



## **Interventions for treating acute Achilles tendon ruptures**

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## **ABSTRACT**

### **Background**

There is lack of consensus on the best management of the acute Achilles tendon (TA) rupture. Treatment can be broadly classified into operative (open or percutaneous) and non-operative (cast immobilisation or functional bracing). Post-operative splintage can be with a rigid cast (above or below the knee) or a more mobile functional brace.

### **Objectives**

To identify and summarise the evidence from randomised controlled trials of the effectiveness of different interventions in the treatment of acute Achilles tendon ruptures.

### **Search strategy**

We searched multiple databases including the Cochrane Musculoskeletal Injuries Group specialised register (to September 2003), reference lists of articles and contacted trialists. Keywords included Achilles Tendon, Rupture, and Tendon Injuries.

### **Selection criteria**

All randomised and quasi-randomised trials comparing different treatment regimens for acute Achilles tendon ruptures.

### **Data collection and analysis**

Three reviewers extracted data and independently assessed trial quality by use of a ten-item scale.

### **Main results**

Fourteen trials involving 891 patients were included. Several of the studies had poor methodology and inadequate reporting of outcomes.

Open operative treatment compared with non-operative treatment (4 trials, 356 patients) was associated with a lower risk of rerupture (relative risk (RR) 0.27, 95% confidence interval (CI) 0.11 to 0.64), but a higher risk of other complications including infection, adhesions and disturbed skin sensibility (RR 10.60, 95% CI 4.82 to 23.28).

Percutaneous repair compared with open operative repair (2 studies, 94 patients) was associated with a shorter operation duration, and lower risk of infection (RR 10.52, 95% CI 1.37 to 80.52). These figures should be interpreted with caution because of the small numbers involved.

Patients splinted with a functional brace rather than a cast post-operatively (5 studies, 273 patients) tended to have a shorter in-patient stay, less time off work and a quicker return to sporting activities. There was also a lower complication rate (excluding rerupture) in the functional brace group (RR 1.88 95% CI 1.27 to 2.76).

Because of the small number of patients involved no definitive conclusions could be made regarding different operative techniques (1 study, 51 patients), different non-operative treatment regimes (2 studies, 90 patients), and different forms of post-operative cast immobilisation (1 study, 40 patients).

### **Reviewers' conclusions**

Open operative treatment of acute Achilles tendon ruptures significantly reduces the risk of rerupture compared to non-operative treatment, but produces a significantly higher risk of other complications, including wound infection. The latter may be reduced by performing surgery percutaneously. Post-operative splintage in a functional brace appears to reduce hospital stay, time off work and sports, and may lower the overall complication rate.

## BACKGROUND

The Achilles tendon (TA), formed by the merging of the tendons of gastrocnemius and soleus, is the thickest and strongest tendon in the human body. Acute TA ruptures occur most commonly in males in their third and fourth decades who play sport intermittently; the left TA is more commonly ruptured than the right (Hattrup 1985). The mechanisms of injury include sudden forced plantar flexion of the foot (movement so toes point down) for example during sporting activities; unexpected dorsiflexion of the foot (movement so toes point up) for example during a fall down stairs; and violent dorsiflexion of a plantar flexed foot, for example a fall from a ladder (Arner 1959). The prevalence is approximately 18 per 100,000 per year (in Finland) and is thought to be rising (Leppilahti 1996), possibly as a result of the increasing keep-fit culture.

The pathological mechanism is not understood, although it is generally accepted that ruptures occur in previously abnormal tendons (Arner 1959; Tallon 2001). A number of etiological theories have been proposed which include the adverse influence of oral and topical corticosteroids (Mahler 1992; Newnham 1991), fluoroquinolone antibiotics (e.g. ciprofloxacin) (Royer 1994), exercise-induced hyperthermia (Wilson 1994) and mechanical abnormalities of the foot (Clement 1984).

The diagnosis of an acute rupture can usually be made clinically. Ultrasound (Maffulli 1990) or magnetic resonance imaging (Deutsch 1989) may be used if confirmation is necessary. There is lack of consensus on the best management of the acute TA rupture. Treatment can be broadly classified into operative (open or percutaneous) and non-operative (cast immobilisation or functional bracing). Generally, open operative management has been used in athletes and young fit patients, percutaneous operative in those who do not wish to have an open repair (e.g. for scar avoidance, or cosmesis), and non-operative in the elderly (Bossley 2000; Maffulli 1999; Martinelli 2000; Raisbeck 2000). Two reviews have concluded that operative management has a lower rerupture rate but must be balanced by the risks associated with surgery (Lo 1997; Bhandari 2002). No reviews have addressed the issues of different methods of non-operative treatment, operative treatment or post-operative splintage.

## OBJECTIVES

To identify and summarise the evidence from randomised controlled trials of the effectiveness of different interventions in the treatment of acute Achilles tendon ruptures.

The following null hypotheses were tested:

1. There is no difference in outcome between operative or non-operative treatment.
2. There is no difference in outcome between different methods of non-operative treatment.
3. There is no difference in outcome between different methods of operative treatment.

4. There is no difference in outcome between different techniques of post-operative splintage.

## CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

### Types of studies

All randomised controlled trials comparing operative and non-operative methods for treating acute Achilles tendon ruptures. Quasi-randomised trials (for example, allocation by alternation or date of birth) and trials in which the treatment allocation was inadequately concealed were considered for inclusion.

### Types of participants

Adults with acute ruptures of the TA. Patients with delayed presentation (more than three weeks post-injury) and reruptures were excluded.

### Types of intervention

Operative repair (open and percutaneous) and non-operative treatment (cast immobilisation and functional bracing).

### Types of outcome measures

Data for the following outcome measures were sought and in addition other outcome measures as reported in each individual study were documented:

- Complications (including rerupture, infection, adhesions and nerve damage)
- Length of hospital stay
- Time to return to work
- Time to return to sport
- Level of sports activity post-rupture
- Calf circumference/muscle atrophy
- Tendon elongation
- Power/strength-testing
- Range of movement
- Pain
- Patient satisfaction

## SEARCH STRATEGY FOR IDENTIFICATION OF STUDIES

We searched the Cochrane Musculoskeletal Injuries Group specialised register (up to September 2003), reference lists of articles, proceedings of relevant conferences and contacted trialists where further clarification was required. The register is compiled from multiple databases, including regular searches of the Cochrane Central Register of Controlled Trials in *The Cochrane Library*, MEDLINE (which combines subject specific terms with the optimal trial search strategy (Alderson 2004a)), EMBASE and CINAHL, and handsearch results. For further details see the search strategy in the group's module in *The Cochrane Library*.

Articles of all languages were considered and translated where necessary.

In MEDLINE (OVID-WEB) the following subject specific search was combined with all three levels of the optimal trial search strategy (Alderson 2004a):

1. Achilles Tendon/
2. (achill#s or tendoachill#s).tw.
3. or/1-2
4. Rupture/
5. rupture\$.tw.
6. or/4-5
7. and/3,6
8. Tendon Injuries/
9. and/3,8
10. or/7,9

## METHODS OF THE REVIEW

Trials were independently assessed for inclusion by four reviewers. Data for the outcomes listed above were extracted by three reviewers and each trial assessed independently without masking of the study names or study authors for its quality of methodology. Differences were resolved by discussion.

Ten aspects of methodology were used to give a maximum score for each study of 12. In addition, risk of pre-allocation disclosure of assignment were rated A, B or C according to the Cochrane Reviewers' Handbook (Alderson 2004b) The following aspects of internal and external validity were assessed:

### Selection biases

1. Method of randomisation. Was there clear concealment of allocation? Score 3 (and code A) if allocation clearly concealed (e.g. numbered sealed opaque envelopes drawn consecutively). Score 2 (and code B) if there was a possible chance of disclosure before allocation. Score 1 (and code B) if the method of allocation concealment or randomisation was not stated or was unclear. Score 0 (and code C) if allocation concealment was clearly not concealed such as those using quasi-randomisation (e.g. even or odd date of birth).

2. Were the inclusion and exclusion criteria clearly defined? Score 1 if text states which patients were included and excluded. Otherwise score 0.

3. Were the treatment and control groups adequately described at entry and if so were the groups well matched, or appropriate covariate adjustment made? Score 1 if at least three admission details were given (e.g. age, sex, affected side, time from injury, mechanism of injury, participation in sports, previous injury to TA) with either no statistically significant difference between groups or appropriate adjustment made. Otherwise score 0.

### Performance biases

4. Were the attending surgeons experienced at both treatment methods prior to commencement of the trial. Score 1 if text

states there was an introductory period or all surgeons experienced in both treatment methods. Otherwise score 0.

5. Were the care programmes other than trial options identical? Score 1 if text states they were. Otherwise score 0.

### Detection biases

6. Were the outcome measures clearly defined in the text with a definition of any ambiguous terms encountered? Score 1 if yes. Otherwise score 0.

7. Were the outcome assessors blind to assignment status? Score 1 if text states they were. Otherwise score 0.

### Attrition biases

8. Were the outcomes of patients who withdrew or were excluded after allocation described and included in an intention to treat analysis? Score 1 if yes or text states that no patients were withdrawn after randomisation. Otherwise score 0.

9. Was the timing of outcome measures appropriate? A minimum of 12 months follow-up for all surviving patients with active follow-up at set periods, as opposed to passive (review only if indicated or if referred back). Score 1 if yes. Otherwise score 0.

10. Were less than five per cent of patients lost to follow-up (excluding deaths)? Score 1 if yes. Otherwise score 0.

The authors of studies were contacted for additional details of methodology and trial results as indicated.

For each study, relative risks and 95% confidence intervals were calculated for dichotomous outcomes, and weighted mean differences and 95% confidence intervals calculated for continuous outcomes. Results from individually randomised trials were pooled wherever possible using the fixed effects model. A random effects model was used where there was statistical or graphical evidence of heterogeneity.

## DESCRIPTION OF STUDIES

Details of the 14 randomised controlled trials included in the review are documented in the Characteristics of Included Studies table. A total of 891 patients were involved.

Four studies, involving 356 patients, compared open operative treatment with non-operative treatment. In three studies operative treatment involved end-to-end tendon suture plus paratenon (tendon covering) repair, followed by 6-9 weeks of immobilisation in either a cast (Cetti 1993; Nistor 1981) or functional brace (Moller 2001) in equinus (plantar-flexed or toes pointing down). Non-operative treatment was with cast immobilisation for eight weeks: four weeks in equinus, four weeks in neutral (Cetti 1993; Moller 2001) or semi-equinus (Nistor 1981). Schroeder 1997 reported on 43 patients randomised to three groups: open surgical repair (13), percutaneous repair (15) and non-operative treatment (15); all patients were immobilised in a special boot with a 3 cm heel

raise for four weeks followed by gradual reduction in heel size over the following four weeks. For the purpose of this section of the review the percutaneous group was excluded.

Six studies assessed different post-operative techniques of splintage. Five studies (involving 273 patients) compared cast immobilisation (i.e. rigid) versus functional brace (i.e. semi-mobile). Cetti 1994 compared a dorsal equinus splint incorporating a stirrup (allowing weight-bearing, and active plantar-flexion) with a complete non-weight bearing cast in equinus for six weeks. In Mortensen 1999 two weeks functional bracing in equinus in an immobile dorsal splint, followed by four weeks in a mobile Don-Joy brace allowing active dorsi-flexion (toes pointing down to neutral), was compared with eight weeks of immobilisation in a cast (six in equinus and two in neutral); weight bearing was allowed after four weeks and six weeks respectively. Kangas 2003 compared six weeks in a neutral dorsal splint (allowing active plantar-flexion) with six weeks in a neutral cast; weight-bearing was permitted after three weeks. Kerkhoffs 2002 compared a "semi-rigid wrap" (poorly described) worn for six weeks with a complete cast in neutral for six to eight weeks; weight-bearing was allowed at variable times. Maffulli 2003 compared two weeks in a cast in equinus followed by a dorsal splint in neutral for four weeks (allowing active plantar-flexion) with six weeks in a cast (two in equinus, two in mid-equinus and two in neutral); weight bearing was permitted immediately in the functional brace group and at four weeks in the cast only group. One study (Mortensen 1996) of 40 patients compared two forms of rigid immobilisation: above-knee cast in equinus for four weeks, followed by a walking cast for four weeks versus a below-knee cast in equinus for four weeks, followed by a walking cast for four weeks.

