written in English, French, German or Dutch were excluded.
Data collection and analysis: Two reviewers independently screened search results, assessed methodological quality and extracted data. The sum of all positive ratings divided by the maximum score was the percentage quality score (QS). Only studies with a QS higher than 60% were included in the analysis. The following data were extracted: study design; number and characteristics of participants; diagnostic criteria for ITBS; exposure/treatment characteristics; analyses/outcome variables of the study; and setting and theoretical perspective on ITBS.
Main results: The studies of the aetiology of ITBS in runners provide limited or conflicting evidence and it is not clear whether hip abductor weakness has a major role in ITBS. The kinetics and kinematics of the hip, knee and/or ankle/foot appear to be considerably different in runners with ITBS to those

without. The biomechanical studies involved small samples, and data seem to have been influenced by sex, height and weight of participants. Although most studies monitored the management of ITBS using clinical tests, these tests have not been validated for this patient group. While the articles were inconsistent regarding the treatment of ITBS, hip/knee coordination and running style appear to be key factors in the treatment of ITBS. Runners might also benefit from mobilization, exercises to strengthen the hip, and advice about running shoes and running surface.

Conclusion: The methodological quality of research into the management of ITBS in runners is poor and the results are highly conflicting. Therefore, the study designs should be improved to prevent selection bias and to increase the generalizability of findings.

1. Background

In the last 30 years, running has become popular worldwide.[1] The Royal Dutch Athletics Federation (KNAU) has estimated that about 12.5% of the Dutch population runs regularly, and that the popularity of running events is still growing.[2] Running is an inexpensive form of vigorous-intensive physical activity and can be done anywhere and at any time;[1] it is also a basic aspect of many recreational and professional sports. However, running may cause overuse injuries, especially in the legs.[3] Various studies have reported on the prevalence and incidence of running injuries occurring during training or races,[3] with injury rates varying between 25% and 65%,[4] although a rate of about 51% has been reported in college athletes and between 20% and 50% in soldiers.[5,6]

Iliotibial band syndrome (ITBS) is the most common running injury of the lateral side of the knee.[7] It is a non-traumatic overuse injury caused by repeated flexion and extension of the knee that causes irritation in the structures around the knee.[8-11] Orchard et al.[12] described an ‘impingement zone’ occurring at, or slightly below, 30° of knee flexion during foot strike and the early stance phase of running. During this impingement period in the running cycle, eccentric contraction of the tensor fascia latae muscle and of the gluteus maximus muscle causes the leg to decelerate, generating tension in the iliotibial band.[12,13]

ITBS is usually diagnosed on the basis of a detailed history and physical examination.[14] It was first initially described by Colson and Armour,[15] and later by Renne,[8] as pain in the lateral side of the knee during running. The incidence of ITBS by runners is estimated to be between 5% and 14%[11,16-21] depending on the differences in study design, sample size and running population; weekly running time/distance, level of performance and sex. In the ITBS population the prevalence of women is estimated to be between 16% and 50%[11,17,19-22] and for men between 50% and 81%.[11,17,19-21]

However, it is still difficult to establish the incidence of ITBS in runners because many studies do not specifically report the incidence of ITBS and the characteristics of this group but, instead, report the incidence of all knee injuries.[13]

The aetiology of ITBS is mostly multifactorial, involving both intrinsic and extrinsic factors.[23] Several authors have reported that ITBS responds well to conservative and surgical treatment.[11,13,24-28]

This study aims to systematically review the literature on ITBS to gain insight into the aetiology, diagnosis and treatment of ITBS in runners, in order to promote evidence-based management.

2. Methods

2.1 Literature Search

We performed a computerized search of bibliographical databases, including MEDLINE (from

1966 to December 2011), EMBASE (from 1980 to December 2011), CINAHL (from 1982 to December 2011), Web of Science (from 1988 to December 2011) and the Cochrane Library (from 2009 to December 2011) using the following search terms: 'iliotibial band friction syndrome', 'iliotibial band syndrome' and 'iliotibial band strain' all in combination with running and with no restriction for language. The first author (MvdW) screened titles and abstracts of all identified citations to identify relevant studies and searched the reference lists of the retrieved articles to identify other potential studies.

Two independent reviewers (MvdW and NvdH) screened the retrieved articles, using the following inclusion criteria: studies that investigated the aetiology, diagnostics and/or treatment of ITBS; study subjects who were adult runners (aged >18 years); study designs that were systematic reviews, (randomized) clinical trials or observational studies (longitudinal, cross sectional or case referent), and studies reported in English, French, German or Dutch. Differences in article selection between the two reviewers were resolved in a consensus meeting. If consensus was not reached, a third reviewer (AW) made the final decision for inclusion or exclusion of the article.

2.2 Methodological Quality

The methodological quality of the articles was assessed by two independent reviewers (NvdH and MvdW), using appropriate Cochrane Collaboration criteria.[29] Criteria not applicable for a given design were not taken into account. This resulted in nine items being scored for randomized clinical trials, eight for cohort analyses, and six for case referent and cross-sectional studies. Scoring of the different study types were as follows:

- Randomized clinical trials: (i) subjects were randomly allocated to groups; (ii) allocation was concealed; (iii) there was blinding of all subjects/patients; (iv) there was blinding for all care providers; (v) there was blinding of all assessors who measured at least one key outcome; (vi) groups were similar at baseline; (vii) follow-up assessment is of sufficient length; (viii) study included an intent-to-treat analysis; and (ix) all groups, except those in the intervention group, were treated similarly.[29]
- Observational studies: (i) description of the main characteristics of the study population or cases; (ii) description of the main characteristics of the referents; (iii) exclusion of selection bias; (iv) description and measurement of exposure; (v) description and measurement of the outcome variable; (vi) blinding of the measurement outcome variable; (vii) follow-up assessment is of sufficient length; (viii) exclusion selective loss to follow-up; (ix) inclusion of confounding variables in statistical analysis.[29]

For each study, a quality score (QS) was calculated by summing the positive ratings and dividing this by the maximum score for that type of study. The methodological QS was judged adequate if the score was more than 60%. Differences in the assessment of methodological quality were settled in a consensus meeting and, if necessary, by a third reviewer (AW). The rate of agreement about the quality of studies was then calculated.

The level of scientific evidence regarding ITBS was as follows:[30]

- level I, strong evidence provided by systematic reviews;
- level II, moderate evidence provided by generally consistent findings in multiple adequate quality studies (QS >60%);
- level III, limited evidence provided by one high-quality study or by generally consistent findings in multiple low-quality studies;
- level IV, conflicting evidence in case of inconsistent findings;
- level V, no evidence, expert based.

2.3 Data Extraction and Analysis

Only studies with a QS higher than 60% were included in the analysis. The following information was extracted from articles providing level I–IV evidence: study design; population characteristics; number of participants; how ITBS was diagnosed; exposure/treatment characteristics; analyses/outcome variables of the study; and setting and the theoretical perspective of ITBS.

3. Results

3.1 Literature Search

A flow chart for article retrieval is given in figure 1. Of 209 articles retrieved as potentially relevant, 108 were considered eligible for full-text screening, and 36 of these met the inclusion criteria. Articles that failed to meet inclusion criteria were narrative reviews,[9,23-28,31-48] casuistic cases,[49-59] case reports[60-62] and a commentary.[63] Thirteen studies did not involve runners,[5,7,8,64-73] 18 did not investigate ITBS[14,20,74-88] and one was written in Serbian.[89]

3.2 Methodological Quality

The 36 included studies are ranked by QS and subsequently in alphabetic order of first author's name in table I. Initially, both reviewers agreed about 151 (60%) of the 232 items. All disagreements were resolved during one consensus meeting. Fourteen (11 observational and 3 randomized clinical trials) studies fulfilled the methodological quality criteria (QS >60%) and provided level I–IV evidence according to the CEBM (Centre of Evidence Based Medicine).[30] The three randomized clinical trials met requirements regarding randomization, baseline similarity of groups, length of follow-up and similarity of treatment (except the intervention) between groups. However, treatment allocation was not concealed (or reported) in these three studies and it could not be ascertained from the information provided whether the outcome assessor was blinded in the study of Gunter and Schwellnus.[91] All observational studies met the requirements regarding the description of the population/cases and, where appropriate, the length of follow-up.

