

Sports activities after lower limb osteotomy

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Introduction: Active sports participation can be important in some patients with degenerative joint disease in the lower limb. We investigated whether this is possible after an osteotomy for osteoarthritis of the hip, knee and ankle joints.

Sources of data: We performed a literature search using Medline, Cochrane, CINAHL and Google Scholar with no restriction to time period or language using the keywords: 'osteotomy and sports'. Eleven studies (all level IV evidence) satisfied our inclusion and exclusion criteria. Nine reported on high tibial osteotomies, one on periacetabular osteotomies and one on distal tibial osteotomies. The Coleman Methodology Score to assess the quality of studies showed much heterogeneity in terms of study design, patient characteristics, management methods and outcome assessment.

Areas of agreement: Participation in recreational sports is possible in most patients who were active in sports before lower limb osteotomy. In no study were patients able to participate in competitive sports.

Areas of controversy: Intensive participation in sports after osteotomy may adversely affect outcome and lead to failures requiring re-operation.

Growing points: Patients may be able to remain active in selected sports activities after a lower limb osteotomy for osteoarthritis. More rapid progression of arthritis is however a possibility.

Areas timely for developing research: Prospective comparative studies investigating activities and sports participation in age-matched patients undergoing osteotomy or joint replacement could lead to useful conclusions. Increased activity and active sports participation may lead to progression of arthritis and earlier failure requiring additional surgery.

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Introduction

In current clinical practice, patients with joint problems are frequently active and want to maintain an active life style, including sports participation. When non-operative management fails to control the symptoms, surgical options are considered.

Hip and knee osteoarthritis are usually idiopathic, and total joint replacements benefit patients¹ and improve their quality of life.² Higher failure rates in young male patients¹ indicate that realignment osteotomies should be, when feasible, probably preferred in younger and more active patients.^{3,4} Recent advances in joint replacement surgery include bone preserving implants such as hip resurfacing⁵ and unicompartmental knee arthroplasty.⁶ Ankle arthritis is more frequently post-traumatic, and surgical management includes arthrodesis, replacement⁷ and distal tibial osteotomy in selected patients.^{8,9}

Although it is possible for patients to remain relatively active after a joint replacement, including participating in certain sports, most surgeons do not recommend vigorous activities.¹⁰ Early aseptic loosening and failure is a concern. Realignment osteotomies are a viable alternative, and can delay the need for a joint replacement for several years.^{3,11} Examples are acetabular and femoral osteotomies for painful hips,⁴ high tibial or distal femoral osteotomies for varus or valgus unicompartmental knee arthritis,^{10,12} distal tibial osteotomies for varus ankles with preservation of articular cartilage in half the joint.^{8,13} Best candidates are patients less than 50 years old,¹⁴ who are not obese.¹¹ It is not known whether these procedures permit a very active lifestyle. Furthermore it may be unrealistic to expect continuation of sports beyond light recreational, given the joint degeneration that is usually present and the high joint loadings with sports.

The current study is a systematic review of the literature, investigating whether it is possible to participate in sports activities after lower limb osteotomies for the management of hip, knee and ankle osteoarthritis or for prevention of its progression.

Search strategy and methods

A literature search using Medline, Cochrane, CINAHL and Google Scholar with no restriction to time period or language was performed by two of the authors (NG and AK). The date of latest search was 27 January 2009. Databases search was performed using the keywords: 'osteotomy and sports'. All titles relevant to the subject were retrieved and abstracts were scanned, applying inclusion and exclusion criteria