Two studies, involving 94 patients compared percutaneous with open operative surgical repair. Lim 2001 compared open repair using a modified Kessler core suture (plus interrupted sutures) with percutaneous repair with a modified Ma and Griffith technique (involving six or eight stab incisions); post-operatively patients were immobilised in a cast for 10-14 weeks. As previously stated Schroeder 1997 compared open repair (single or double Kessler core suture), percutaneous repair (modified Ma and Griffith technique) and non-operative treatment; all patients were immobilised in a special boot with a 3 cm heel raise for four weeks followed by gradual reduction in heel size over the following four weeks. For the purpose of this section of the review the non-operative group was excluded. Analysis of the open operative group (13 patients) in two sections of the review accounts for the discrepancy in overall number of patients involved (i.e. 891+13).

Mortensen 1992 compared two suture techniques in 51 patients: an open 2-strand technique (Mason) with a 6-strand technique (CSSS); immobilisation was with a cast for seven weeks.

Two studies involving 90 patients compared different non-operative treatment regimes. Saleh 1992 compared cast

immobilisation alone (above-knee cast in equinus for four weeks, below-knee cast in semi-equinus for four weeks and below-knee cast in neutral for two weeks) versus cast and functional brace splintage (below-knee cast in equinus two weeks, below-knee cast in semi-equinus one week, "Sheffield splint" for six to eight weeks). Weight-bearing was allowed after eight weeks and three weeks respectively. Petersen 2002 compared immobilisation in a traditional cast versus splintage in a CAM-walker functional brace.

## METHODOLOGICAL QUALITY

The methodological quality assessment scores of the included studies are detailed in Table 01.

Generally, methodology of identified studies was poor. Only five studies used an appropriate method of randomisation: Petersen 2002 and Moller 2001 used sealed identical envelopes; Mortensen 1992 and Mortensen 1999 used random numbers generated from Geigy scientific tables or by computer, in sealed envelopes, opened in the operating theatre; Kangas 2003 used randomly mixed sealed envelopes opened post-operatively. Four studies were quasi-randomised. Nistor 1981 alternated admissions between two hospitals; treatment was operative in one and non-operative in the other. Kerkhoffs 2002 alternated treatment according to week of admission, and Maffulli 2003 according to day of admission. Lim 2001 randomised according to the patients' hospital number. Five studies did not state their method of randomisation (Cetti 1993; Cetti 1994; Mortensen 1996; Saleh 1992; Schroeder 1997).

No studies stated that surgeons were experienced with all forms of treatment compared. Only one study reported that outcome assessors were blind to assignment status (Maffulli 2003).

## RESULTS

### Open operative versus non-operative treatment

This was considered in four studies (Cetti 1993; Moller 2001; Nistor 1981; Schroeder 1997).

#### *Rerupture*

This was documented in the four studies comparing operative with non-operative treatment. Nistor 1981 reported rerupture in 2/45 patients treated operatively and 5/60 treated non-operatively; no statistical analysis was performed. Cetti 1993 reported rerupture in 3/56 in the operative group and 7/55 in the non-operative group (not statistically significant). Moller 2001 reported the greatest difference with a rerupture rate of 1/59 in the operative group compared with 11/53 in the non-operative group; this difference was statistically significant ( $p = 0.0013$ ). Schroeder 1997 found no reruptures in any of the groups. Results give a pooled incidence of 6/173 (3.5%) in the operatively treated group and 23/183 (12.6%) in the non-operatively treated group (RR (relative risk) 0.27, 95% CI (confidence interval) 0.11 to 0.64).

### ***Complications of treatment***

Nistor 1981 reported 20 cases of adhesions, nine cases of disturbed sensibility (numbness, hypersensitivity or tingling) and two cases of deep wound infection in the operative group (45 patients). No complications were reported in the non-operative group. No statistical analysis was performed.

Cetti 1993 reported one case of delayed wound healing, six cases of adhesions and seven cases of disturbed sensibility in the 56 patients managed operatively; in the 55 non-operatively treated patients there were two cases of adhesions and one of disturbed sensibility; the difference in these "minor complications" was statistically significant ( $p = 0.004$ ). There were also two cases of deep infection reported in the operative group compared with none in the non-operative group (not statistically significant).

Moller 2001 noted eight cases of adhesions, one case of superficial infection and one case of disturbed sensibility in the 59 patients managed operatively; in the non-operative group (53 patients) one patient had a deep vein thrombosis and another excessive tendon lengthening. No statistical analysis was documented on this data.

Schroeder 1997 documented two cases of wound infection that occurred in the open surgical group (13 patients); no other complications were reported.

The pooled incidence of reported complications (other than rerupture) was 59/173 (34.1%) in the operatively treated group and 5/183 (2.7%) in the non-operative group (RR 10.60, 95% CI 4.82 to 23.28). Similar analysis gave an overall wound infection rate of 7/173 (4.0%) in the operative group; there was no infection in the non-operative group (RR 4.89, 95% CI 1.09 to 21.91).

### ***In-patient stay***

Nistor 1981 reported a mean duration of hospital stay of four days (range 2 to 9); no comparison was made between groups. Cetti 1993 reported a mean stay of 3.5 days (range 1 to 15) in the operative group and 1.9 (range 0 to 10) in the non-operative group; the difference was not statistically significant. Moller 2001 noted an in-patient stay of 1.1 days in those who were operated upon compared with no days in the non-operative group.

### ***Time off work***

Nistor 1981 found the mean time off work was greater in the operative group, 13 weeks (range 0 to 30) compared with nine weeks (range 0 to 44) in the non-operative group; the difference was statistically significant ( $p$  value not stated). Cetti 1993 and Moller 2001 reported contrary findings: Cetti found a mean period of 6.2 weeks (range 0.5 to 19) in the operative group and 8 weeks (range 0 to 52) in the non-operative group; this difference was not statistically significant. Moller reported a mean period of 54.9 days (SD 47.9) off work in the operative group and 73.4 days (SD 56.5) in the non-operative group ( $p = 0.06$ ); for those with light mobile work (as opposed to heavy

and sedentary) time off work was 35 days in the operative group and 67 days in the non-operative group ( $p = 0.03$ ).

### ***Sporting activity post rupture***

Nistor 1981 and Moller 2001 reported no statistical difference in reduction in level of sporting activity post-rupture between the two groups. Cetti 1993 reported that 20/56 in the operatively treated group had a lower level of activity compared with 31/55 in the non-operative group (no statistical difference); however 32/56 (57%) in the operative group managed the same level of sporting activity compared with 16/55 (29%) in the non-operative group; this difference was statistically significant ( $p = 0.005$ ).

### ***Patient satisfaction***

Patient-centred assessment was poorly measured. Cetti 1993 reported that 16/56 (29%) patients in the operative group had problems with pain, walking or wearing shoes at 12 months, compared with 27/55 (49%) in the non-operative group ( $p = 0.04$ ). Moller 2001 assessed quality of life in the first 8 weeks using visual analogue scales (VAS); the score in the operative group was 91 (SD 9.2) and in the non-operative group 73 (SD 22.7), a difference that was highly statistically significant ( $p < 0.0001$ ). Similarly the VAS scores for the results of treatment at 2 years were significantly higher in the operative group ( $p = 0.0001$ ). However Nistor 1981 reported that significantly more of the operative group complained of stiffness of the ankle and increased tendon width than in the non-operative group. Schroeder 1997 assessed patients at follow-up using a non-validated method based on activity level; they reported that 71% in the non-operative group compared with 64% in the open operative group had a good or excellent result (and 80% of the percutaneous operative group).

### ***Objective assessment***

Power of plantar-flexion was assessed by Nistor 1981, and power of both plantar-flexion and dorsiflexion by Moller 2001; both reported a slight reduction at follow-up, but no significant difference between the two groups.

No significant difference in endurance between groups was noted on the heel-raise test at any point in follow-up (Moller 2001).

Range of motion of the ankle was measured by Nistor 1981 and Cetti 1993: Nistor noted no significant difference between the groups, although the operative group tended to lose plantar-flexion and the non-operative group gain dorsi-flexion. Cetti reported 10/56 of the operatively treated patients and 26/55 of the non-operatively treated group had more than 10 degrees reduction in ROM compared to the contralateral ankle; this reduced stiffness in the operative group was statistically significant at one year ( $p = 0.002$ ).

Nistor 1981 and Moller 2001 reported no difference in calf muscle circumference between the two groups. However Cetti 1993 found calf atrophy of at least 0.5 cm compared with the contralateral side in 22/56 of the operatively treated patients

and 35/55 in the non-operative group at one year; this difference was statistically significant ( $p = 0.017$ ).

Maximum tendon width was measured by Moller 2001 and reported to be significantly greater in the surgical versus the non-surgical group even at final follow-up of two years ( $p = 0.01$ ). However, no significant difference in width was found by Nistor 1981.

### **Post-operative splintage: cast immobilisation versus functional brace**

This was considered in five studies (Cetti 1994;Kangas 2003; Kerkhoffs 2002;Maffulli 2003; Mortensen 1999).

#### ***Rerupture***

Rerupture rates were reported in five studies, none of which found a statistically significant difference: Cetti 1994 noted 2/30 reruptures in the cast immobilisation group and 1/30 in the functional brace group; Mortensen 1999 reported incidences of 2/35 and 1/36, Kerkhoffs 2002 1/23 and 0/16 and Kangas 2003 2/25 and 1/25 respectively. Maffulli 2003 reported none in either group. Results give a pooled incidence of 7/140 (5.0%) in the cast immobilisation group and 3/133 (2.3%) in the functional brace group (RR 2.04, 95%CI 0.59 to 7.06).

#### ***Complications of treatment***

Five studies commented upon complications of treatment. Cetti 1994 reported one case of superficial infection, four cases of adhesion, five cases of disturbed sensibility and seven cases of keloid in the 30 patients managed with cast immobilisation; in the 30 patients managed with functional brace there was one case of adhesions, one of disturbed sensibility and one case of keloid.

Mortensen 1999 reported no cases of disturbance of sensibility or deep venous thrombosis (DVT) in either group and one case of deep infection in the functional brace group. A statistically significant difference was reported in the adhesion rate between groups: 12 cases in the functional brace group compared with 21 in the cast group ( $p < 0.01$ ).

Kerkhoffs 2002 noted one case of delayed wound healing, one case of adhesions and two cases of disturbance of sensibility in the cast group, and only one case of delayed healing in the functional brace group (no statistical difference reported)

Kangas 2003 reported one case of deep infection in the cast group, associated with one of the reruptures. No other complications were documented.

Maffulli 2003 documented two cases of superficial wound infection in both groups, nine cases of scar hypersensitivity (six in the cast only group), and one case of hypertrophic scar in the functional brace group.

The pooled incidence of reported complications (other than rerupture) was 50/140 (35.7%) in the cast immobilised group and 26/133 (19.5%) in the functional brace group (RR 1.88, 95%CI 1.27 to 2.76).

#### ***In-patient stay and duration of treatment***

Kerkhoffs 2002 reported the mean inpatient stay in the cast group was 10 days (range 7 to 17) compared with 8.6 (4 to 17) in the functional brace group, a difference that reached statistical significance ( $p < 0.05$ ).

Maffulli 2003 noted that the functional brace group discarded their crutches significantly earlier ( $p = 0.021$ ), had fewer out-patient visits ( $p = 0.027$ ), and were discharged from physiotherapy significantly sooner ( $p = 0.03$ ) than the cast only group.

#### ***Time off work***

Both Cetti and Mortensen reported that the functional brace group returned to work significantly sooner than the cast immobilisation group: 20.2 days (range 3 to 75) and 53 days (range 1 to 182),  $p = 0.0009$  (Cetti 1994) and 43 days and 68 days,  $p < 0.05$  (Mortensen 1999) respectively. These findings were supported by Maffulli 2003 for both manual and sedentary workers ( $p = 0.041$  and  $p = 0.04$  respectively) .