3.3 Data Extraction and Analysis

The 14 studies investigated factors contributing to ITBS in runners,[16,17,22,93-97] its diagnosis, if it was based on history, physical examination complemented by clinical findings and supplementary tests,[90-92,94,96-98] and treatment.[16,90-92,97-99] One study[100] established normative data for the Ober and modified Thomas tests. All these studies are summarized in tables II–IV, respectively, in alphabetic order of first author's name.

3.3.1 Aetiology

Three main factors were investigated with regard to the aetiology of IBTS: the strength of the hip abductors, biomechanics and the choice of shoe and running surface.

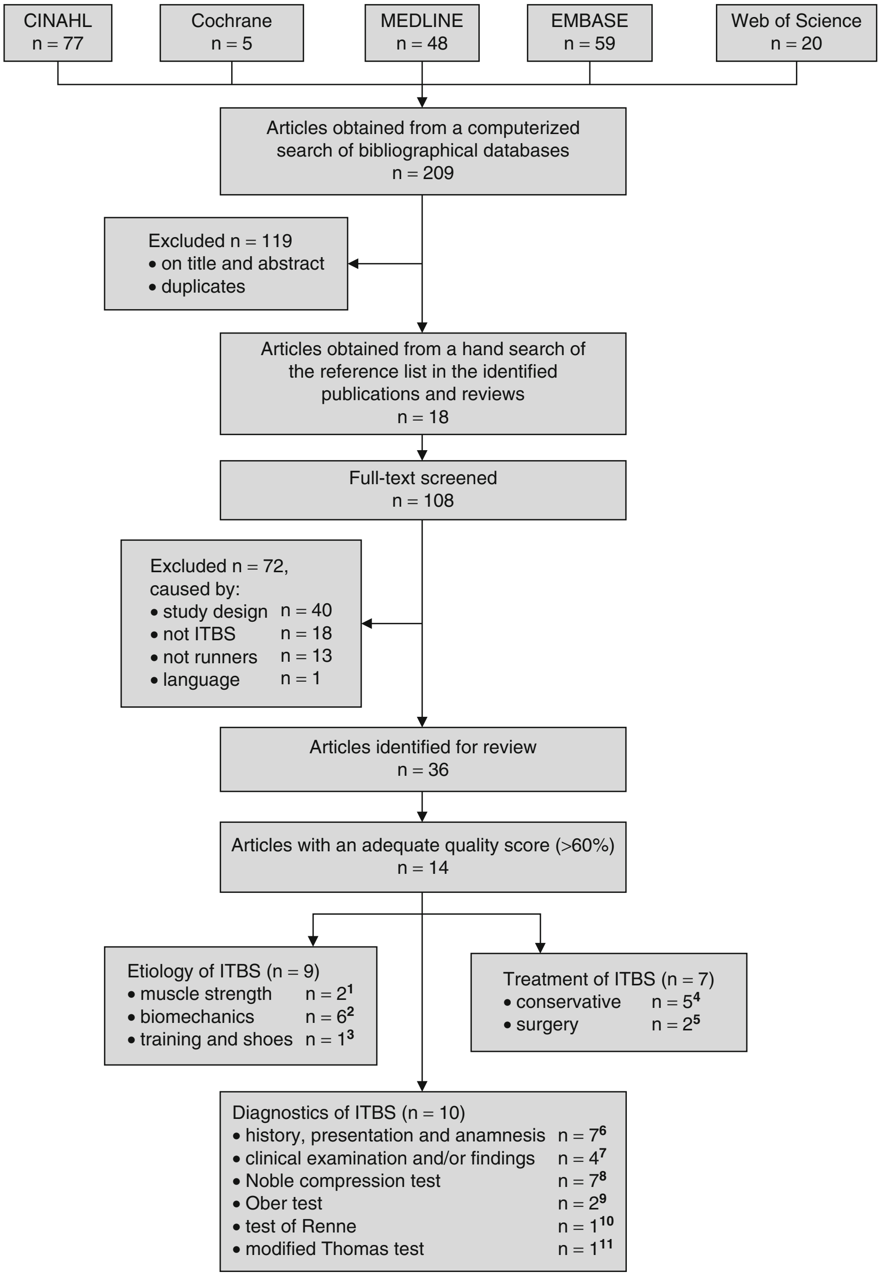
Strength of the Hip Abductors

Grau et al.[93] measured the isometric, concentric and eccentric peak torque of the hip abductors/adductors at 30°/s and calculated the concentric endurance quotient at 30°/s. They found no difference between runners with (n = 10) or without ITBS (n = 10), matched by age, sex, weight and weekly running distance (at least 20 km).[93]

Fredericson et al.[97] compared the pre-rehabilitation hip abductor torque (measured with a hand-held dynamometer; break method) between the injured and uninjured side in runners with and without ITBS. The ITBS group for this study consisted of 24 consecutive collegiate and club long-distance runners who presented to the Runners' Injury Clinic for initial evaluation and were diagnosed with ITBS. The mean age and weight of this group was 27.6 years (95% CI 3.66) and 58.73 kg (95% CI 4.02) for women (n = 10), and 27.07 years (95% CI 4) and 71.85 kg (95% CI 2.69) for men (n = 10), respectively. The control group of 30 distance runners (14 female, 16 male) subjects were all Stanford University cross-country and track runners, who were randomly selected to participate in this study during their pre-season physicals. They found in this larger and homogeneous group that the pre-rehabilitation hip abductor torque was significantly lower on the injured side in male and female runners with ITBS than in runners without ITBS.[97]

Biomechanics

In another study, Grau et al.[94] investigated biomechanical (kinematic and kinetic) differences between runners with and without ITBS, using control groups of healthy runners: control group (CG) I (n = 18) unmatched, CG II (n = 18) matched for sex, and CG III (n = 18) matched for sex, height and weight. All subjects ran barefoot along a 13 m ethylene vinyl acetate (EVA) foam



1 = [93,97]
2 = [16,17,22,94,96,95]
3 = [16]
4 = [16,90-92,97]
5 = [98,99]
6 = [90-92,94,96-98]
7 = [91,94,97,99]
8 = [16,90-92,96-98]
9 = [96,100]
10 = [91]
11 = [100]

Fig. 1. Flow chart of the search of scientific publications and the studies with an adequate quality scores in the management of iliotibial band syndrome. **ITBS** = iliotibial band syndrome.

Table I. Methodological quality assessment of the randomized controlled trials and the observational studies with their quality score

Study (y)	Scoring items										
	1[a,b]	2[a,b]	3[a,b]	4[a,b]	5[a,b]	6[a,b]	7[a,b]	8[a,b]	9[a,b]	Total scores[c]	QS
RCTs											
Schwellnus et al.[90] (1991)	+	–	+	+	+	+	+	–	+	7	78
Gunter and Schwellnus[91] (2004)	+	–	+	–	–	+	+	+	+	6	67
Schwellnus et al.[92] (1992)	+	–	–	–	+	+	+	+	+	6	67
Observational studies											
Grau et al.[93] (2008)	+	+	+	+	NA	NR	NA	NA	+	5	100
Grau et al.[94] (2008)	+	+	+	+	NA	NR	NA	NA	+	5	100
Noehren et al.[22] (2007)	+	+	+	+	NA	NR	NA	NA	+	5	100
Taunton et al.[17] (2002)	+	NA	+	+	+	NR	NA	NA	+	5	100
Ferber et al.[95] (2010)	+	+	–	+	NA	NR	NA	NA	+	4	80
Grau et al.[96] (2011)	+	+	+	–	NA	NR	NA	NA	+	4	80
Fredericson et al.[97] (2000)	+	NA	+	–	–	NR	+	+	+	5	71
Hariri et al.[98] (2009)	+	NA	–	+	+	NR	+	+	–	5	71
Michels et al.[99] (2009)	+	NA	+	+	–	NR	+	+	–	5	71
Pinshaw et al.[16] (1984)	+	NA	–	+	+	NR	+	–	+	5	71
Ferber et al.[100] (2010)	+	NA	–	+	+	–	NA	NA	+	4	67
Fredericson et al.[101] (2002)	–	NA	–	+	+	NR	NA	NA	+	3	60
Hein et al.[102] (2011)	+	+	–	+	NA	NR	NA	NA	–	3	60
Miller et al.[103] (2008)	+	+	–	+	NA	NR	NA	NA	–	3	60
Drogset et al.[104] (1999)	–	NA	–	+	–	NR	+	+	–	3	43
Lindenberg et al.[105] (1984)	–	NA	–	+	–	NR	+	+	–	3	43
McNicol et al.[11] (1981)	+	NA	–	–	–	NR	+	–	+	3	43
Sutker et al.[21] (1985)	–	NA	–	+	–	NR	+	+	–	3	43
Messier et al.[19] (1995)	–	–	–	+	NA	NR	NA	NA	+	2	40
Nishimura et al.[106] (1997)	+	–	–	+	NA	NR	NA	NA	–	2	40
Barber and Sutker[107] (2008)	–	NA	–	+	–	NR	+	–	–	2	29
Beers et al.[108] (2008)	–	NA	–	–	+	NR	–	+	–	2	29
Noble[109] (1979)	–	NA	–	+	–	NR	+	–	–	2	29
Noble[110] (1980)	–	NA	–	+	–	NR	–	–	+	2	29
Hamill et al.[111] (2008)	–	–	–	+	NA	NR	NA	NA	–	1	20
Messier and Pittala[112] (1988)	–	–	–	+	NA	NR	NA	NA	–	1	20
Miller et al.[113] (2007)	–	–	–	+	NA	NR	NA	NA	–	1	20
Orchard et al.[12] (1996)	–	NA	–	+	–	NR	NA	NA	–	1	20
Barber and Sutker[114] (1992)	–	NA	–	–	–	NR	–	+	–	1	14
Martens et al.[115] (1989)	–	NA	–	+	–	NR	–	–	–	1	14
Nillson and Staff[116] (1973)	–	NA	–	–	–	NR	–	+	–	1	14
Nemeth and Sanders[10] (1996)	–	NA	–	–	–	NR	–	–	–	0	0
Noehren et al.[117] (2006)	–	–	–	–	NA	NR	NA	NA	–	0	0