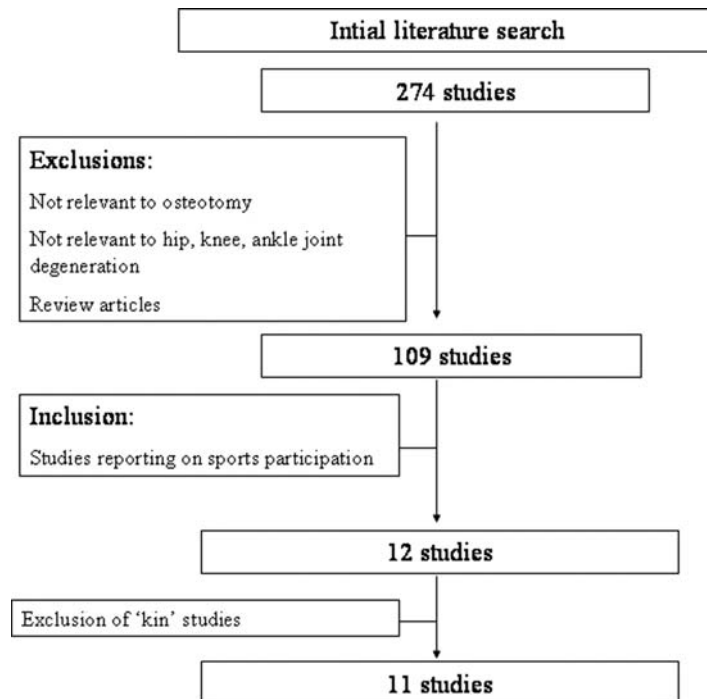


Fig. 1 Literature search and application of exclusion and inclusion criteria revealed 11 studies.

(Fig. 1). If several studies reported on the same patients' population ('kin studies'), only the most recent study was included. Full texts of 11 included studies^{13–23} were processed for data extraction and analysis. Data collected were number of patients/joints, affected joint, type of osteotomy, follow-up and participation in sports before and after surgery.

The quality of the included studies was evaluated by two of the authors (NG and AK) using a modified Coleman Methodology Score (CMS)²⁴ (Table 1). The subsections which compose the CMS are based on the subsections of the CONSORT statement (for randomized controlled trials),²⁵ but are modified to allow for other trial designs. Each investigator scored the quality of the studies twice, with a time interval of 3 weeks between scoring sessions. Intra- and inter-observer reliability was examined. Where differences were encountered, agreement was achieved by consensus.

Results

All studies were level of evidence IV.²⁶ The CMS (Fig. 2) ranged from 39 to 76 (mean 60, SD 11). No comparative studies (e.g. HTO versus

Table 1 Criteria used to compute the CMS for studies reporting participation in sports after osteotomy for hip, knee, ankle joint degeneration.

	Score
Part A: Only one score to be given for each of the seven sections	
Study size—number of osteotomies	
<25	0
25–49	4
50–74	7
>75	10
Mean follow-up (years)	
<2	0
≥2 to <5	4
≥5 to <10	7
≥10	10
Number of different surgical techniques used	
Not stated, unclear or <90% of subjects receiving same technique	0
More than one techniques, but ≥90% of subjects receiving one technique	7
One technique used	10
Type of study	
Retrospective cohort study	0
Prospective cohort study	10
Randomized control trial	15
Description of indications/diagnosis	
No	0
Yes	10
Descriptions of surgical technique	
Inadequate (not stated, unclear)	0
Fair (technique only stated)	3
Adequate (technique stated, details of surgical procedure given)	5
Postoperative management described	
Yes	5
No	0
Part B: Scores may be given for each option in each of the three sections if applicable	
Outcome criteria	
Outcome measures clearly defined	2
Timing of outcome assessment clearly stated	2
Use of outcome criteria that has reported reliability	3
General health measure included	3
Procedure of assessing outcomes	
Subjects recruited	5
Investigator independent of surgeon	4
Written assessment	3
Completion of assessment by patients themselves with minimal investigator assistance	3
Description of subject selection process	
Selection criteria reported and unbiased	5
Recruitment rate reported	
≥90%	5
<90%	0

arthroplasty) were found. The ability to participate in sports was the primary outcome measure in three studies.^{13,15,16} Intra-observer reliability test was 0.88 for examiner A (NG) and 0.82 for examiner B (AK). Inter-observer reliability was 0.98 (substantial agreement).²⁷