#### ***Sporting activity post rupture***

Three studies found that the time to return to sports was significantly shorter in the functional brace group. In the study by Mortensen 1999 this period was 7.5 months (range 3 to 22) in the cast group and 4 months (2 to 13) in the functional brace group ( $p < 0.001$ ); Kerkhoffs 2002 reported 73 days (range 54 to 112) and 57 days (range 49 to 70) ( $p < 0.01$ ), and Maffulli 2003 six months (range 4.5 to 11.2) and 5.1 months (range 4.1 to 8) ( $p = 0.04$ ) respectively.

Cetti 1994 noted that 24/30 of the functional brace group reached the pre-injury level of sporting activity compared with 15/30 in the cast group ( $p = 0.029$ ); Maffulli 2003 and Mortensen 1999 however found no difference, but Mortensen noted that the time to reach the pre-injury level of activity was 6 months (2.5 to 13) in the functional brace group and 9 months (6 to 14) in the cast group ( $p < 0.001$ ).

#### ***Patient satisfaction***

Cetti 1994 reported that 18/30 of the cast group complained of pain in the cast compared with 9/30 in the functional brace ( $p = 0.0037$ ). Mortensen 1999 found no difference between the groups with regard to pain at 12 weeks and Kangas 2003 found no significant difference in pain at any point in the follow-up.

Kangas 2003 and Cetti 1994 both reported no difference in patient satisfaction between the groups; this was supported by a patient-centred assessment (modified Rupp score) performed by Kerkhoffs 2002. Only one study (Maffulli 2003) found improved patient satisfaction in the functional brace group, 23/26 reporting good or excellent results compared with 18/27 in the cast only group ( $p = 0.04$ ). Kangas 2003 and Maffulli 2003 reported no difference in footwear restrictions. Kangas 2003 noted 76% of patients in both groups had no subjective calf muscle weakness, and no difference in overall ankle performance score ( $p = 0.85$ ) at final review (mean 60 weeks).

Maffulli 2003 assessed patient satisfaction, effect on occupational and sporting activities and pain using the Victorian Institute of Sports Assessment (VISA-A) questionnaire and found no significant difference between the groups.

#### **Objective assessment**

Two studies reported reduced range of motion (ROM) in the cast group at the time of cast removal: Cetti 1994 found the total ROM to be 29.5 degrees in the cast group compared with 54.3 in the functional brace group ( $p < 0.00001$ ); the difference was reduced at one year but remained statistically significant. Similar early findings were reported by Mortensen 1999, however by final review (median 16 months) the difference was no longer statistically significant. Likewise, Kangas 2003 reported no statistical difference in ROM or stiffness at final review (mean 60 weeks).

Cetti 1994 found that calf atrophy (of at least 0.5 cm compared with the opposite side) was significantly more common in the cast group than the functional brace group at the time of cast/brace removal ( $p = 0.0019$ ) and at one year ( $p = 0.02$ ). However Mortensen 1999 and Maffulli 2003 reported no significant difference between the groups.

Cetti 1994 compared power of plantar flexion at one year, and reported that the cast group achieved 90.9% (range 78 to 104) of the power of the normal side compared with 99.5% (88 to 118) in the functional brace group ( $p = 0.00006$ ). Kangas 2003 found significantly better "isokinetic calf muscle scores" in the functional brace group at 60 weeks ( $p = 0.17$ ), 88% reporting good or excellent results compared with 79% in the cast group. However, there was no significant difference in "peak torque deficit", "average work" or "isometric strength". Mortensen 1999 and Maffulli 2003 reported no statistically significant difference in power between the groups.

Two studies placed radio-opaque markers in the tendon ends to measure elongation, and found conflicting results. Cetti 1994 reported a mean separation of 6.1 mm (range -8 to +22) in the functional brace group and 13.5 mm (range -14 to +37) in the cast group, at one year ( $p = 0.0033$ ). Mortensen 1999 noted a statistically significant increase in separation in the functional brace group at six weeks, but no difference at 12 weeks; there was no associated increase in dorsi-flexion.

Kangas 2003 measured motor performance in the two groups. No statistical difference was found regarding simple reaction time, choice reaction time, speed of movement and foot tapping speed, at 12 weeks and 24 weeks, between the two groups and between the normal and abnormal side. However they reported that coordination was better in the cast group at 12 weeks ( $p < 0.05$ ); this difference failed to reach statistical significance at 24 weeks.

Maffulli 2003 assessed tendon width and intrasubstance quality with ultrasound. They report no significant difference in width, incidence of calcification or hypoechogenicity between the groups.

#### **Post-operative immobilisation: above-knee versus below-knee cast**

This was considered in one study (Mortensen 1996).

#### **Rerupture**

One rerupture was reported in the above-knee cast group only.

#### **Complications of treatment**

There was significantly more quadriceps atrophy and knee stiffness in the above-knee group at four weeks, but no difference at later review. There was no difference in complaints of tenderness or stiffness.

#### **Time off work**

Median time off work in the above-knee group was 10 weeks, and 7 weeks in the below-knee group.

#### **Sporting activity post-rupture**

Significantly more of the below-knee group had resumed sports post-rupture (no further details given).

#### **Patient satisfaction**

There was no difference between the groups regarding pain or analgesic requirement, nor patients' subjective evaluation of the result at 15 months of follow-up.

#### **Objective assessments**

There was no significant difference in ROM, plantar-flexion strength, work capacity or atrophy between the groups. Nor was there a difference in radiographic marker separation at 12 weeks. Both groups' Tegner score fell from a median of six to five.

#### **Open versus percutaneous surgical repair**

This was considered in two studies (Lim 2001; Schroeder 1997).

#### **Duration of operation**

The mean duration of the procedure was 45 minutes (range 30 to 75) in the open group and 30 (20 to 45) in the percutaneous group (Lim 2001).

#### **Rerupture**

No reruptures were reported by Schroeder 1997. In the study by Lim 2001 no statistical difference was found in the rerupture rate: 2/33 in the open group and 1/33 in the percutaneous group. Ruptures were secondary to trauma and occurred between 12 and 16 weeks.

#### **Complications of treatment**

Lim 2001 reported a statistically significant higher rate of wound infections in the open group: 7/33 (one of which was a deep infection requiring plastic surgery) compared with 0/33 in the percutaneous group ( $p = 0.01$ ). There was no statistical difference in the incidence of all other complications including adhesions, disturbance of sensibility, keloid and skin puckering. There were two cases of wound infection in the open surgical group reported by Schroeder 1997. The pooled incidence of infection was 9/46 (19.6%) in the open group and 0/48 (0%) in the percutaneous group (RR 10.52, 95%CI 1.37 to 80.52).

#### **Sporting activity post rupture**

Lim 2001 found that of the "active" patients 4/9 in the open group reached their pre-injury level of sporting activity compared with 9/11 in the percutaneous group. There was no statistical difference between the two groups in time to reach normal activities of daily living.

#### **Patient satisfaction**

Lim 2001 reported that 27/33 (81.8%) patients in the open group had good or excellent results at six months compared with 33/33 (100%) in the percutaneous group. As commented upon earlier, Schroeder 1997 assessed patients at follow-up using a non-validated method based on activity level; they reported that 80% of the percutaneous operative group had a good or excellent result, compared with 64% in the open operative group (and 71% in the non-operative group).

#### **Two-strand versus six-strand open repair**

This was considered in one study (Mortensen 1992).

#### **Rerupture**

In the study by Mortensen addressing this issue there were no reruptures in either group

#### **Complications of treatment**

There were two cases of minor skin necrosis in the 6-strand group and none in the 2-strand group.

#### **Patient satisfaction**

There was no statistical difference in patient satisfaction between the groups.

#### **Objective assessment**

No statistical difference was reported in range of movement or power of plantar flexion.

Radio-opaque markers were inserted into the tendon ends; no difference in separation was noted at 12 months between the groups.

#### **Non-operative treatment: cast versus functional brace**

This was considered in two studies (Petersen 2002; Saleh 1992).

#### **Rerupture**

In the study by Saleh 1992 looking at non-operative regimes there was one rerupture in each group. However Petersen 2002 noted 5/29 reruptures in the cast group and 0/21 in the functional brace. The pooled incidence gives a rerupture rate of 1/41 (2.4%) in the functional brace group and 6/49 (12.2%) in the cast group (RR 3.59, 95% CI 0.59 to 21.76).

#### **Complications of treatment**

No other complications were documented in either study.

#### **Pain and satisfaction**

Patients were asked how long it took before they were able to walk comfortably indoors and outdoors; both scores were significantly longer in the cast only group ( $p < 0.001$ ) (Saleh 1992). Petersen 2002 reported no difference in satisfaction with treatment or subjective functional assessment (with VAS) between the groups.

#### **Objective assessment**

Saleh 1992 assessed range of motion: there was no difference in plantar flexion, however there was significantly more dorsi-flexion in the cast plus functional brace group at 3, 6 and 12 months of follow-up ( $p < 0.001$ ). There was no excessive dorsi-flexion as a result of over stretching of the tendon in either group. Petersen 2002 reported no statistical difference in atrophy, increased dorsi-flexion, reduced plantar-flexion and reduced heel-floor distance between the groups at 4 or 12 months follow-up. Neither studies found a difference in power between groups.

## **DISCUSSION**

Fourteen prospective randomised studies involving the treatment of acute Achilles tendon ruptures were included in this analysis. The quality assessment scores indicate a poor level of methodological rigour in many studies, particularly with regard to method of randomisation and concealment of allocation. Also, since only one used blinded assessors there may be biases in the reporting of outcome measures.

#### **Open operative versus non-operative treatment**

This was considered in four studies involving 356 patients (Cetti 1993; Moller 2001; Nistor 1981; Schroeder 1997).

There was a consistent finding of increased rerupture rate in the non-operatively treated patients. Summation of data gave a pooled incidence of 3.5% in the operatively treated group and 12.6% in the non-operative group. These figures should be interpreted with caution due to differences in the method and period of splintage used by the different studies.

There was also a consistent finding of increased complication rate (other than rerupture) in the operatively treated group; pooled data gave an overall incidence of 34.1% in the operative group and 2.7% in the non-operative group. The most common complications in the operative group were adhesions (19.7%), altered sensation (9.8%), wound infection (4.0%) and other (0.6%).

No statistically significant difference was reported in the duration of in-patient stay, although there was an expected trend for longer stay associated with surgery. Conflicting results were reported for the duration of time off work and level of sporting activities post-rupture therefore no definite conclusions can be made. Type of work performed (e.g. manual versus office-based) plays an important role in determining ones ability to return to employment; unfortunately this was recorded in only one of the studies (Moller 2001).

There was marked non-uniformity in the reporting of patients' satisfaction as well as conflicting results between the three studies. However the best assessment was made by Moller 2001 using visual analogue scales: operatively treated patients had significantly better quality of life at eight weeks and two years post-rupture. Two studies reported no difference in power of

plantar flexion at follow-up. There were conflicting results reported for other objective measures of range of motion and calf atrophy.

In summary, pooled evidence from randomised studies suggest non-operatively treated patients have an over three times higher risk of rerupture, but minimal risk of other complications from their treatment; a third of operatively treated patients will suffer a complication, however their quality of life remains higher than patients managed non-operatively.

#### **Post-operative splintage: cast immobilisation versus functional brace**

This was considered in six studies involving 273 patients (Cetti 1994; Kangas 2003; Kerkhoffs 2002; Maffulli 2003; Mortensen 1999). It is noted that there was wide variation in the type of functional brace used, with variable degrees of movement permitted and duration of non-weight bearing status.

Five studies compared rerupture rates, and no significant difference was found; the pooled incidence was 5.0% in the cast immobilisation group and 2.3% in the functional brace group ( $p = 0.26$ ).