a Scoring items – RCT: 1 = randomization; 2 = treatment allocation concealed; 3 = patient blinded; 4 = care-provider blinded; 5 = outcome assessor blinded; 6 = groups similar at baseline; 7 = follow-up of sufficient length; 8 = included an intent-to-treat analysis; 9 = all groups, except intervention, treated similarly.

b Scoring items – observational studies: 1 = description population/cases; 2 = description referents; 3 = exclusion selection bias; 4 = description and measurement exposure; 5 = description and measurement outcome variable; 6 = blinding measurement outcome variable; 7 = follow-up of sufficient length; 8 = exclusion selective loss to follow-up; 9 = inclusion confounding variables.

c Total score from both RCT and observational studies.

NA = not applicable; **NR** = not relevant; **QS** = quality score; **RCTs** = randomized controlled trials; + indicates yes; – indicates no.

Table II. Observational studies: aetiology of iliotibial band syndrome in runners

Study (y)	Design	Population[a]	Follow up	Diagnostic ITBS	Exposure/treatment	Analyses/outcome[b]	Setting	Theoretical perspective
Ferber et al.[95] (2010)	Case referent	N = 400; 100% F; runners, minimum 30 km/wk; aged between 18 and 45 y: ITBS group in the past - N = 35; all F - Age 35.47 ± 10.35 y - Height 1.65 ± 0.06 m - Weight 58.62 ± 3.97 kg - MRD 123.82 ± 62.64 km CG: - N = 35; 100% F - Age 31.23 ± 11.05 y - Height 1.67 ± 0.07 m - Weight 61.30 ± 6.97 kg - MRD 119.27 ± 52.02 km	NA	NF	All subjects ran along 25 m runway - Speed; 3.65 m/s - Data from 5 trails were averaged: • Foot Peak RFEA, RFIM • Knee Peak knee IR angle, peak knee ERM, peak KF angle • Hip Peak (HADD), peak HABM	Foot (ITBS vs CG) - RFEV: 8.94 ± 3.16° vs 10.04 ± 3.22°; p = 0.36 - RFIM: 014 ± 0.13 Nm/kg vs 0.09 ± 0.08 Nm/kg; p = 0.05 Knee (ITBS vs CG) - IR: 1.75 ± 5.94° vs –1.14 ± 4.94°; p = 0.03 - ERM: 0.09 ± 0.06 Nm/kg vs 0.09 ± 0.05; Nm/kg p = 0.68 - KF; 45.30 ± 4.50° vs 45.21 ± 5.00°; p = 0.95 Hip (ITBS vs CG) - HADD: 10.39 ± 4.36° vs 7.92 ± 5.84°; p = 0.05 - HABM; 15.33 ± 0.24 Nm/kg vs 1.33 ± 0.18 Nm/kg; p = 0.94	NF (lab?)	NF
Fredericson et al.[97] (2000)	Cohort: longitudinal prospective	N = 54; 26 M, 28 F; ITBS group: - N = 24; 10 M, 14 F; distance runners; M: - Age 27.07 y (95% CI 4.0) - Height 1.78 m (95% CI 0.03) - Weight 71.85 kg (95% CI 2.69) F: - Age 27.6 y (95% CI 3.66) - Height 1.67 m (95% CI 0.06) - Weight 58.73 kg (95% CI 4.02) CG: - N = 30, 16 M, 14 F distance runners; cross-country and track team	6 wk	History, presentation, clinical examination and Noble compression test	ITBS group: 6 wk standardized rehabilitation programme: - No running at the beginning - Once a wk physical therapy; • Ultrasound with corticosteroid gel, etc. - NSAIDs until pain free with daily activities - Stretch exercises for iliotibial band (3 × day) - Hip abd exercises and pelvic drop exercise 5 sets of 30 reps	Pre-rehab. hip abd torque M: - ITBS: 6.86 ± 1.19% injured leg - ITBS: 8.62 ± 1.16% non-injured leg - CG: 9.73 ± 1.3% F: - ITBS: 7.82 ± 1.93% injured leg - ITBS: 9.82 ± 2.987% non-injured leg - CG: 10.19 ± 1.10% All groups differed significantly p ≤ 0.05 Post-rehab. hip abd torque - ITBS: M 51% increase - ITBS: F 34.9% increase After 6 wk 22 athletes pain free and running. After 6 mo no reports of recurrence	Stanford University Sports Medicine Clinics, California, USA	Biomedical; iliotibial band

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Table II. Contd

Study (y)	Design	Population[a]	Follow up	Diagnostic ITBS	Exposure/treatment	Analyses/outcome[b]	Setting	Theoretical perspective
Grau et al.[93] (2008)	Case Referent	N = 20; 14 M, 6 F; ITBS group: - N = 10; 7 M, 3 F - Age 41 ± 7 y - Height 178 ± 8 cm - Weight 69 ± 9 kg - Weekly running >20 km CG: - N = 10; 7 M, 3 F; healthy runners - Age 38 ± 6 y - Height 179 ± 8 cm - Weight 70 ± 98 kg - Weekly running >20 km	NA	NF	Isokinetic measurement (30°/s) - Isometric hip abd/add - Concentric hip abd/add - Eccentric hip abd/add - Endurance (concentric) • 20 reps at 30°/s, 3 max. of the last 5 contractions divided by 3 max. of the first 5 contractions	No significant difference between the CG and the ITBS group for isometric, concentric, eccentric and the endurance contractions. No significant difference between the injured and non-injured side ITBS group for isometric, concentric, eccentric and the endurance contractions	Department of Sports Medicine, Medical Clinic University of Tübingen, Tübingen Germany	Biomedical; liotibial band
Grau et al.[94] (2008)	Case referent	N = 70; runners ITBS group: - N = 18; 13 M, 5 F - Age 35.7 ± 6.8 y - Height 177 ± 8.6 cm - Weight 71 ± 11.6 kg - BMI 22 ± 2.6 kg/m^2 CG I healthy runners: - N = 18; 11 M, 7 F - Age 36.6 ± 6.7 y - Height 172 ± 8 cm - Weight 65 ± 11.6 kg - BMI 22 ± 2.2 kg/m^2 CG II sex-matched healthy runners: - N = 18; 13 M, 5 F - Age 41.8 ± 6.5 y - Height 173 ± 7.8 cm - Weight 66 ± 9,8 kg - BMI 22 ± 2.0 kg/m^2 CG III sex/age/height/weight-matched healthy runners: - N = 18; 13 M, 5 F - Age 41.8 ± 6.5 y - Height 173 ± 7.8 cm - Weight 66 ± 9.8 kg - BMI 22 ± 2.0 kg/m^2	NA	History and clinical examination	Running barefoot with a speed of 3.3 m/s (± 5%) on a 13 m EVA foam runway - Kinematics measurements: • Hip joint add, tibia IR and subtalar joint eversion; • At touchdown and max. Kinetics measurements: • Pressure distribution of the feet • Max. force normalized to bodyweight and relative force-time integral	- ITBS vs CG I ≥AddTD, diff. = 3.2° p = 0.49, AddMax diff. = 2.2° p = 0.081, IRTD diff. = 1.5° p = 0.44, IRMax diff. = 1.1° p = 0.355, EVTD diff. = 1.2° p = 0.318, EVMax diff. = 1.0°, p = 0.359 - ITBS vs CG II => AddTD diff. = 3.8° p = 0.008, AddMax diff. = 3.0° p = 0.024, IRTD diff. = 1.8° p = 0.03, IRMax diff. = 1.3° p = 0.193, EVTD diff. = 2.7° p = 0.053, EVMax diff. = 1.2° p = 0.311 - ITBS vs CG III ≥ AddTD diff. = 3.9° p = 0.006, AddMax diff. = 3.0° p = 0.008, IRTD diff. = 2.0° p = 0.008, IRMax diff. =1.8°, p = 0.052, EVTD diff. = 3.2° p = 0.002, EVMax diff. = 1.9° p = 0.081 Pressure measurements also depend on the matching process, with decreasing (NS) between ITBS and CG after refining the process (ITBS vs CG I ≥ ITBS vs CG III)	Department of Sports Medicine, Medical Clinic University of Tübingen, Tübingen Germany	Biomedical; iliotibial band