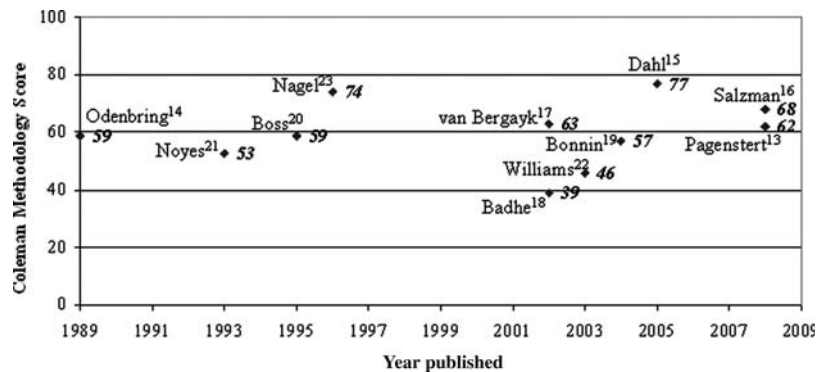


Fig. 2 CMS for each study in relation to year of publication. The numbers in bold and italics represent the value of CMS for the individual papers.

One study reported that periacetabular osteotomy for developmental hip dysplasia in patients younger than 50 years improved their ability to participate in sports¹⁷ (Table 2).

One study¹³ evaluated distal tibial osteotomies, performed for 'asymmetric' ankle arthritis (affecting half of the joint), which were combined with various other procedures (calcaneal osteotomies, midfoot corrections, fibula osteotomies, tendon and ligament procedures). Improvement of the sports activity level was reported (Table 2); however, increased sports participation frequency was associated with need for additional surgery (arthrodesis or ankle replacement).

Nine studies evaluated high tibial osteotomy (HTO) for medial or lateral knee compartment pain and degeneration,^{14–16,18–23} reporting on patients' ability to participate in sports. In some patients in five studies, HTO was combined with ligament reconstruction.^{18–22}

Salzmann *et al.*¹⁶ specifically assessed sporting activity after HTO. Several parameters tested (Table 2) were not significantly different before and after surgery.

Two studies^{14,19} evaluated relatively young patients at a minimum of 6 years (average of more than 10 years) after HTO and found that many patients had a relatively high level of activities (Table 2). Similarly, Nagel *et al.*²³ showed that relatively older patients could maintain their sporting activities at a mean of 8 years after HTO. Participation in recreational sports can be as high as 90% more than 2 years after HTO,^{18,22} and participation in light sports without pain was reported in most patients at an average of 5 years after HTO in young patients.²¹ In a recent study¹⁵ in relatively older patients, less than half of them were active in sports preoperatively, HTO improved their sport and recreation function (Table 2). None of the studies demonstrated patients' ability to participate in sports at a competitive level.

Table 2 Data showing patient's participation in sports in various studies before and after surgery.

Study	Joint	Type of surgery	Patients/joints	Age (years)	Follow-up (years)	Participation in sports
Pagenstert et al. ¹³	Ankle	DTO	35/35	43 (26–68)	5 (3–10.5)	Before the surgery 15/35 patients (43%) did not participate in sport, compared with 7/35 (20%) at follow-up Sports activity level (range 0–4) improved from 1.3 (0–3) before surgery to 1.8 (0–3) at follow-up ($P = 0.02$) Sports frequency had no correlation to patients' symptoms but showed higher revision rate None of the patients was able to participate at competitive sports before or after the surgery
Van Bergayk and Garbuz ¹⁷	Hip (DDH)	Periacetabular osteotomy	26/26 (21 included for analysis)	32 (15–50)	>2 (2–3.5)	11/21 did not participate in any sport before surgery versus 2/21 at follow-up Tegner score improved from 1.9 (0–3) before surgery to 4.4 (2–8) at follow-up
Odenbring et al. ¹⁴	Knee	HTO	27/28	42 (27–50)	11 (7–18)	At follow-up 9/27 patients had a high activity level and 13/27 could run without pain Tegner score ranged between 0 and 6 at follow-up (maximum 10)
Dahl et al. ¹⁵	Knee	HTO	58/58 (52 followed)	54 ± 7	2	45/52 were physically active earlier in life (23 recreational, 12 competitive) 22/52 were physically active the year before surgery Sports and recreation function was assessed postoperatively using the relevant subscale (range 0–100) of KOOS (knee injury and osteoarthritis outcome score). The mean subscale score improved from 9 ± 12 before surgery to 29 ± 28 at 2 years follow-up.