A wide discrepancy of the incidence of other complications was reported - notably for adhesions. This may reflect varying degrees of rigour in assessing complications. Of this heterogeneous group the pooled incidence was 35.7% in the cast group and 19.5% in the functional brace group ( $p = 0.001$ ). The most common complications in the cast group were adhesions (18.6%), altered sensibility (8.6%), keloid or scar hypertrophy (5.0%) and other (3.5%), and in the functional brace group adhesions (9.7%), altered sensibility (3.8%), keloid (3.0%) and other (3.0%).

One study addressed the issue of in-patient stay, reporting a statistically significant shorter stay in the functional brace group (Kerkhoffs 2002). Maffulli 2003 noted the functional brace group discarded their crutches earlier, had fewer out-patient visits and were discharged from physiotherapy sooner, but this is to be expected given the different regimens used. Patients treated with a functional brace also returned to sports sooner (Kerkhoffs 2002; Maffulli 2003; Mortensen 1999), although there were conflicting results reported about the proportion that reached their pre-injury level of activity (Cetti 1994; Mortensen 1999).

Only one study found better satisfaction in the functional brace group (Maffulli 2003) and the others reported no difference (Kangas 2003; Cetti 1994; Kerkhoffs 2002). However, Cetti 1994 noted more of those in the cast group complained of pain during the period of immobilisation.

Cetti 1994 reported reduced range of motion, increased calf atrophy and reduced power of plantar flexion at one year in the cast group. Kangas 2003 reported reduced isokinetic calf muscle score in the cast group at a mean of 60 weeks. These findings were not supported by Mortensen 1999 or Maffulli 2003 who found no statistically significant difference between the groups

at final follow-up. Interestingly Cetti 1994 found increased separation of tendon ends in the cast group whereas the contrary findings were reported by Mortensen 1999. There was no relationship between separation of markers and ROM. A thorough assessment of motor performance was carried out by Kangas 2003: the only difference between the groups was better coordination in the cast group at 12 weeks, although the significance was lost at 24 weeks.

In summary, the functional brace group tended to have a shorter in-patient stay, less time off work and a quicker return to sporting activities; there was also a trend for lower complications including reruptures in this group. Conflicting results regarding motor function preclude meaningful conclusions. Pooled data should be interpreted with caution because of the variety of regimes used and the small numbers of patients involved.

#### **Post-operative immobilisation: above-knee versus below-knee cast**

No conclusions can be made from this one study involving 40 patients published in abstract form only (Mortensen 1996).

#### **Open versus percutaneous surgical repair**

Two studies involving 94 patients compared open with percutaneous surgical repair (Lim 2001; Schroeder 1997).

There was no significant difference in rerupture rates between the groups in either study, however there was a significantly higher rate of wound infection in the open surgical group. It should be noted that the rate of infection in the open group (19.6%) is significantly higher than in the open operative group versus non-operative studies (4.0%). There is no obvious explanation for this variation.

No definitive conclusions can be made regarding differences in activity levels or objective scores between the groups because of the limited number of patients involved, and non-standardised techniques of assessment.

In summary, the results on the small numbers of patients presented showed a tendency for a lower complication rate, notably wound infection, in the percutaneously treated group.

#### **Two-strand versus six-strand open repair**

Limited conclusions can be drawn from this single study involving 51 patients (Mortensen 1992); results however suggest there is no advantage in using the more extensive 6-strand suture technique over the simpler 2-strand method.

#### **Non-operative treatment: cast versus functional brace**

Again, limited conclusions can be drawn from these two studies of 90 patients (Petersen 2002; Saleh 1992) because of the small numbers involved, differences in regimes and minimal reporting of outcomes.

## REVIEWERS' CONCLUSIONS

### Implications for practice

On the basis of the randomised studies reviewed, there is evidence that open operative treatment of acute TA ruptures significantly reduces the risk of rerupture compared to non-operative treatment, but has the drawback of a significantly higher risk of other complications, including wound infection. These complications may be reduced by performing surgery percutaneously, but this is based upon data from a small number of patients. Post-operative splintage in a functional brace rather than a cast appears to reduce hospital stay, time off work and sports, and may lower the overall complication rate.

There is inadequate evidence to comment on different suture techniques, different non-operative treatment regimes, or different forms of post-operative cast immobilisation.

### Implications for research

Further rigorously conducted prospective randomised trials with larger sample sizes, full reporting of outcomes and blinding of assessors are required to establish the ideal surgical intervention and non-operative regime, as well as method of splintage. Increased transparency is needed if the same cohort of patients are reported on in later studies, to allow meaningful data interpretation at meta-analysis. Avoidance of multiple publication is strongly recommended.

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## POTENTIAL CONFLICT OF INTEREST

None known.

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## SYNOPSIS

Open surgery for repair of acute Achilles tendon ruptures reduces the risk of rerupture compared with non operative treatment in a cast or a brace

Open operative repair significantly reduces the risk of rerupture compared to non-operative treatment (plaster cast or functional brace) but has the drawback of a significantly higher risk of other complications, including wound infection. These complications may be reduced by performing surgery percutaneously (through a number of very short skin incisions). Post-operative splintage in a functional brace rather than a cast appears to reduce hospital stay, time off work and sports, and may lower the overall complication rate. Further well-conducted research is needed.

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Royer RJ, Pierfitte C, Netter P. Features of tendon disorders with fluoroquinolones. *Therapie* 1994;**49(1)**:75-6.

**Tallon 2001**

Tallon C, Maffulli N, Ewen SW. Ruptured Achilles tendons are significantly more degenerated than tendinopathic tendons. *Medicine and Science in Sports and Exercise* 2001;**33(12)**:1983-90.

**Wilson 1994**

Wilson AM, Goodship AE. Exercise-induced hyperthermia as a possible mechanism for tendon degeneration. *Journal of Biomechanics* 1994;**27(7)**:899-905.

\* Indicates the major publication for the study

## TABLES

### Characteristics of included studies

Study	Cetti 1993
Methods	Method of randomisation: not stated Number lost to follow-up: none Methodological quality score: 6/12 Length of follow-up: 12 months
Participants	8 orthopaedic hospitals in Denmark 111 patients with acute Achilles tendon ruptures Mean age: 37/38 years (range 21-65) Percentage male: 84/82% Time between injury and treatment: 0.7/0.6 days (mean)
Interventions	Open end-to-end repair plus equinus cast non weight-bearing for 6 weeks [56] versus cast treatment only for 8 weeks (4 weeks equinus non weight-bearing, 4 weeks neutral weight-bearing) [55]; all patients given heel raise for 2 weeks and identical rehabilitation protocols.
Outcomes	"minor complications" (including superficial infection, haematoma, adhesions) "major complications" (including re-rupture, extreme tendon lengthening, deep infection) In-patient stay Time off work Time off sports Level of sports post-rupture Pain, or problems with walking or wearing shoes at 12 months Ankle movements Calf atrophy
Notes	Variable anaesthetic and suture type (52% absorbable) was used in the operative group
Allocation concealment	B
Study	Cetti 1994
Methods	Method of randomisation: not described, performed after skin closure Number lost to follow-up: 1 Methodological quality score: 6/12 Length of follow-up: 12 months
Participants	Orthopaedic hospital in Denmark 61 patients with acute Achilles tendon ruptures Mean age: 37 years (range 20-60) Percentage male: 83% Time between injury and treatment: 38 hours (mean)
Interventions	Standard open repair; post-operative functional brace allowing weight-bearing (dorsal splint plus stirrup in equinus for 6 weeks, heel raise 2 weeks) [30] versus cast immobilisation (complete cast in equinus non-weight bearing for 6 weeks, heel raise 2 weeks) [30].

## Characteristics of included studies

Outcomes	<ul style="list-style-type: none"> <li>Superficial infection</li> <li>Adhesion of scar</li> <li>Disturbance of sensibility</li> <li>Rerupture</li> <li>Keloid</li> <li>Time off work</li> <li>Level of sports post-rupture</li> <li>Pain during immobilisation</li> <li>Satisfaction with treatment</li> <li>Ankle movements</li> <li>Calf atrophy</li> <li>Strength</li> <li>Tendon width</li> <li>Tendon elongation</li> </ul>
Notes	
Allocation concealment	B

<b>Study</b>	<b>Kangas 2003</b>
Methods	<ul style="list-style-type: none"> <li>Method of randomisation: randomly mixed sealed envelopes</li> <li>Number lost to follow-up: 1</li> <li>Methodological quality score: 9/12</li> <li>Length of follow-up: mean 60 weeks (SD 6.4)</li> </ul>
Participants	<ul style="list-style-type: none"> <li>Orthopaedic hospital in Oulu, Finland</li> <li>50 patients with acute Achilles tendon ruptures</li> <li>Age range: 21-55</li> <li>Percentage male: 94%</li> <li>Time between injury and treatment: less than 1 week</li> </ul>
Interventions	Open repair augmented with gastrocnemius turn-down; post-operative functional brace (dorsal splint in neutral, allowing active plantar-flexion, for 6 weeks) [25] versus cast immobilisation (complete cast in neutral for 6 weeks) [25]. Weight-bearing at 3 weeks.
Outcomes	<ul style="list-style-type: none"> <li>Motor performance</li> <li>Pain relief</li> <li>Stiffness</li> <li>Calf muscle weakness</li> <li>Foot wear restrictions</li> <li>ROM</li> <li>Subjective result</li> <li>Complications</li> </ul>
Notes	Kauranen et al report preliminary results (30 patients) looking chiefly at motor performance; data has been assimilated with that of this paper.
Allocation concealment	A

<b>Study</b>	<b>Kerkhoffs 2002</b>
Methods	<ul style="list-style-type: none"> <li>Method of randomisation: quasi-randomised, odd weeks received "wrap", even received cast.</li> <li>Number lost to follow-up: none</li> <li>Methodological quality score: 6/12</li> <li>Length of follow-up: 6.7 years (range 5-8)</li> </ul>

## Characteristics of included studies

Participants	Orthopaedic hospital in Amsterdam, Holland 39 patients with acute Achilles tendon ruptures Mean age: 37/36 years (range 22-52) Percentage male: 82% Time between injury and treatment: 0.4 / 0.3 days (mean)
Interventions	Three-tissue bundle open repair followed by cast in equinus for 1 week; semi-rigid "wrap" (for 6 weeks; partial weight-bearing for first 4 weeks; full thereafter) [16] versus cast immobilisation (complete cast in neutral for 6-8 weeks; weight-bearing allowed when cast removed) [23].
Outcomes	Delayed wound healing Adhesion of scar Disturbance of sensibility Rerupture In-patient stay Time off sports Patient-centred assessment (modified Rupp score) Calf atrophy
Notes	Inadequate description of treatments compared
Allocation concealment	C

Study	Lim 2001
Methods	Method of randomisation: quasi-randomised according to whether last digit of hospital number even or odd Number lost to follow-up: None Methodological quality score: 4/12 Length of follow-up: 6 months
Participants	7 orthopaedic hospitals in the NE Thames and Oxford regions, UK 66 patients with acute Achilles tendon ruptures Mean age: 38.5 years (range 26-53) Percentage male: 61% Time between injury and treatment: not stated
Interventions	Open repair (modified Kessler core suture plus interrupted sutures) [33] versus percutaneous repair (modified Ma and Griffith technique involving 6 or 8 stab incisions) [33]; post-operative immobilisation in an above or below-knee cast for 10-14 weeks
Outcomes	Superficial infection Adhesion of scar Disturbance of sensibility Rerupture Deep infection / necrosis Keloid Skin puckering Time to perform normal activities of daily living Level of sports post-rupture Patient satisfaction
Notes	Significant number of variables in the treatment types which are not corrected for.
Allocation concealment	C

## Characteristics of included studies

Study	Maffulli 2003
Methods	Method of randomisation: quasi-randomised, alternation depending on day of week. Number lost to follow-up: 4 from each group Methodological quality score: 6/12 Length of follow-up: average 21 months (range 16-26; SD 4.6)
Participants	Department of Trauma and Orthopaedic surgery, Keele University school of medicine. 53 patients with acute Achilles tendon ruptures Mean age: 44.7 years (range 31-69) in group 1 and 43.8 years (range 30-67) in group 2. Percentage male: 85% Time between injury and treatment: within 1 week
Interventions	Open repair (single modified Kessler suture) with either no. 1 vicryl or polydioxanone; post-operative cast in equinus (for 2 weeks) followed by functional brace (dorsal splint in neutral, allowing active plantar-flexion, for 4 weeks) [26] versus cast immobilisation (complete cast in equinus for 2 weeks, mid-equinus for 2 weeks and neutral for 2 weeks) [27]. Weight-bearing in group 1 was as soon as possible and in group 2 at 4 weeks.
Outcomes	Anthropometric measures Isometric gastrocsoleus muscle strength Ultrasound Patient satisfaction. activity and pain Complications
Notes	
Allocation concealment	D
Study	Moller 2001
Methods	Method of randomisation: blinded with identical envelopes Number lost to follow-up: 1 Methodological quality score: 10/12 Length of follow-up: 24 months
Participants	Orthopaedic hospitals in Sweden 112 patients with acute Achilles tendon ruptures Mean age: 39.1 years (SD 8.2) Percentage male: 86/91% Time between injury and treatment: 0.5-3 days
Interventions	Open end-to-end repair plus functional brace for 8 weeks [59] versus cast treatment only for 8 weeks (4 weeks equinus, 4 weeks neutral) [53]. All patients given heel raise for 4-8 weeks and identical rehabilitation protocols; full weight-bearing allowed at 8 weeks.