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Table II. Contd

Study (y)	Design	Population[a]	Follow up	Diagnostic ITBS	Exposure/treatment	Analyses/outcome[b]	Setting	Theoretical perspective
Grau et al.[96] (2011)	Case referent	N = 36; 26 M, 10 F ITBS group runners: - N = 18; 13 M, 5 F - Age 36 ± 7 y - Height 177 ± 8 cm - Weight 71 ± 12 kg - BMI 23 ± 3 kg/m^2 - Runner type • 1 forefoot (forefoot-heel-forefoot) • 17 rearfoot (heel-forefoot) Training speed 3.3 m/s CG healthy runners: - N = 18; 13 M, 5 F - Age 37 ± 9 y - Height 177 ± 9 cm - Mass 70 ± 10 kg - BMI 22 ± 2 kg/m^2 - Runner type: • 1 forefoot (forefoot-heel-forefoot) • 17 rearfoot (heel-forefoot) - Training speed 3.3 m/s	NA	History, presentation and positive Ober test or Noble compression test	Running barefoot with a speed of 3.3 m/s a 13 m EVA foam Kinematic measurements: - Max. values (°), ROM values (°) and max. velocity values (°/s) of sagittal hip motion and frontal hip motion, sagittal knee motion, sagittal ankle motion and frontal rearfoot motion for CG and ITBS subjects - Timing of max. joint angle excursions relative to the % of the ROP; joint coordination: ≥ hip flexion, hip add, KF, internal tibial rotation, ankle flexion and RFEV for control group and ITBS subjects	- Kinematic evaluation: • ITBS group: less hip add (at the point of max. add at about 32% of ground contact) and frontal ROM at the hip joint in runners with ITBS - Kinetic evaluation • ITBS group: max. hip flexion velocity and max. KF velocity were lower • No difference between groups with regard to ankle joint and rear foot motions - Lack of joint coordination (earlier hip flexion [$p < 0.05$] and a tendency toward earlier KF) ITBS compared with CG subjects	Department of Sports Medicine, Medical Clinic University of Tübingen, Tübingen Germany	Biomedical; fad pad compression beneath the iliotibial band
Noehren et al.[22] (2007)	Case referent	N = 400; 100% F runners, minimum 20 miles/wk; 18–45 y Incidence rate of ITBS 16% among all reported injuries ITBS group: - N = 18; 100% F - Age 26.8 y - Monthly mileage 96.2 - BMI 21.9 kg/m^2 CG: - N = 18; all F - Age 28.5 y - Monthly MRD 99.3 - BMI 22.1 kg/m^2	2 y	NF	An instrumented gait analysis: - Peak moments of hip, knee and rear foot angles during stand phase of running - Averaged over the five running trails (25 m of 3 m/s [± 5%]) and averaged across groups	Significant - Hip add peak; ITBS 14.1 ± 2.5°, CG 10.6 ± 5.1°; $p = 0.01$ - Knee IR peak ITBS 3.9 ± 3.7°, CG 0.02 ± 4.6°; $p = 0.01$ - Femur in lab.; peak –4.6 ± 6.9°, CG 1.3 ± 7.5°; $p = 0.02$ - Moment: hip abd, knee external rotation and rear foot inversion; NS - Tibia in lab.; peak and KF at heel strike; NS	NF	Biomedical: iliotibial band

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Table II. Contd

Study (y)	Design	Population[a]	Follow up	Diagnostic ITBS	Exposure/treatment	Analyses/outcome[b]	Setting	Theoretical perspective
Pinshaw et al.[16] (1984)	Cohort: longitudinal prospective	N = 210; sex NF - Consecutive pts over a period of 6 mo - 14 were excluded because of no running athletes: - N = 196; 169 M 27 F Four common injuries (78%): 1. Peri-patellar pain syndrome (runner's knee); n = 42 2. Shin splints; n = 36 3. ITBS group n = 24; sex = NF - 2% combination with runner's knee/shin splints 4. Chronic muscle injuries; n = 11	8 wk	Noble compression test	Treatment ITBS; applicable advice: - Running shoes: change to 'soft' running shoes - Foot orthoses and shoe alterations: the outside heel flare of the shoe corresponding injured side removed - Leg-length discrepancies; full correction at the heel, 50% correction mid-sole and 25% correction at the ball of the foot - Training methods: appropriate advice in training distances, running speed, amount of hill running and adequate rest days - Ice application: encouraged to apply ice twice a day for 30 min	ITBS pts: - 50% previous seen a GP, orthopaedic surgeon or non-medical practitioner - Not found below age of 20 y and evenly distributed between all groups >20 y - ITBS was common among athletes who run <1 y, running 41–80 km/wk, 70–80% middle-distance runners, 70% performing stretching exercise <10 min/day, knee varus 52% and normal 48%, patellar medially pointing 10% and normal 89% - Foot alignment 12% normal, 35% mild, 47% moderate and 6% severe varus - Running shoe: 28% Adidas, 30% New Balance, 23% Nike Treatment ITBS: 78% runners were seen 8 wk later: - 44% were 100% cured, 67% followed advice; - 22% were 75% cured, 75% followed advice; - 11% were 50% cured, 50% followed advice; - 7% were 25% cured, 25% followed advice; - 16% were 0% cured, 75% followed advice	Cape Town SAB Sports Injury Clinic, Cape Town, South Africa	Biomedical: iliotibial band
Taunton et al.[17] (2002)	Cross sectional	N = 2002; 926 M, 1076 F runners; ITBS group: - N = 168; 63 M, 105 F - Age 32.2 y - Activity history 7.3 y - Weekly h 4.9 M: • Height 169.9 cm • Weight 75.7 kg	NA	NF	Biomechanical assessment: - Leg length inequality; >0.05 - Leg alignment; genu valgus/genu varum - Q angle; >16° - Patellar position; Patellar squinting through femoral	- Leg length inequality n = 17 - Leg alignment • valgus n = 25 • varus n = 54 - Q angle n = 3 - Patellar position • patellar squinting n = 13 - Arch position • pes planus n = 25	AMSMC University of British Colombia, Vancouver, BC, Canada	NF

Continued next page

Table II. Contd

Study (y)	Design	Population[a]	Follow up	Diagnostic ITBS	Exposure/treatment	Analyses/outcome[b]	Setting	Theoretical perspective
		• BMI 23. 7 kg/m³ F: • Height 158.1 cm • Weight 60.0 kg • BMI 21.2 kg/m³			anteversion - Arch position (low/normal/high) History and anamnestic - Previous injury to same anatomical area - Running ability on level of competition; recreational/ competitive (provincial, national or international)	• pes cavus n = 12 <34-y-old risk factor for men; OR 2.77 (95% CI 1.42 to 5.40)		

a Population data are presented as means, means ± SDs and 95% confidence intervals where stated.

b Analyses/outcome data are presented as means ± SDs where stated.