Salzmann <i>et al.</i> ¹⁶	Knee	HTO	65/65	41 (19–65)	3 (1.2–7)	88% before versus 91% after HTO ($P = 0.18$) Number of sporting activities was 3.5 before versus 3.5 after HTO ($P = 0.18$) Sports frequency per week was 2.1 sessions before versus 2.3 after HTO ($P = 0.21$) Activity duration was 4.1 h before versus 4.2 after HTO ($P = 0.71$) No patient returned to competitive sports after HTO Tegner score ($P < 0.05$) and Activity Rating Scale ($P = 0.001$) scores, declined after surgery Downhill skiing and mountain biking was possible 13/14 (93%) patients were able to participate in light recreational activities None returned to competitive sports 14/29 patients (47%) participated in intensive sports and 11/29 (37%) in moderate sports
Badhe and Forster ¹⁸	Knee	HTO	11/11		2.8	
Bonin <i>et al.</i> ¹⁹	Knee	HTO + ACL reconstruction HTO + ACL reconstruction	29/30 3/4	30 (18–41)	12 (6–16)	
Boss <i>et al.</i> ²⁰	Knee	HTO + ACL reconstruction	27/27		2–10	14/27 patients had a higher level of sports activities at follow-up, compared with preoperatively
Noyes <i>et al.</i> ²¹	Knee	HTO + ligament reconstruction	41/41	32 (16–47)	4.9 (1.9–7.2)	11/41 (27%) could perform only light sports activities without pain before surgery versus 32/41 patients (78%) at follow-up
Williams <i>et al.</i> ²²	Knee	HTO	12/12		>2	14/26 (56%) patients participated in recreational sports before HTO, versus 23/26 (92%) at follow-up
Nagel <i>et al.</i> ²³	Knee	HTO + ACL reconstruction HTO	14/14 34/37	49 (26–68)	8 (2–14)	Tennis: 15/34 before versus 13/34 at follow-up Ski: 11/34 before versus 9/34 at follow-up Jogging: 14/34 before versus 10/34 at follow-up Biking: 30/34 before versus 26/34 at follow-up

HTO, distal tibial osteotomy; SFS, sports frequency score; ACL, anterior cruciate ligament; DDH, developmental dysplasia of the hip.

Discussion

Maintenance of an active life style is desirable by patients with lower limb degenerative joint disease. High tibial osteotomies have been performed for many decades^{11,12} to improve knee function and pain²⁸ and prevent progression to advanced arthritis,^{11,12} whereas distal tibial osteotomies could postpone or prevent ankle arthrodesis or replacement.⁸ Osteotomies to prevent degeneration of the hip joint are usually performed in patients with developmental hip problems.⁴

The current literature is characterized by heterogeneity in terms of study design, patient characteristics (eg age and activities preoperatively), management methods and outcome assessment. Therefore results between different studies are not directly comparable and pooling of data would not lead to clinically useful conclusions. Furthermore, the ability to participate in sports was the primary outcome measure in only a few studies.^{13,15,16}

Although participation in sports is possible after joint arthroplasty,^{10,29–31} there is scepticism regarding the longer term outcomes and the possibility of early failures.¹⁰ Polyethylene wear is a major concern, especially in patients younger than 50 years.³² On the other hand, osteotomies preserve the natural joint. How osteotomies, for knee and ankle problems, affect sports participation has to be compared to alternative surgical procedures. Such comparative studies are not available, though.