## Characteristics of included studies

Outcomes	"Minor complications" (including superficial infection, disturbance of sensibility, adhesions) Rerupture Extreme tendon lengthening DVT In-patient stay Time off work Level of sports post-rupture Visual analogue scores for quality of life, result of treatment Functional scores Strength
Notes	
Allocation concealment	A

Study	Mortensen 1992
Methods	Method of randomisation: sealed envelopes with random numbers Number lost to follow-up: 4 (8%) Methodological quality score: 6/12 Length of follow-up: median 12 months (range 7-22)
Participants	3 orthopaedic hospitals in Denmark 51 patients with acute Achilles tendon ruptures Median age: 36 years (range 21-68) Percentage male: 80% Time between injury and treatment: not stated
Interventions	Operative repair: Mason 2-strand suture technique [27] versus continuous 6-strand suture technique [24]. Post-operatively patients immobilised in a below-knee non-weight bearing cast for 7 weeks (3½ weeks in plantar-flexion, 3½ in neutral).
Outcomes	Superficial infection Rerupture Deep infection Patient satisfaction Ankle movements Power of plantar-flexion Radiographic separation of tendon ends
Notes	
Allocation concealment	A

Study	Mortensen 1996
Methods	Method of randomisation: not stated Number lost to follow-up: not stated Methodological quality score: 4/12 Length of follow-up: 1-2 years
Participants	40 patients with Achilles tendon ruptures
Interventions	Above-knee cast (in equinus for 4 weeks, followed by a walking cast for 4 weeks) versus a below-knee cast (in equinus for 4 weeks, followed by a walking cast for 4 weeks).

## Characteristics of included studies

Outcomes	Complications Patient satisfaction Time off work ROM Power Atrophy
Notes	Minimal reporting - abstract only. Author contacted for additional information. No response.
Allocation concealment	B

Study	Mortensen 1999
Methods	Method of randomisation: computer-generated random numbers Number lost to follow-up: none Methodological quality score: 7/12 Length of follow-up: median 16 months
Participants	Odense University Hospital in Denmark 71 patients with acute Achilles tendon ruptures Median age: 39/35 years (range 20-73) Percentage male: 72% Time between injury and treatment: less than 35 hours
Interventions	Standard open repair; post-operative functional brace (dorsal splint in equinus for 2 weeks, Don-Joy brace in 30 degrees flexion 2 weeks, and Don-Joy brace in neutral, FWB 2 weeks) [36] versus cast immobilisation (complete cast in equinus for 6 weeks, neutral cast FWB 2 weeks) [35].
Outcomes	Superficial infection Adhesion of scar Disturbance of sensibility Rerupture Deep infection DVT Time off work Time off sports Time to pre-injury level of sports Number who reached pre-injury level of sports Satisfaction at final follow-up Ankle movements Calf atrophy Strength Radiographic separation of markers in tendon
Notes	
Allocation concealment	B

Study	Nistor 1981
Methods	Method of randomisation: admissions alternated between 2 hospitals; in one treatment was operative and in the other its was non-operative. Number lost to follow-up: 5 Methodological quality score: 4/12 Length of follow-up: 1-5 years (mean 2.5)

### Characteristics of included studies

Participants	2 orthopaedic hospitals in Sweden 105 patients with Achilles tendon ruptures; up to 3 weeks from injury Mean age: 41 years (range 21-77) Percentage male: 91% Time between injury and treatment: all within 3 weeks
Interventions	Open end-to-end repair plus cast for 6-9 weeks [45] versus cast treatment only for 8 weeks (4 weeks equinus, 4 weeks semi-equine) and heel raise for 4 weeks [60].
Outcomes	Adhesion of scar Disturbance of sensibility Re-rupture Deep infection In-patient stay Time off work Level of sports post-rupture Ankle movements/stiffness Calf atrophy
Notes	
Allocation concealment	C

<b>Study</b>	<b>Petersen 2002</b>
Methods	Method of randomisation: sealed envelopes Number lost to follow-up: 8 Methodological quality score: 6/12 Length of follow-up: 12 months
Participants	An orthopaedic hospital in Denmark. 50 patients with acute Achilles tendon ruptures Mean age: 42 years Percentage male: 70% Time between injury and treatment: not stated (though late diagnosed ruptures were excluded)
Interventions	Traditional cast [29] versus Cam-walker [21]
Outcomes	Patient satisfaction Re-rupture rate Subjective functional assessment Atrophy ROM Power
Notes	Translated from Danish
Allocation concealment	A

<b>Study</b>	<b>Saleh 1992</b>
Methods	Method of randomisation: not stated Number lost to follow-up: none Methodological quality score: 6/12 Length of follow-up: 12 months

## Characteristics of included studies

Participants	Orthopaedic hospitals in Sheffield, UK 40 patients with acute Achilles tendon ruptures (presenting within 48 hours of injury) Mean age: 39/41 years (range 19-71) Percentage male: 78% Time between injury and treatment: <48 hours
Interventions	Non-operative treatment: cast immobilisation alone (above-knee cast in equinus 4 weeks, below-knee cast in semi-equinus 4 weeks, below-knee cast in neutral 2 weeks; weight-bearing allowed after 8 weeks) [20] versus cast and functional brace (below-knee cast in equinus 2 weeks, below-knee cast in semi-equinus 1 week, "Sheffield splint" (AFO) in 15 degrees plantar flexion for 6-8 weeks; weight-bearing allowed after 3 weeks) [20].
Outcomes	Rerupture Time before walking comfortably Ankle movements Power of plantar flexion at follow-up
Notes	
Allocation concealment	C

<b>Study</b>	<b>Schroeder 1997</b>
Methods	Method of randomisation: not stated Number lost to follow-up: not stated Methodological quality score: 3/12 Length of follow-up: 8 months (range 6-12)
Participants	Orthopaedic hospitals in Germany 43 patients with acute Achilles tendon ruptures Mean age: 44/38/38 years Percentage male: not stated Time between injury and treatment: not stated
Interventions	Open repair (single or double Kessler suture) [13] versus Percutaneous repair (modified Ma and Griffith) [15] versus Non-operative treatment [15]; post-operative all patients were immobilised in a special boot with a 3 cm heel raise for 4 weeks followed by gradual reduction in heel size over the following 4 weeks.
Outcomes	Infection Rerupture DVT Clinical rating according to activity level (not validated) Ultrasound
Notes	Abstract only; inadequate documentation of outcomes
Allocation concealment	C

### Footnotes:

#### ABBREVIATIONS

DVT: deep venous thrombosis

ROM: range of movement

## Characteristics of excluded studies

Study	Reason for exclusion
Coombs 1981	This study was reported as a conference abstract only; 27 patients from 11 hospitals were "prospectively randomised" to receive either operative or non-operative management. 5 of the 13 patients allocated to non-operative treatment reruptured and were added to the operative treatment group. The trial was excluded as there was inadequate reporting of results. Further information from the author was not available since no address for correspondence was given.
Haggmark 1986	This was a retrospective study without randomisation comparing operative with non-operative treatment
Helgeland 1997	This was a retrospective study without randomisation comparing operative with non-operative treatment.
Jorgensen 1986	Randomised controlled trial comparing Hexcelite and plaster of Paris in below knee walking casts for mixed injuries (malleolar fracture, ligamental rupture and rupture of the Achilles tendon). No separate data for Achilles tendon ruptures.
Kakiuchi 1995	This study compared open plus percutaneous repair with open repair alone in 34 patients. It was excluded because of inadequate method of randomisation: the first 6 patients were allocated to the former group; the remainder were alternated between the 2 groups.
Kern 1996	The reviewers were not confident this was a true prospective randomised study. There was minimal reporting of outcomes. Attempts to contact the authors for further information was unsuccessful.
Majewski 2000	Limited data due to early termination of control group because of high recurrence rate (continuation of the control group was felt to be ethically unacceptable); no allocation concealment (personal communication with the author).
Paes 1985	This was a retrospective study without randomisation comparing two surgical techniques
Rolf 1997	Unrelated to ruptured Achilles tendon
Solveborn 1994	Non-comparative study
Steele 1993	This was a retrospective study without randomisation comparing two surgical techniques
Thermann 1995	Comparative study of operative versus non-operative treatment. Multiple publications. The study was excluded because authors planned to 'randomise' by alternation; however there were 28 patients in the non-operative group compared with 22 in the operative group.
Weber 1999	This was a retrospective study without randomisation comparing two post-operative regimes
Weber 2003	This was a retrospective study without randomisation comparing operative with non-operative treatment
Wellner 1990	This was a retrospective study without randomisation comparing two surgical techniques

## ADDITIONAL TABLES

**Table 01 Methodological quality assessment scores**

Study	Scores (10 items)	Total (max 12)
Cetti 1993	1110110010	6
Cetti 1994	1110010011	6
Kangas 2003	3110100111	9

**Table 01 Methodological quality assessment scores**

Kerkhoffs 2002	0110110011	6
Lim 2001	0100010101	4
Maffulli 2003	0110111010	6
Moller 2001	3110110111	10
Mortensen 1992	3100110000	6
Mortensen 1996	1000010011	4
Mortensen 1999	2110110010	7
Nistor 1981	0010010011	4
Petersen 2002	3110010010	7
Saleh 1992	1100110011	6
Schroeder 1997	1100100000	3

**COVER SHEET**

Title	<b>Interventions for treating acute Achilles tendon ruptures</b>
Reviewer(s)	<b>Khan RJ K, Fick D, Brammar TJ, Crawford J, Parker MJ</b>
Contribution of reviewer(s)	Riaz Khan initiated and designed the study with the help of Martyn Parker. Riaz Khan read all the studies, extracted the data and compiled the first drafts. Dan Fick, Tim Brammar and Jon Crawford read the studies, extracted data, read through and checked all text and results. All other tasks were shared. Riaz Khan is the guarantor of the review.
Issue protocol first published	2002/2
Issue review first published	2004/3
Date of most recent amendment	<b>Information not available</b>
Date of most recent SUBSTANTIVE amendment	01 February 2004
Most recent changes	<b>Information not supplied by reviewer</b>
Date new studies sought but none found	<b>Information not supplied by reviewer</b>
Date new studies found but not yet included/excluded	<b>Information not supplied by reviewer</b>
Date new studies found and included/excluded	01 February 2004

Date reviewers' conclusions section amended **Information not supplied by reviewer**

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Editorial group Cochrane Musculoskeletal Injuries Group