abd = abduction; **add** = adduction; **AddMax** = maximal hip add; **AddTD** = hip add at touchdown; **AMSMC** = Allan McGavin Sports Medicine Centre; **BMI** = body mass index; **CG** = control group; **CI** = confidence interval; **diff.** = difference; **ERM** = knee external rotation moment; **EVA** = ethylene vinyl acetate; **EVMax** = maximal subtalar joint eversion; **EVTD** = subtalar joint eversion at touchdown; **F** = female; **GP** = general practitioner; **HABM** = hip abductor moment; **HADD** = hip adduction angel; **IR** = internal rotation; **IRMax** = maximal internal rotation of the knee; **IRTD** = knee internal rotation at touchdown; **ITBS** = iliotibial band syndrome; **KF** = knee flexion; **lab.** = laboratory; **M** = male; **max.** = maximum; **MRD** = monthly running distance; **NA** = not applicable; **NF** = not found; **N/n** = number; **NS** = not significant; **NSAIDs** = non-steroidal anti-inflammatory drugs; **OR** = odds ratio; **pts** = patients; **rehab.** = rehabilitation; **reps.** = repetitions; **RFEV** = rear foot eversion angle; **RFIM** = peak rear foot invertor moment; **ROM** = range of motion; **ROP** = roll over process; ? indicates the setting was possibly a laboratory but was not explicitly mentioned/found in this study.

runway at a speed of 3.3 m/s. Analysis showed that the differences in kinematic variables (hip joint adduction, tibia internal rotation and subtalar joint eversion) became more pronounced in comparisons with more closely matched controls. Hip joint adduction at touchdown was significantly lower in the ITBS group than in the three CGs. Maximal adduction at the hip was lower in the ITBS group and was significantly different from that in the CG II and CG III groups. Internal knee rotation at touchdown was significantly lower in the ITBS group than in the three CGs, but the maximal knee internal rotation was not significantly different. Subtalar joint eversion was significantly lower at touchdown in the ITBS group than in CG III. The differences in kinetic variables (rearfoot loading and forefoot loading) became less pronounced in comparisons with more closely matched controls. Only the lateral rearfoot (force time integral) and medial forefoot (maximum force normalized to bodyweight) forces were significantly greater and lower in the ITBS group than in the CG I group, respectively.[94]

In 2007, Noehren et al.[22] followed up 400 runners for 2 years, as part of a larger prospective investigation of lower limb injuries in female runners. Eighteen runners developed ITBS and their running kinematics and kinetics were compared with those of age-, body mass index- and monthly mileage-matched controls. The subjects wore standard neutral running shoes and ran along a 25 m runway at a speed of 3.7 m/s (± 5%), striking a force plate at its centre. The ITBS group exhibited greater peak hip adduction, peak knee internal rotation and femoral external rotation, and remained more adducted throughout stance than did the control group. No difference was found in rearfoot eversion, tibia rotation (in global) and knee flexion. Group analyses in the ITBS group showed that subjects (n = 4) with a greater peak rearfoot motion than the mean, showed a higher tibial internal rotation.[22]

In a retrospective study, Taunton et al.[17] analysed data on 2002 individuals with running-related injuries, including 63 men and 105 women with ITBS. The most common overuse running injury was patello-femoral pain syndrome (PFPS),

Table III. Observational study diagnostics of iliotibial band syndrome in runners

Study (y)	Design	Population[a]	Diagnostics ITBS	Exposure/treatment	Analyses/outcome[a]	Setting	Theoretical Construct
Ferber et al.[100] (2010)	Cohort: cross sectional	N = 300; 125 M, 175 F Recreational athletes; minimal 30 min activity, 3 × wk: - N = 250 injured; 104 M, 146 F ITBS group: - N = 31; 10 M, 21 F - Age 32.3 ± 9.7 y - Height 167 ± 29.2 cm - Weight 73.7 ± 21.4 kg	NF	Ober test and modified Thomas test	Ober test: Overall = −24.59° ± 7.27°, n = 600 Negative = −27.13° ± 5.53°, n = 432 Positive = −16.29° ± 6.87°, n = 168 Critical criteria = −23.16°, inter-agreement = 95% Modified Thomas test: Overall = −10.60° ± 9.61°, n = 600 Negative = −15.51° ± 5.82°, n = 382 Positive = −0.34° ± 7.00°, n = 208 Critical criteria = −6.69°, inter-agreement = 97.6%	Running Injury Clinic and Faculties of Kinesiology and Nursing, University of Calgary, Calgary, AB, Canada	NF

a Population data and Analyses/outcome data are presented as means ± SDs where stated.

F = female; **ITBS** = iliotibial band syndrome; **M** = male; **NF** = not found.

followed by ITBS. Varus and valgus knee alignment were present in 33% and 15% of the ITBS group, respectively, and the length of the right versus left leg varied by 10%. Multivariate analysis revealed younger age (mean <34 years) to be a risk factor for ITBS in men; odds ratio of 2.77 (95% CI 1.42 to 5.40). Risk factors for ITBS in women were not identified.[17]

Ferber et al.[95] investigated female runners, comparing 35 females who had previously sustained ITBS with 35 healthy age- and running-distance-matched healthy females. All the subjects involved in this study were part of a larger, ongoing prospective investigation of female runners (n = 400; ages 18–45 years, minimum running distance of 30 km/wk). Subjects ran along a 25 m runway at a speed of 3.7 m/s (± 5%), striking a force plate at its centre. The footwear was not described. Women with ITBS had a greater peak hip adduction angle, knee internal rotation angle and peak rearfoot invertor moment than the controls.[95]

Grau et al.[96] subsequently investigated the same group of runners with ITBS, as in their earlier study.[94] The subjects, all rearfoot strikers, ran barefoot along a 13 m EVA foam runway at a pre-specified speed of 3.3 m/s. In the kinematic evaluation, hip adduction was found to be smaller in the ITBS group (n = 18) compared with the sex-, height- and weight-matched control runners (n = 18). Furthermore, maximum hip flexion velocity and maximum knee flexion velocity were lower in runners with ITBS. Joint coordination, expressed as earlier hip flexion and a tendency toward earlier knee flexion, was also poorer in the ITBS group. No differences were found between the groups with regard to ankle joint and rearfoot motion.[96]

Pinshaw et al.[16] studied a series of 169 running injuries to determine the nature of the common injuries, the type of runners with the different injuries, specific factors causing the most common injuries and the response of these injuries to correction of the biomechanical abnormalities believed to have caused them. Over 6 months they diagnosed 24 runners with ITBS; in 37% of these runners one leg was shorter than the other, and these runners had injuries such as

Table IV. Observational studies and randomized clinical trials: treatment of iliotibial band syndrome in runners

Study (y)	Design	Population[a]	Follow-up[a]	Diagnostic ITBS	Exposure/treatment	Analyses/outcome[a]	Setting	Theoretical Construct
Gunter and Schwellnus[91] (2004)	RCT	N = 9; sex NF Runners with ITBS Experimental group: - N = 9; sex NF - Age 29.0 ± 6.5 y - Height 176.4 ± 8.3 cm - Weight 73.3 ± 7.3 kg - Total weekly distance running: 83.3 ± 9.7 km - Best 10 km time 46.8 ± 6.9 min CG: - N = 9; sex NF - Age 28.9 ± 5.0 y - Height 177.9 ± 11.1 cm - Weight 70.5 ± 8.0 kg - Total weekly distance running: - 82.5 ± 9.3 km - Best 10 km time 46.6 ± 6.7 min	14 days	History, presentation, clinical examination, Noble compression test and test of Renne	EG: - 40 mg methylprednisolone acetate mixed with local anaesthetic CG: - Local anaesthetic Treadmill running test: - VAS per min - Total pain during running - Days 0, 7 and 17	There was a tendency (p = 0.07) for a greater decrease in total pain during the treadmill running in EG vs CG from day 0 EG = mean 222 (SEM 71), CG = mean 197 (SEM 31) to day 7 EG = mean 140 (SEM 87), CG = mean 178 (SEM 76) There was a significant (p = 0.01) decrease of total pain during running from day 7 EG = mean 140 (SEM 87), CG = mean 178 (SEM 76) to day 14 EG = mean 103 (SEM 89), CG = mean 157 (SEM 109) in the EG vs CG)	Sports Medicine Clinic of a Staff Model Health Maintenance Organization in South Africa	Biomedical: tissue beneath the iliotibial band
Hariri et al.[98] (2009)	Cohort: longitudinal retrospective	N = 11; 7 M, 4 F pts with ITBS - Age of onset symptoms: • 29 ± 8 y - Age at surgery: • 32 ± 5 y - BMI 24 ± 47 kg/m^3	38 ± 16 mo	History, presentation and Noble compression test	Iliotibial band bursectomy by a single surgeon	Post-operative - Tegner activity score: • Pre-operative • Post-operative 5 ± 2 (NS) - VAS • Pre-operative 8 ± 2 • Post-operative 2 ± 3 - Lysholm score: excellent 7 pts, good in 4 pts - IKDC 88 ± 11 • Surgical outcome; 6 pts completely satisfied, 3 mostly satisfied, 2 somewhat satisfied	Division of Sports Medicine, Department of Orthopedic Surgery, Boston, MA, USA	Biomedical: Bursa