Ankle osteoarthritis is most commonly post-traumatic.^{7–9,13,31,33} These are probably patients who would benefit from surgery that allows increased level of activities. Pagenstert *et al.*¹³ showed that distal tibial osteotomy improved the ability to participate in sports in a patient cohort with a mean age of 43 years and arthritis affecting the medial or lateral half of the joint. They found, however, higher failure rates, in high demand patients. Larger scale studies confirmed this preliminary finding. Recently, two groups^{31,33} reported that more than half of their patients, who had a mean age of approximately 60 years, participated in sports (hiking, biking, swimming, jogging, aerobics, skiing) at a mean follow-up of less than 4 years after total ankle arthroplasty. Overall, preoperative sports activity level was maintained³¹ or improved,³³ but there was a remarkable 24% of active patients who could not return to sports after ankle arthroplasty because of pain.³³ Intermediate results³⁰ did not show increased rates of ankle replacement failures in high impact sports participants, but the long-term outcomes are unknown. Given the different patient demographics and the indications for ankle replacement and distal tibial osteotomy in the referenced studies, results are not directly comparable.

Athletic individuals with knee problems, as a result of sports injuries (e.g. meniscal tears, cruciate deficiency), would probably expect to participate in sports after a surgical intervention. HTO, occasionally combined with ligament reconstruction, for knee joint degenerative joint disease allows activities such as tennis, jogging, biking and downhill skiing, but return to competitive level is probably not possible, or, at least, it is infrequent.^{16,18} Recent research²⁹ showed that 95% in a cohort of 83 patients (mean age of 65 years) were able to return to sports activities (mainly hiking, swimming, biking, down hill skiing, exercise walking) after a unicompartmental knee replacement, whereas tennis, soccer and cross country skiing had to be abandoned by the vast majority of patients.²⁹ Unicompartmental knee replacements performed in 31 patients less than 50 years old (mean 46 years), however, allowed only 60% of them to return to the preoperative level of sports activities, and prosthesis survivorship was lower than that reported for older patients.³² Total knee replacement was less successful regarding participation in sports.³⁴ Patient populations and knee pathologies were different and therefore results are not directly comparable between studies reporting on knee replacements versus high tibial osteotomies.

Young patients with hip dysplasia are challenging, and the aim of surgery is to improve hip function and prevent joint degeneration. van Bergayk *et al.*¹⁷ showed that periacetabular osteotomy improved the ability to participate in sports, possibly offering their young patients (mean age 32 years, range 15–50) a better lifestyle. In comparison, Naal *et al.*³⁰ reported that hip resurfacing for osteoarthritis secondary to hip dysplasia allowed sports activities. However, a 6% failure rate in 32 arthroplasties performed in patients with a mean age of 44.2 years after 28–60 months follow-up was disappointing. These two cohorts are not directly comparable, as indications for surgery and patients' age were different.

It would be difficult to conduct randomized trials, comparing outcomes of high and low tibial osteotomy versus knee and ankle replacement, respectively, or periacetabular osteotomy versus hip replacement. Since, patients with ankle joint degeneration are candidates for ankle arthrodesis, the benefits of distal tibial osteotomy compared with ankle fusion should be investigated as well. Surgeon's preference and patients' demographic (age) and anatomical characteristics (limb alignment, ligament deficiency and degree of joint degeneration) indicate the optimal management method. Carefully designed prospective comparative studies with age-matched patient populations could lead to useful conclusions. Adequate follow-up is needed to test the hypothesis that increased activity, and sports participation can lead to earlier failure requiring additional surgery.

Conclusions

Lower limb osteotomies, including periacetabular osteotomies for hip dysplasia and proximal and distal tibial osteotomies for knee and ankle problems, can result in maintenance or improvement of sports activity levels. Activities such as downhill skiing, biking, swimming and jogging are possible, whereas return to competitive sports level is probably not possible. Whether sports activities result in progression of joint degeneration and deterioration of symptoms needs to be determined.

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