Editorial group code HM-MUSKINJ

## SUMMARY TABLES

### 01 Open operative versus non-operative treatment

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Rerupture rate	4	356	Relative Risk (Fixed) 95% CI	0.27 [0.11, 0.64]
02 Pooled complication rate other than rerupture	4	356	Relative Risk (Fixed) 95% CI	10.60 [4.82, 23.28]
03 Infection rate	4	356	Relative Risk (Fixed) 95% CI	4.89 [1.09, 21.91]
04 Duration of in-patient stay			Other data	No numeric data
05 Time off work			Other data	No numeric data
06 Sporting activity post rupture vs before rupture			Other data	No numeric data
07 Satisfaction			Other data	No numeric data
08 Objective assessment			Other data	No numeric data
09 Adhesion rate	4	356	Relative Risk (Fixed) 95% CI	12.57 [4.08, 38.69]
10 Altered sensibility rate	4	356	Relative Risk (Fixed) 95% CI	9.76 [2.40, 39.74]

**02 Post-operative splintage: cast immobilisation versus functional brace**

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Rerupture rate	5	273	Relative Risk (Fixed) 95% CI	2.04 [0.59, 7.06]
02 Pooled complication rate other than rerupture	5	273	Relative Risk (Fixed) 95% CI	1.88 [1.27, 2.76]
03 Duration of in-patient stay and overall treatment			Other data	No numeric data
04 Time off work			Other data	No numeric data
05 Sporting activity post rupture vs before rupture			Other data	No numeric data
06 Satisfaction			Other data	No numeric data
07 Objective assessment			Other data	No numeric data
08 Keloid or hypertrophy rate	5	273	Relative Risk (Fixed) 95% CI	1.65 [0.55, 4.94]
09 Altered sensibility rate	5	273	Relative Risk (Fixed) 95% CI	2.12 [0.82, 5.47]
10 Adhesions rate	5	273	Relative Risk (Fixed) 95% CI	1.98 [1.17, 3.34]

**03 Open versus percutaneous surgical repair**

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Duration of operation			Other data	No numeric data
02 Rerupture rate	2	94	Relative Risk (Fixed) 95% CI	2.00 [0.19, 21.00]
03 Pooled complication rate other than rerupture	2	94	Relative Risk (Fixed) 95% CI	2.84 [1.06, 7.62]
04 Infection rate	2	94	Relative Risk (Fixed) 95% CI	10.52 [1.37, 80.52]
05 Sporting activity post-rupture			Other data	No numeric data
06 Satisfaction			Other data	No numeric data

**04 Two-strand versus six-strand open repair**

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Rerupture rate	1	51	Relative Risk (Fixed) 95% CI	Not estimable
02 Other complication rate	1	51	Relative Risk (Fixed) 95% CI	0.18 [0.01, 3.54]

### 05 Non-operative treatment: cast vs functional brace

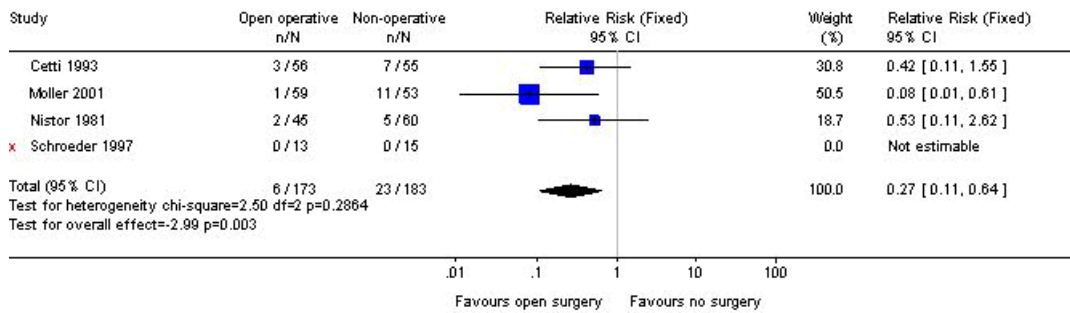
Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Rerupture rate	2	90	Relative Risk (Fixed) 95% CI	3.59 [0.59, 21.76]
02 Satisfaction			Other data	No numeric data
03 Objective assessment: ROM (dorsi-flexion)			Other data	No numeric data

## GRAPHS AND OTHER TABLES

**Fig. 01 Open operative versus non-operative treatment**

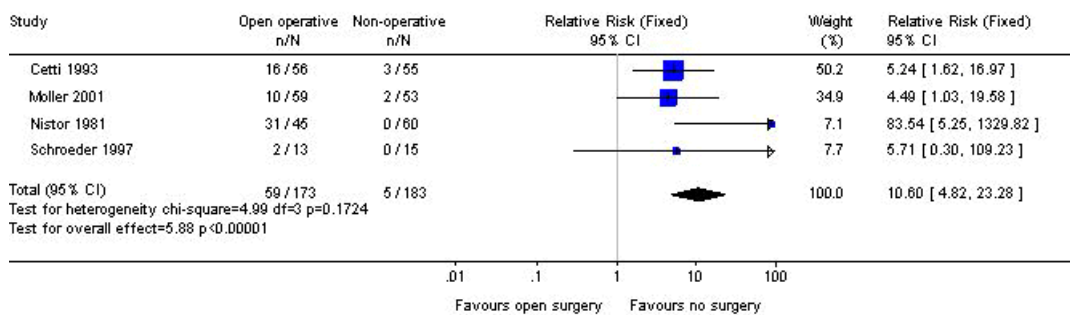
### 01.01 Rerupture rate

Review: Interventions for treating acute Achilles tendon ruptures  
 Comparison: 01 Open operative versus non-operative treatment  
 Outcome: 01 Rerupture rate



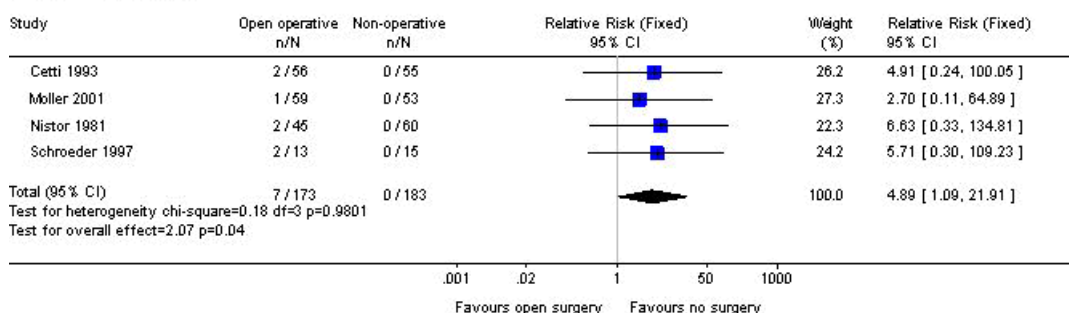
### 01.02 Pooled complication rate other than rerupture

Review: Interventions for treating acute Achilles tendon ruptures  
 Comparison: 01 Open operative versus non-operative treatment  
 Outcome: 02 Pooled complication rate other than rerupture



### 01.03 Infection rate

Review: Interventions for treating acute Achilles tendon ruptures  
 Comparison: 01 Open operative versus non-operative treatment  
 Outcome: 03 Infection rate



### 01.04 Duration of in-patient stay

#### Duration of in-patient stay

Study	Open operative	Non-operative	p value
Cetti 1993	Mean 3.5 days (range 1 to 15)	Mean 1.9 days (range 0 to 10)	NSS
Moller 2001	Mean 1.1 days	Mean 0 days	Not stated

### 01.05 Time off work

#### Time off work

Study	Open operative group	Non-operative group	p value
Cetti 1993	Mean 6.2 weeks (range 0.5 to 19)	Mean 8 weeks (range 0 to 52)	NSS
Moller 2001	Overall: mean 54.9 days (SD 47.9) [Light work only: 35 days]	Overall: mean 73.4 days (SD 56.5) [Light work only: 67 days]	p = 0.06 [Light work only: p = 0.03]
Nistor 1981	Mean 13 weeks (range 0 to 30)	Mean 9 weeks (range 0 to 44)	"Statistically significant"

### 01.06 Sporting activity post rupture vs before rupture

#### Sporting activity post rupture vs before rupture

Study	Open operative	Non-operative	p value
Cetti 1993	Less 20/56 Same 32/56 None 8/56	Less 31/55 Same 16/55 None 12/55	NSS except for number that reached same level of activity: p=0.005
Moller 2001	Less 30% Same 54% Had not resumed sports 16%	Less 30% Same 54% Had not resumed sports 14 %	NSS
Nistor 1981	Less 8/45	Less 8/60	NSS

### 01.07 Satisfaction

#### Satisfaction

Study	Open operative	Non-operative	p value
Cetti 1993	Problems with pain, walking or wearing shoes at 12 months: 16/56	Problems with pain, walking or wearing shoes at 12 months: 27/55	p=0.04
Moller 2001	Mean Quality of Life score (VAS) 8 weeks: 91.0 (SD 9.2) 2 years: 88.7 (SD 9.0)	Mean Quality of Life score (VAS) 8 weeks: 73.0 (SD 22.7) 2 years: 70.3 (SD 20.1)	8 weeks: p<0.0001 2 years: p=0.0001
Schroeder 1997	Good or excellent results: 64%	Good or excellent results: 71%	Not stated

### 01.08 Objective assessment

#### Range of motion (ROM)

Study	Open operative	Non-operative	p value
Cetti 1993	> 10 degrees less ankle ROM compared with other side at 1 year: 10/56	> 10 degrees less ankle ROM compared with other side at 1 year: 26/55	p=0.002
Nistor 1981	No difference between groups		

#### Calf circumference

Study	Open operative	Non-operative	p value
Cetti 1993	Atrophy of at least 5 mm compared with other side : 22/56	Atrophy of at least 5 mm compared with other side : 35/55	p=0.017
Nistor 1981	Reduced	Reduced	NSS

#### Power of plantar flexion

Study	Open operative	Non-operative	p value
Moller 2001	Mean % of full strength recovered at 1 year: 87%	Mean % of full strength recovered at 1 year: 90%	NSS
Nistor 1981	Reduced	Reduced	NSS

#### Endurance

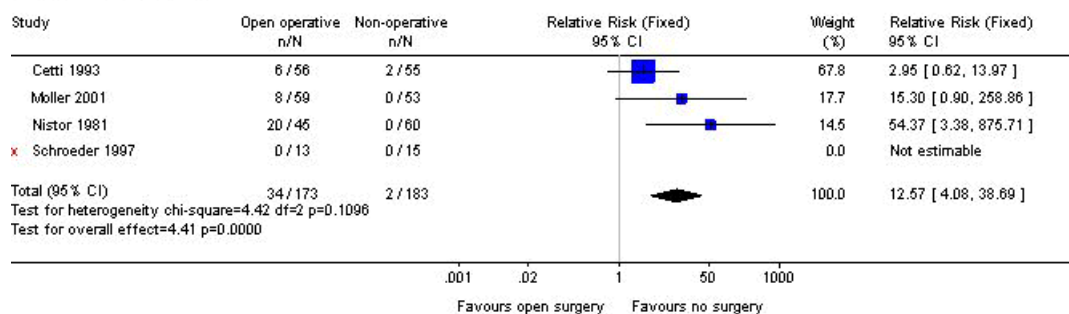
Study	Open operative	Non-operative	p value
Moller 2001	Mean no. of single-leg heel raises 6 months: 9.7 (SD 9.8) 1 year: 15.6 (SD 11.2) 2 years: 16.8 (SD11.5)	Mean no. of single-leg heel raises 6 months: 7.6 (SD 8.2) 1 year: 15.6 (SD 12.9) 2 years: 13 (SD 9.9)	NSS

#### Tendon width

Study	Open operative	Non-operative	p value
Moller 2001	Maximum width 1 year: 25.5 mm (SD 3.1) 2 years: 22.9 mm (SD 3.4)	Maximum width 1 year: 23.6 mm (SD 3.5) 2 years: 20.9 mm (SD 2.5)	1 year: p=0.04 2 years: p=0.01
Nistor 1981	Increase in width averaged 7 mm (range 2 to 12) Similar in both groups		NSS

### 01.09 Adhesion rate

Review: Interventions for treating acute Achilles tendon ruptures  
Comparison: 01 Open operative versus non-operative treatment  
Outcome: 09 Adhesion rate