Continued next page

Table IV. Contd

Study (y)	Design	Population[a]	Follow-up[a]	Diagnostic ITBS	Exposure/treatment	Analyses/outcome[a]	Setting	Theoretical Construct
Michels et al.[99] (2009)	Cohort: longitudinal prospective	N = 36: 21 M,15 F Pts with ITBS, 33 pts for follow-up: - N = 33; sex NF - Age 31.1 range 19–44 y - Suffering from ITBS for 18 mo preoperatively, range 1–7 y - Recreational or professional athletes: running (n = 22), triathlon (n = 5), cycling (n = 4), athletics (n = 3), rugby (n = 3), soccer (n = 1), swimming (n = 1), fencing (n = 1) and basketball (n = 1)	2 y and 4 mo, at least 6 mo	Clinical findings	Standardized arthroscopic technique, limited to the resection of lateral synovial recess: 16 right knees, 22 left, 2 pts bilaterally	Running: - 2 mo post-operative 74.2% start slow running, 100% at 3 mo Results: - 28 (80%) excellent, 6 (17.1%) good, 1 (2.9%) fair Satisfaction - mean 6, range 6–10 points Complications: - 1 pt cartilage lesions of the femoral condyle, 2 pts with a menisci lesion, 1 pt calcified loose body in the lateral synovial recess, 1 developed a haematoma	Bordeaux Merignac Sports Clinic	Biomedical: Fibrous and fat tissue
Schwellnus et al.[92] (1992)	RCT	N = 17; sex NF Pts with unilateral ITBS Group A: - N = 9; sex NF - Age 25 ± 6 y - Duration of injury 23 ± 17 wk - Years of running 7.7 ± 5.5 - Weekly training distance 45 ± 15 km - Grade of injury 3.4 ± 0.5 units Group B: - N = 8; sex NF - Age 29 ± 5 y - Duration of injury 74 ± 95 wk - Years of running 5.4 ± 6.2 - Weekly training distance 64 ± 30 km - Grade of injury 3.4 ± 0.5 units	14 days	History, presentation and test of Noble	Treatment: - Rest - Ice; twice daily local application 20 min - Basic physiotherapy • Daily stretching of the iliotibial band • Ultrasound on day 3, 4, 5, 6, 7 and 10 - Deep transverse friction for group A on days 3, 5, 7 and 10	Daily pain recall: - The mean daily pain scores recorded for overall pain over three treatments periods (days 0–2, days 3–6 and days 7–14) significantly decrease for both group with no difference between group A and B Treadmill running: - Total pain experienced during running (area under the pain vs time curve) was not significantly decreased between the groups of any of the days (days 0, 3, 7 and 14) - Significant decrease in the pain values and maximum pain experienced (%) over the treatment period. But not significant between groups	Sports Injury Clinic at the University of Cape Town Sports Center, Cape Town, South Africa	Biomedical: Under the iliotibial tract over the lateral epicondyle

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Table IV. Contd

Study (y)	Design	Population[a]	Follow-up[a]	Diagnostic ITBS	Exposure/treatment	Analyses/outcome[a]	Setting	Theoretical Construct
Schwellnus et al.[90] (1991)	RCT	N = 43; sex NF Pts with unilateral IBTS Group 1: - N = 13, sex NF - Age 22 ± 5 y - Weight 74 ± 5 kg - Height 181 ± 3 cm - Years of running 10 ± 5 - Duration of symptoms 6.8 ± 7.1 wk - Weekly training distance 44 ± 29 km - Training speed 4.9 ± 0.3 min/km - Grade of injury 3.2 ± 0.4 units Group 2: - N = 14, sex NF - Age 24 ± 6 y - Mass 72 ± 6 kg - Height 181 ± 6 cm - Years of running 5 ± 5 - Duration of symptoms 6.1 ± 6.1 wk - Weekly training distance 48 ± 33 km - Training speed 4.6 ± 1.0 min/km - Grade of injury 3.1 ± 0.5 units Group 3: - N = 16, sex NF - Age 22 ± 2 y - Weight 68 ± 7 kg - Height 178 ± 4 cm - Years of running 6 ± 6 y - Duration of symptoms 7.4 ± 13.1 wk - Weekly training distance 39 ± 14 km - Training speed 4.6 ± 0.8 min/km - Grade of injury 3.2 ± 0.4 units	7 days	Anamnesis and compression test of Noble	Treatment: - Rest - Ice; twice daily local application - Physiotherapy; day 3 till day 7 • Daily stretching Iliotibial band; • Daily ultrasongraphy; • Deep transverse friction on days 3, 5 and 7 - Medication • Group 1; placebo capsule; 3 ×/day • Group 2; 50 mg. diclophenac sodium; 3 ×/day • Group 3; 400 mg ibuprofen, 500 mg paracetamol (acetaminophen) and 20 mg codeine phosphate; 3 ×/day	Daily 24 h recall pain: - Decreased significantly for the three groups over the treatment period • Group 3 ≥ significantly decrease from day 0 to day 3 • Group 1 and 3 ≥ significantly decreased from day 3 to day 7 • All groups ≥ significantly decreased from day 0 to day 6 - No difference between groups Treadmill running test (day 0, 3 and 7) - Total running time did not differ significantly between groups on each of the test days. Total distance run did not differ significantly on each of the test days - In all three groups the total distance run, did not change significantly from day 0 to day 3, but did significantly change from day 3 to day 7. Group 3 distance significantly increased from day 0 to day 7 - Group 3 improved their total running time and distance from day 0 to day 7 and group 1 and group 2 improved from day 3 to day 7 - In all groups the area under the pain vs time curve decreased from day 0 to day 7	Two sports injury clinics, South Africa	Biomedical: Under the iliotibial tract over the lateral epicondyle

a Population, follow-up and analyses/outcome data are presented as means ± SDs where stated.
BMI = body mass index; **CG** = control group; **EG** = experimental group; **IKDC** = International Knee Documentation Committee; **ITBS** = iliotibial band syndrome; **Pt/s** = patient/s; **VAS** = visual analogue scale.

ITBS, shin splints and PFPS. The prevalence of genu varum was similar in runners with these injuries, but runners with ITBS were more likely to have normal patellar alignment. Pinshaw at al.[16] concluded that runners with ITBS were more likely to have a 'normal' lower limb structure than runners with either PFPS or shin splints.

Training and Shoes

Neither the type of training (as a percentage of time spent running long distances at low speed) nor the training surface influenced the type of injury sustained in the study of Pinshaw et al.,[16] although most runners with ITBS spent more than 90% of their training time running long distances at low speed wearing 'New Balance' shoes and mainly running on tar and dirt roads.[16]

Summary

Studies of the aetiology of ITBS in runners provide limited or conflicting evidence, and it is currently not clear whether hip abductor weakness has a role in ITBS. The kinetics and kinematics of the hip, knee and ankle/foot appear to be different in runners with and without ITBS,[22,94-96] although results regarding the kinematics of adduction of the hip, (maximal) internal rotation of the knee and the inversion and eversion of the ankle/foot are conflicting.[22,94-96] There is limited evidence that runners with ITBS have poor joint coordination, showing earlier hip flexion and a tendency toward earlier knee flexion.[22,94-96] These biomechanical studies involved small samples, and data seemed to have been influenced by the sex, height and weight of participants. Many runners with ITBS have one leg shorter than the other,[16,17] but have a normal patella alignment.[16] These runners tended to train by running long distances at low speed, wearing 'New Balance' shoes, and to run on tar and dirt roads.[16] Young (aged <34 years) male runners were at the highest risk of sustaining an ITBS injury.[17] However, the small size of these uncontrolled studies[16,17] means that firm conclusions cannot be drawn about factors that could promote ITBS.