### 01.10 Altered sensibility rate

Review: Interventions for treating acute Achilles tendon ruptures  
 Comparison: 01 Open operative versus non-operative treatment  
 Outcome: 10 Altered sensibility rate

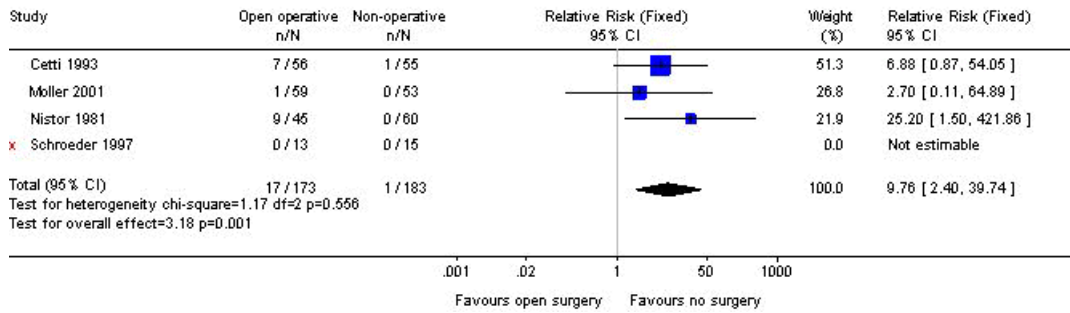
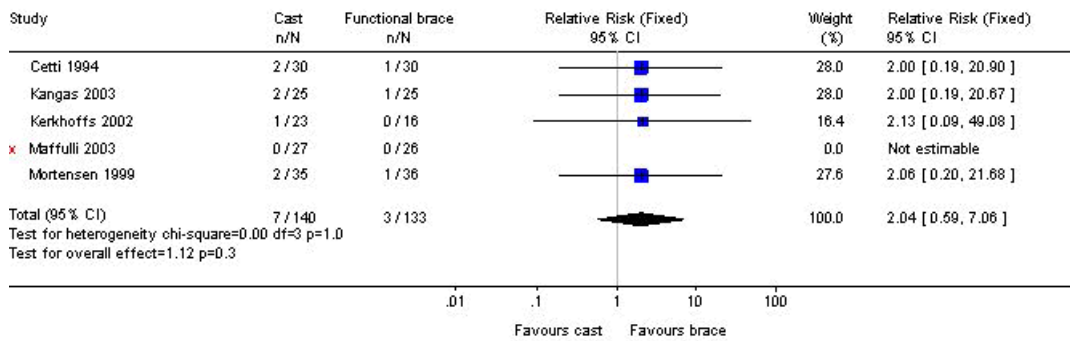


Fig. 02 Post-operative splintage: cast immobilisation versus functional brace

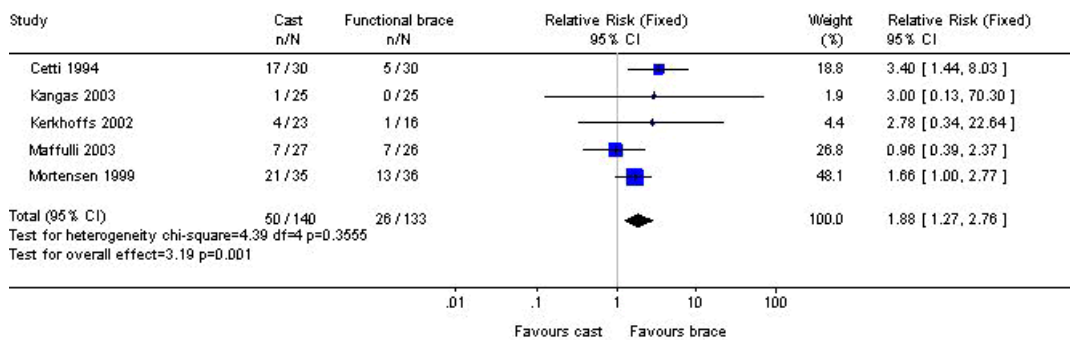
### 02.01 Rerupture rate

Review: Interventions for treating acute Achilles tendon ruptures  
 Comparison: 02 Post-operative splintage: cast immobilisation versus functional brace  
 Outcome: 01 Rerupture rate



### 02.02 Pooled complication rate other than rerupture

Review: Interventions for treating acute Achilles tendon ruptures  
 Comparison: 02 Post-operative splintage: cast immobilisation versus functional brace  
 Outcome: 02 Pooled complication rate other than rerupture



### 02.03 Duration of in-patient stay and overall treatment

#### Duration of in-patient stay and overall treatment

Study	cast only	Functional brace	p value
Kerkhoffs 2002	Mean 10 days (range 7 to 17)	Mean 8.6 days (range 4 to 17)	p<0.05
Maffulli 2003	Average time to discard crutches: 5.5 weeks (range 4.6 to 8.1, SD 2.2) Average number of physiotherapy visits: 13.6 (range 8 to 26, SD 4.8) Average time to be discharged from physiotherapy: 4.6 months (range 4 to 9, SD 2)	Average time to discard crutches: 2.5 weeks (range 1.2 to 3.1, SD 0.4) Average number of physiotherapy visits: 6.1 visits (range 2 to 11, SD 3.1) Average time to be discharged from physiotherapy: 2.1 months (range 1.8 to 5, SD 1.1)	Average time to discard crutches: p=0.021 Average number of physiotherapy visits: p= not stated Average time to be discharged from physiotherapy: p=0.03

### 02.04 Time off work

#### Time off work

Study	Cast	Functional brace	p value
Cetti 1994	Mean 53 days (range 1 to 182)	Mean 20.2 days (range 3 to 75)	p=0.0009
Maffulli 2003	Manual worker: mean 4.5 weeks +/- 1.1 Sedentary worker: mean 3.5 weeks +/- 1	Manual worker: mean 3.2 weeks +/- 0.6 Sedentary worker: mean 2 weeks +/- 0.5	Manual worker: p=0.041 Sedentary worker: p=0.04
Mortensen 1999	Mean 68 days	Mean 43 days	p<0.05

### 02.05 Sporting activity post rupture vs before rupture

#### Sporting activity post rupture vs before rupture

Study	Cast	Functional brace	p value
Cetti 1994	Same 15/30 Less 15/30	Same 24/30 Less 6/30	Difference in those reaching same level: p=0.029
Kerkhoffs 2002	Mean time to return to sports: 73 days (range 54 to 112)	Mean time to return to sports: 57 days (range 49 to 70)	p<0.01
Maffulli 2003	Average time to return to sports: 6 months (range 4.6 to 11.2, SD 3)	Average time to return to sports: 5.1 months (range 4.1 to 8, SD 2.8)	p=0.04
Mortensen 1999	Mean time to pre-injury level of sports: 9 months (range 6-14) Number who reached pre-injury level: 16/30 Mean time to return to sports: 7.5 months (range 3 to 22)	Mean time to pre-injury level of sports: 6 months (2.5-13) Number who reached pre-injury level: 17/31 Mean time to return to sports: 4 months (range 2 to 13)	Mean time to pre-injury level of sports: p<0.001 Number who reached pre-injury level: NSS Mean time to return to sports: p<0.001

### 02.06 Satisfaction

#### Satisfaction

Study	Cast	Functional brace	p value
Cetti 1994	Pain in cast reported by 18/30 Excellent or good results in 26/30	Pain in functional brace reported by 9/30 Excellent or good results in 29/30	Pain: p=0.0037 Excellent or good results: NSS
Kangas 2003	Very satisfied 19/25 Satisfied with minor reservations 4/25 Satisfied with major reservations 2/25	Very satisfied 13/25 Satisfied with minor reservations 11/25 Satisfied with major reservations 1/25	Not statistically significant (overall p value of 0.06 quoted in paper)

### Satisfaction

Kerkhoffs 2002	Mean modified Rupp Score (patient-centred assessment): 91% good or excellent	Mean modified Rupp Score (patient-centred assessment): 94% good or excellent	NSS
Maffulli 2003	18/27 good or excellent	23/27 good or excellent	p=0.04
Mortensen 1999	No difference in pain at 12 weeks between groups		

### 02.07 Objective assessment

#### Range of movement

Study	Cast	Functional brace	p value
Cetti 1994	Mean overall ROM at cast removal: 29.5 degrees	Mean overall ROM at brace removal: 54.3 degrees	p<0.00001
Kangas 2003	ROM at final review: normal in 19/24	ROM at final review: normal in 18/25	p=0.77
Mortensen 1999	Median decrease in ROM At cast removal: 30 degrees (range 0 to 85) At 12 weeks: 15 degrees (range 0 to 45)	Median decrease in ROM At brace removal: 20 degrees (range 0 to 45) At 12 weeks: 10 degrees (range -5 to 45)	At cast/brace removal: p<0.001 At 12 weeks: p<0.05 At final review (median 16 months): NSS

#### Calf atrophy

Study	Cast	Functional brace	p value
Cetti 1994	Atrophy of at least 5 mm compared with other side At cast removal: 30/30 At 1 year: 22/30	Atrophy of at least 5 mm compared with other side At brace removal: 21/30 At 1 year: 12/30	At cast/brace removal: p=0.0019 At 1 year: p=0.0182
Maffulli 2003	Maximum calf circumference: 38.1+/- 7.7cm	Maximum calf circumference: 40.3 +/- 6.4cm	NSS
Mortensen 1999	Median atrophy At final review (median 16 months): 1.25 cm (range 0 to 5)	Median atrophy At final review (median 16 months): 1 cm (range 0 to 3)	NSS

#### Power

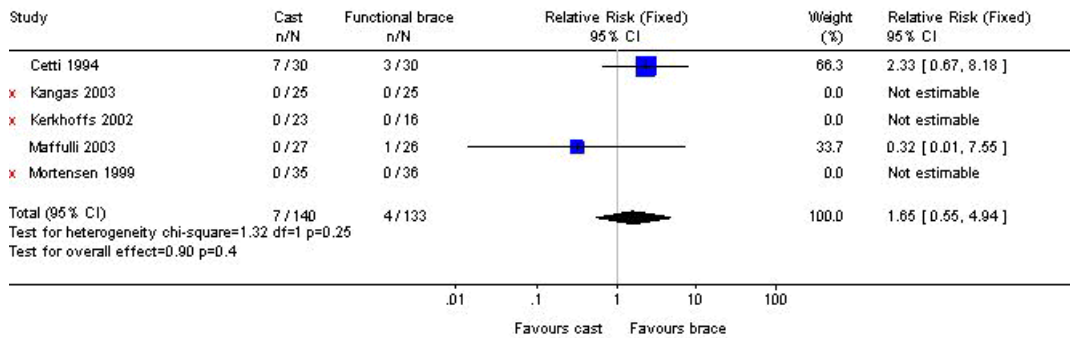
Study	Cast	Functional brace	p value
Cetti 1994	Mean strength of plantar-flexion vs other side at 12 months: 90.9% (range 78 to 104)	Mean strength of plantar-flexion vs other side at 12 months: 99.5% (range 88 to 118)	p=0.00006
Kangas 2003	Isokinetic calf muscle score: Excellent 29% Good 50% Fair 21% Poor 0%	Isokinetic calf muscle score: Excellent 56% Good 32% Fair 8% Poor 4%	Not statistically significant; overall p value of 0.17 quoted in text. NB Discrepancy between results reported in results section, and those in abstract and discussion. Have assumed those of latter to be correct.
Maffulli 2003	no difference between the groups		p=0.07
Mortensen 1999	no difference between groups		

### Separation of markers placed in tendons

Study	Cast	Functional brace	p value
Cetti 1994	Mean separation at 1 year: 13.5 mm (range -14 to 37)	Mean separation at 1 year: 6.1mm (range -8 to 22)	p=0.0033
Mortensen 1999	Median separation of markers At 6 weeks: 5 mm (range 1 to 34) At 12 weeks: 9mm (range 1 to 41)	Median separation of markers At 6 weeks: 9mm (range 0 to 26) At 12 weeks: 11.5mm (range 0 to 33)	At 6 weeks: p<0.001 At 12 weeks: p=0.2