3.3.2 Diagnosis

ITBS in runners tend to be diagnosed on the basis of the history and presentation,[90-92,94,96-98] complemented by clinical findings.[91,94,97,99] In most studies,[16,90-92,96-98] the Noble compression test is used to confirm the diagnosis of ITBS. Supplementary tests such as the Ober test[118] and the test of Renne[8] can be used to verify ITBS.[91,96,100] See tables II–IV and figure 1. The absence of any other signs in the knee such as effusion, joint line tenderness or a positive McMurray's test is often confirmed/rejected with MRI.[17,93,94,96,99]

The Noble[109] compression test confirms the presence of ITBS.[109] The subject's knee is flexed to 90° then pressure is applied to the lateral epicondyle or a 1–2 cm proximal to it and then the knee is gradually extended. At 30° flexion the patient will complain of severe pain over the lateral epicondyle; the pain has the same quality as that experienced when running.[109] The Ober test measures the flexibility of the iliotibial band.[118] The subject is positioned on the side with the extremity to be tested facing upward. The examiner flexes the knee to be tested to 90° and abducts and extends the hip so that the hip is in line with the trunk. The examiner then allows the force of gravity to cause the extremity to adduct as far as possible. The degree of adduction of the hip reflects the flexibility of the iliotibial band.[100] The Renne test evokes the pain experienced during running; the subject is asked to stand on the affected leg while the knee is held in a 30–40° flexion.[8] Two studies[90,92,105] classified the severity of ITBS using the 'injury grade' of Lindenberg et al.[105] This system has four grades of pain as follows: (i) pain comes on after running, but does not restrict distance or speed; (ii) pain comes on during running, but does not restrict distance or speed; (iii) pain comes on during running and restricts distance or speed; and (iv) pain is so severe that it prevents running.

Muscle/Ligament Flexibility

In a cross-sectional study, Ferber et al.[100] established normative values for the flexibility of the iliotibial band and iliopsoas muscle, an aspect that is important in the management of ITBS.[22,95,96] Using a digital inclinometer, the iliotibial band flexibility (Ober test) and the iliopsoas muscle flexibility (modified Thomas test) were determined in 300 athletes (125 men and 175 women): 250 with ITBS and 50 controls. In the modified Thomas test,[100] the subject sits on the end of the plinth, rolls backwards onto the plinth and then holds both knees to the chest. The subject holds the contralateral hip in maximal flexion with the arms, while the test limb is lowered toward the floor. The degree of extension of the hip reflects the flexibility of the iliopsoas muscle.[78] The results showed an average iliotibial band flexibility of –24.59° and iliopsoas flexibility of –10.60°. The critical criteria for the iliotibial band and iliopsoas flexibility were determined to be –23.16° and –9.69°, respectively.[100]

Summary

Most studies used clinical tests to diagnose,[16,90-92,94,96-99] classify[16,17,90,92] and/or evaluate[90-92] ITBS in runners. These tests would appear not to have been validated for this patient group but seem to have a good face validity. Ferber et al.[100] provided normative data for the Ober test and the Modified Thomas test. Only two studies[96,100] used the Ober test to evaluate runners with ITBS; no studies have described the use of the modified Thomas test in the management of ITBS.

3.3.3 Treatment

Conservative

In a randomized controlled trial (RCT), Schwellnus et al.[90] investigated the effect of initial treatment (day 0–7; rest, ice application and medication) in 43 patients with unilateral ITBS. All subjects received physical therapy consisting of ultrasound, deep transverse friction massages (DTFM) on days 3, 5 and 7, and daily stretching of the iliotibial band. Medication was delivered over the 7 days in a double-blind, placebo-controlled fashion. Group 1 was given a placebo anti-inflammatory medication, group II an anti-inflammatory agent and group III a combined anti-inflammatory/analgesic. Compared with the other groups, in group III, pain during running significantly decreased from day 3 onward and running time/distance on the treadmill running test significantly increased from day 0 to 7.[90]

Schwellnus et al.[92] investigated the therapeutic benefit of DTFM. Twenty subjects with ITBS (>14 days' duration) were randomly divided into two groups. Both groups received treatment consisting of rest, ice twice a day and physical therapy (daily stretching of the iliotibial band and 5 minutes of low-dose ultrasound therapy) on days 3, 5 and 7. The intervention group was also given DTFM for 10 minutes on days 3, 5 and 7. The results showed that daily pain and treadmill running pain were significantly reduced in both groups after treatment. The authors concluded that the addition of DTFM did not alter the therapeutic outcome of ITBS.[92]

In an RCT, Gunter and Schwellnus[91] investigated 18 runners with acute-onset ITBS (<14 days' duration). Subjects were randomly allocated into two groups: group I received a corticosteroid injection and group II received a placebo injection. Subjects were instructed not to run for 14 days following the injection and to apply ice to the area for 30 minutes every 12 hours. Running pain was significantly decreased in the group that received the corticosteroid injection.[91]

Fredericson et al.[97] tested the effectiveness of a 6-week standardized rehabilitation programme in 10 female and 14 male runners with ITBS. The programme consisted of a local application of ultrasound with corticosteroid gel for the first two sessions. All patients were instructed to stretch the iliotibial band three times a day. Hip abduction exercises and pelvic drops to strengthen the gluteus were started at 1 set of 15 repetitions over a course of several weeks and increased to the goal of 3 sets of 30 repetitions. The patients were instructed to increase the workout by 5 repetitions per day if there was no significant post-workout soreness the following day. Nonsteroidal anti-inflammatory drugs were prescribed until the patients were pain free during daily activities. All subjects were instructed to discontinue running and any other activities that continued to cause pain. The investigators found a mean increase of 34.9% and 51.4% in the injured limb of the hip abductor torque for females and males, respectively. Twenty-two of the 24 athletes were able to return to running after 6 weeks of rehabilitation.[97]

Pinshaw et al.[16] gave runners with ITBS the following advice about:

1. Running shoes: change to softer running shoes, use of in-shoe supports and shoe alterations and/or removal of the outside heel flare of the shoe for the injured side.
2. Leg-length discrepancies: adapt shoe of the shorter leg by adding material to the mid-sole to ensure 100% correction at the heel, 50% correction in the mid-sole and 25% correction at the ball of the foot.
3. Training methods: if appropriate, one could reduce training distance, decrease running speed and amount of hill running, and one could incorporate a sufficient number of days for recovery.
4. Ice application: apply ice to the injured area for 30 minutes twice a day.

After 8 weeks, 44% of the runners with ITBS were 100% cured, 22% were 75% cured and 34% were 50% cured or less.[16,97]

Surgery

Hariri et al.[98] described the effect of bursectomy in 11 consecutive patients with ITBS (7 men and 4 women; mean ± standard deviation age at symptom onset 29 ± 8 years) who had persistent (>6 months) symptoms despite conservative treatment. After a minimum of 20 months follow-up, all patients were able to return to their pre-injury activity levels and reported less pain (11-point visual analogue scale score decreased by 6 points). The majority of patients were highly satisfied with the results of the procedure.[98]

Michels et al.[99] evaluated arthroscopic resection of the lateral synovial recess as treatment for resistant ITBS. Thirty-six patients underwent 38 procedures; 33 patients (15 women, 21 men; mean age 31.1 years, range 19–44 years; 35 knees) were followed up for at least 6 months (mean 2 years and 4 months). Prior to surgery, all patients had been treated conservatively for at least 6 months with rest, correction of training error, shoe modification, physical therapy and local infiltration with steroids. The patients had suffered from ITBS for 18 months (range 1–7 years). The subjective functional results after surgery were excellent (80%), good (17.1%) and fair (2.9%), and patients were satisfied with the procedure (mean score 9 of 11). In retrospect, all but one patient would still have had the procedure.[99]

Summary

Overall, the results of the five studies[16,90-92,97] on the conservative treatment of ITBS provided some evidence of the effectiveness of different treatment modalities; pain medication/injection, stretching of the iliotibial band, hip abduction exercises and pelvic drops to strengthen the gluteus muscles, and advice about training, shoe inlays and shoes. Two studies provided limited evidence of the beneficial effect of two different surgical interventions in selected groups of patients.[98,99]

4. Discussion

This extensive, quality-controlled, systematic review revealed that there is limited evidence to support a specific approach to the aetiology, diagnosis and treatment of ITBS. Only one systematic review was found,[7] but this review investigated conservative treatments only and included other sufferers of ITBS beside runners and included only RCTs. We included observational studies as well to identify other potentially relevant types of treatment. Other narrative reviews[9,23-28,31-48] merely reported the subjective results achieved with the ITBS management protocol used by the authors.