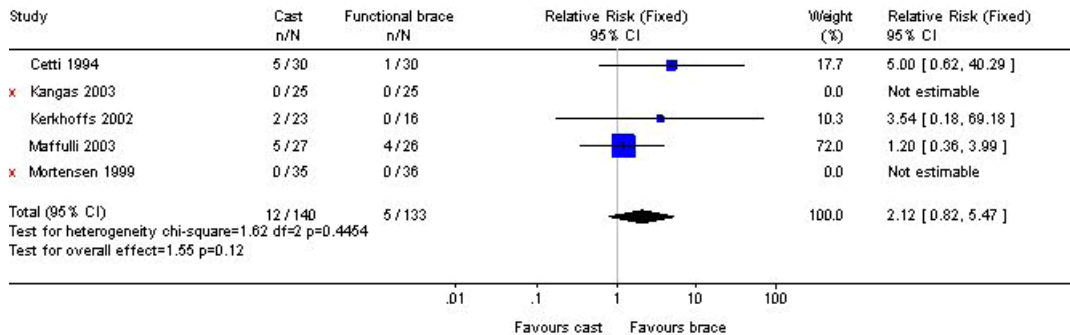
### 02.08 Keloid or hypertrophy rate

Review: Interventions for treating acute Achilles tendon ruptures  
Comparison: 02 Post-operative splintage: cast immobilisation versus functional brace  
Outcome: 08 Keloid or hypertrophy rate



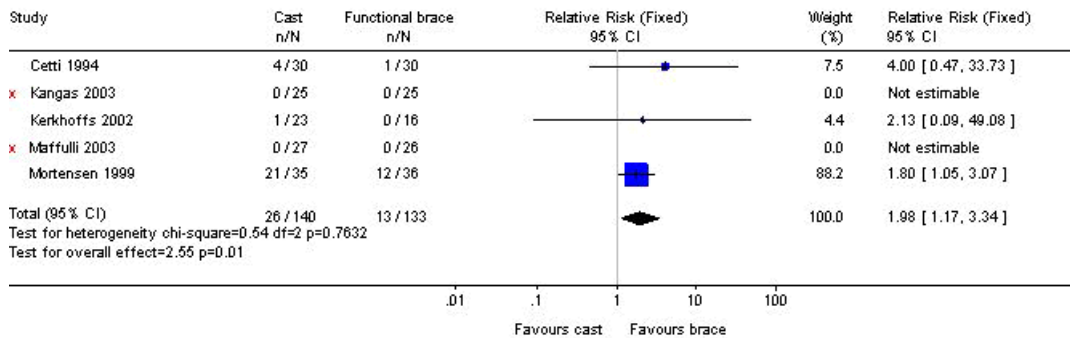
### 02.09 Altered sensibility rate

Review: Interventions for treating acute Achilles tendon ruptures  
Comparison: 02 Post-operative splintage: cast immobilisation versus functional brace  
Outcome: 09 Altered sensibility rate



### 02.10 Adhesions rate

Review: Interventions for treating acute Achilles tendon ruptures  
Comparison: 02 Post-operative splintage: cast immobilisation versus functional brace  
Outcome: 10 Adhesions rate



**Fig. 03 Open versus percutaneous surgical repair**

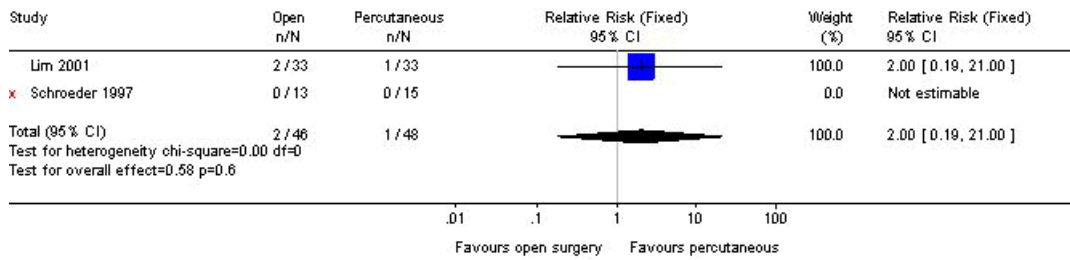
**03.01 Duration of operation**

**Duration of operation**

Study	Open	Percutaneous	p value
Lim 2001	Mean 45 minutes (range 30 to 75)	Mean 30 minutes (range 20 to 45)	Not stated

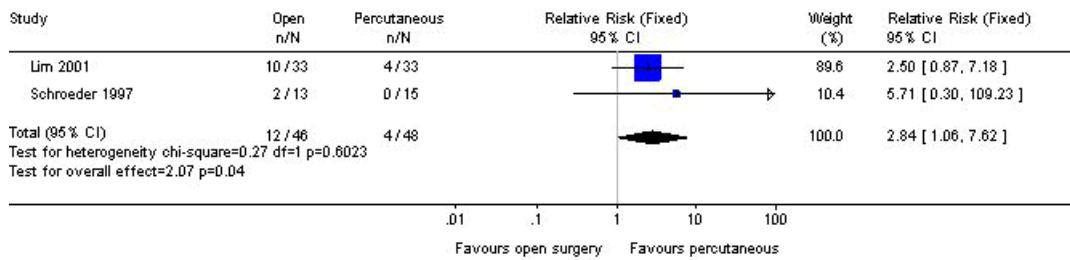
**03.02 Rerupture rate**

Review: Interventions for treating acute Achilles tendon ruptures  
 Comparison: 03 Open versus percutaneous surgical repair  
 Outcome: 02 Rerupture rate



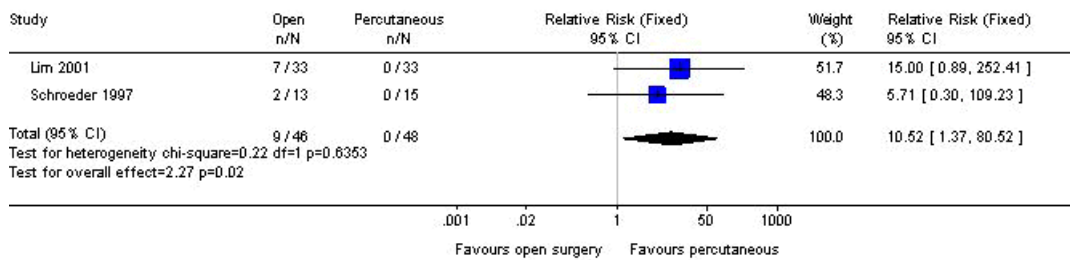
**03.03 Pooled complication rate other than rerupture**

Review: Interventions for treating acute Achilles tendon ruptures  
 Comparison: 03 Open versus percutaneous surgical repair  
 Outcome: 03 Pooled complication rate other than rerupture



**03.04 Infection rate**

Review: Interventions for treating acute Achilles tendon ruptures  
 Comparison: 03 Open versus percutaneous surgical repair  
 Outcome: 04 Infection rate



**03.05 Sporting activity post-rupture**

**Sporting activity post-rupture**

Study	Open	Percutaneous	p value
Lim 2001	4/9 "active" patients reached pre-injury level of activity	9/11 "active" patients reached pre-injury level of activity	NSS

### 03.06 Satisfaction

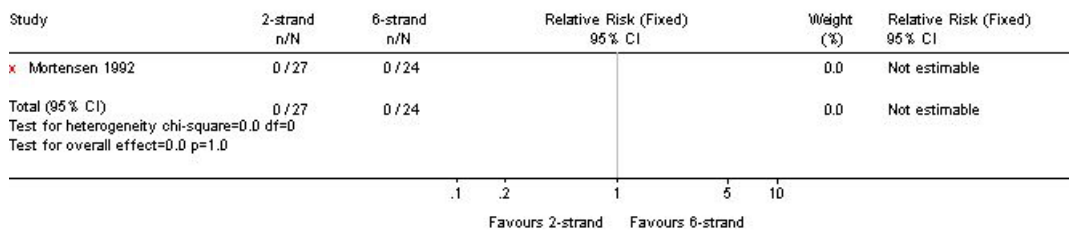
#### Satisfaction

Study	Open	Percutaneous	p value
Lim 2001	Good or excellent results At 6 months: 27/33	Good or excellent results At 6 months: 33/33	Not stated
Schroeder 1997	Good or excellent results At follow-up: 84%	Good or excellent results At follow-up: 80%	Not stated

**Fig. 04 Two-strand versus six-strand open repair**

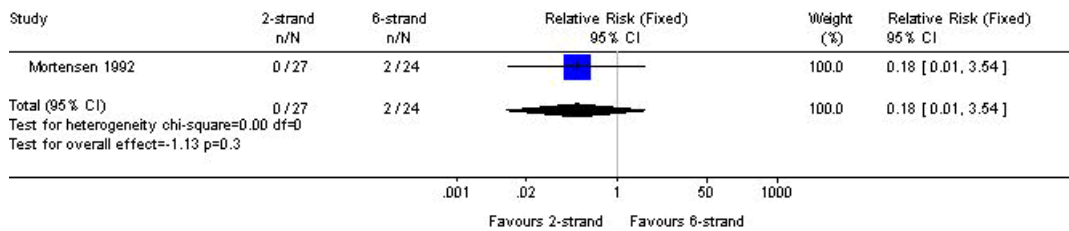
#### 04.01 Rerupture rate

Review: Interventions for treating acute Achilles tendon ruptures  
Comparison: 04 Two-strand versus six-strand open repair  
Outcome: 01 Rerupture rate



#### 04.02 Other complication rate

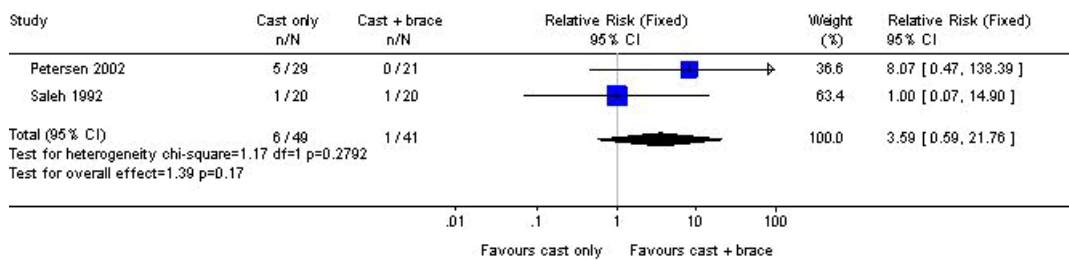
Review: Interventions for treating acute Achilles tendon ruptures  
Comparison: 04 Two-strand versus six-strand open repair  
Outcome: 02 Other complication rate



**Fig. 05 Non-operative treatment: cast vs functional brace**

#### 05.01 Rerupture rate

Review: Interventions for treating acute Achilles tendon ruptures  
Comparison: 05 Non-operative treatment: cast vs functional brace  
Outcome: 01 Rerupture rate



### 05.02 Satisfaction

#### Satisfaction

Study	cast only	cast + brace	p value
Petersen 2002	Subjective functional assessment (VAS): 4 months: 5.5 +/- 3.9 12 months: 7.9 +/- 3.9	Subjective functional assessment (VAS): 4 months: 6.3 +/- 2.6 12 months: 8.7 +/- 3.2	4m: p>0.15 12m: p>0.20
Saleh 1992	Mean time to walk comfortably indoors: 11 weeks Mean time to walk comfortably outdoors: 15 weeks	Mean time to walk comfortably indoors: 6 weeks Mean time to walk comfortably outdoors: 9 weeks	p<0.001 for both

### 05.03 Objective assessment: ROM (dorsi-flexion)

#### Objective assessment: ROM (dorsi-flexion)

Study	cast only	cast + brace	p value
Saleh 1992	Mean ROM dorsi-flexion (degrees) 3 months: 1.4 6 months: 3.8 12 months: 8.6	Mean ROM dorsi-flexion (degrees) 3 months: 7.9 6 months: 13.2 12 months: 13.6	p<0.001 at 3, 6 and 12 months