4.1 Methodological Quality

The Cochrane Collaboration criteria were used to assess the methodological quality of the studies identified by the computerized database search.[29] While the usefulness of quality control is disputed,[119,120] and it is difficult to determine how to weight each item in an overall QS,[121] sum scores are considered helpful in a systematic review to make a distinction between studies with both a low and high risk of bias, and there is empirical evidence to support this view.[122] We evaluated the QS of the studies in order to gain insight into the risk of bias within the results[121] and excluded studies of poor methodological quality to enable us to draw meaningful conclusions.

A point of concern is the lack of blinding of treatment allocation in three RCTs,[90-92] which could affect results.[123] Inadequate or unclear allocation concealment can lead to higher estimated treatment effects. However, it is not generally possible to predict the magnitude or even the direction of possible selection bias and consequent distortions of treatment effects, as a result of inadequate or unclear allocation concealment.[123] The methodological flaws of poor-quality observational studies mainly concerned the poor description of the population,[10,12,19,21,101,104,105,107-117] selection bias,[10,12,19,21,101,103-117] and the poor description of potential confounding variables.[10,12,21,103-109,111-117] These aspects help readers understand the applicability of the results, and the lack of this information limits generalizability.[124] The study by Grau et al.[94] showed that, in addition to generally accepted confounders, participants' sex, height and weight also affected study outcomes.

To summarize, the poor methodological quality of the studies makes it difficult to draw firm conclusions about the management of ITBS in runners. Future studies should take into account the problems of concealing treatment allocation, the description of the population, potential selection bias and the description of confounding variables.

4.2 Pathogenesis, Diagnosis and Management of Iliotibial Band Syndrome

Knowledge of the pathogenesis of ITBS is essential for providing runners with appropriate treatment and advice.[34] However, the exact pathogenesis of ITBS is still controversial. It was originally thought to be due to excessive friction between the tract and the lateral femoral condyle, leading to inflammation of the tract or bursa.[109,115] However, Nemeth and Sanders[10] found that the lateral femoral condyle is actually a lateral extension of the joint capsule and suprapatellar synovial cavity of the knee joint. In runners with ITBS, histopathology studies have revealed chronic inflammation, hyperplasia, fibrosis and mucoid degeneration of the lateral femoral recess.[10] Muhle et al.[125] found ITBS to be correlated with MRI signal intensity alterations in the fatty tissue deep in the iliotibial band. Using cadavers, Fairclough et al.[51] showed that the iliotibial band is firmly anchored to the distal femur by fibrous strands, associated with a layer of richly innervated and vascular fat. This femoral anchorage prevents the iliotibial band from rolling over the epicondyle.

Eight observational studies investigated the role of muscle strength,[93,97] biomechanics,[16,17,22,94-96] training, and shoes[16] in the aetiology of ITBS.

While deficits in the hip abductors are presumed to be a major factor in the development of ITBS in runners,[36] we found conflicting evidence that hip abductor weakness is important to the aetiology of ITBS in runners. Possible reasons for the different findings might be the measurement device, the variables measured, sample size and the heterogeneous population (age, sex and level of performance).[93,97]

Future studies should measure hip abductor strength in more patients (>30) in a more functional way, to reflect the reality of running and include a control group.[93,97,126] Prospective studies could determine whether runners with weakness in their hip abductors are at a greater risk of developing ITBS or whether weakness of the muscle is caused by ITBS,[97] with a focus on the endurance and muscle activation patterns.[96]

From studies of biomechanics (kinetics and kinematics) in runners both with and without ITBS, it is not clear whether ITBS appeared before the change in biomechanics or if a difference in biomechanics caused the ITBS. However, the results of the studies of Grau et al.[96] and Ferber et al.[95] suggest that lower extremity running mechanics do not change as a result of ITBS. In contrast, the results of Grau et al.[94] showed that biomechanical differences between healthy runners and those with ITBS do depend on the matching (weight, height and sex) of the participants. For instance, it is unclear whether there is a sex-specific biomechanical aspect to the development of ITBS in runners.[17,96] Other studies showed that differences between runners with or without ITBS might also depend on the acuity of ITBS (i.e. painful or not painful), the method of the diagnosis, running style, running experience (i.e. elite, competitive and casual), shoe, surface and speed of the runner.[127-130]

Thus, in the future, it might be advisable to consider running shoes, running surface and speed as matching variables when investigating the biomechanics of ITBS based on resulting differences in running style.[127-130] Attention should also be paid to the study design (e.g. only one study is a prospective study that focuses on kinematic deviations[22]), sample size, the age of the population and possible sex-specific differences in biomechanics, in order to generate qualitatively good studies of adequate size.

In the studies included in this review, ITBS was mainly diagnosed based on the history, signs and symptoms, and clinical findings.[90-92,94,96-99] However, in many cases, the signs and symptoms were not adequately described, which makes the validity of the diagnosis of ITBS difficult to determine in several studies.[17,93,95,100] Clinical investigations included palpation, compression test of Noble and/or the test of Renne.[16,90-92,96-98] Further research should focus on the validation of these tests for runners with ITBS. The functional running test to assess the efficacy of the treatment of ITBS seemed to be more sensitive than conventional pain-recall methods,[90] but further clinometric research is necessary to identify its reliability and responsiveness in runners with ITBS. The severity of ITBS was classified according to the 'injury grade' of Lindenberg et al.[90,92,105] This classification tool has good face validity and was validated in the study of Schwellnus et al.,[90] but no clinometric studies are available. Future studies should focus on the reliability of this tool and whether it can be used to identify subgroups of ITBS to enable more effective treatment of the condition.[131]

The flexibility of the iliotibial band and iliopsoas muscle seems to be an important aspect in the management of ITBS.[22,95,96] The Ober test and the modified Thomas test can be used in daily practice to identify runners with a high risk of ITBS and to evaluate the effect of stretching exercises as a component of ITBS treatment. Further research with these tests should focus on the differential effect of stiffness of the iliotibial band and iliopsoas muscle, and of acute, sub-acute and chronic ITBS on treatment outcomes. In the acute phase (<14 days duration), corticosteroid injection appears to be beneficial, with runners being able to run pain free within 14 days.[91] In the subacute stage (>14 days duration), a combination of anti-inflammatory/analgesic medication appeared to be more beneficial than anti-inflammatory medication alone.[90] The use of DTFM is supported by anecdotal evidence of its effectiveness. However, it seems somewhat illogical to use friction techniques to treat an injury that might be caused by friction.[7] Schwellnus et al.[90] found DTFM in combination with ultrasound and stretching exercises to be no better than ultrasound and stretching alone,[90] as both treatment regimens reduced daily pain and pain experienced on treadmill running.

Overall, the studies confirm the benefits for the conservative treatment of ITBS in runners; pain medication/injection, stretching of the iliotibial band, hip abduction exercises/pelvic drops to strengthen the gluteus muscles and advice about training, inlays and shoes.[16,90-92,97] Unfortunately, to date, no (randomized) clinical trials have investigated the benefit of these different modalities in isolation.[7] Although iliotibial band bursectomy and arthroscopic resection of the lateral synovial recess proved effective in runners with chronic (>6 months) ITBS,[98,99] the studies investigating these techniques were small.

In summary, conservative treatment appears to be beneficial in the management of ITBS in runners, although the evidence supporting this comes from studies with small, heterogeneous samples. Further investigation of the specific clinical benefit of conservative therapies for runners with ITBS will be of great importance to the evidence-based management of this condition and to research.[7] Surgical approaches appear to be effective, and the arthroscopic technique would seem especially appropriate because it allows assessment and treatment of any intra-articular pathology. In the future, it would be interesting to compare these treatments in an RCT with more participants.

5. Conclusion

ITBS is a common injury of the lateral aspect of the knee in runners.[7] Although several investigations have been published, there is a paucity of research of adequate quality on the management of ITBS in runners. As the studies included in this review provided limited evidence, hard conclusions about the prevention and treatment of this injury cannot be drawn.

This review shows that future research on the management of ITBS in runners should pay more attention to the methodological aspects of the study design, such as concealing treatment allocation and adequately describing the study population, exclusion criteria and confounding variables. Knowledge of the pathology of ITBS could contribute to the development of a diagnostic protocol for ITBS in runners. In addition, uniformity in the diagnostic protocol for ITBS in runners is essential for the effective management of this type of musculoskeletal injury.

On the basis of the limited evidence generated in this review, treatment of ITBS should include advice about coordination and running style, choice of shoes and an appropriate running surface in combination with training to strengthen the hip muscles.

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