Clinical outcome and return to sport after the surgical treatment of spondylolysis in young athletes


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We studied prospectively 22 young athletes who had undergone surgical treatment for lumbar spondylolysis. There were 15 men and seven women with a mean age of 20.2 years (15 to 34). Of these, 13 were professional footballers, four professional cricketers, three hockey players, one a tennis player and one a golfer. Preoperative assessment included plain radiography, single positron-emission CT, planar bone scanning and reverse-gantry CT. In all patients the Oswestry disability index (ODI) and in 19 the Short-Form 36 (SF-36) scores were determined preoperatively, and both were measured again after two years in all patients. Three patients had a Scott’s fusion and 19 a Buck’s fusion.

The mean duration of back pain before surgery was 9.4 months (6 to 36). The mean size of the defect as determined by CT was 3.5 mm (1 to 8) and the mean preoperative and postoperative ODIs were 39.5 (SD 8.7) and 10.7 (SD 12.9), respectively. The mean scores for the physical component of the SF-36 improved from 27.1 (SD 5.1) to 47.8 (SD 7.7). The mean scores for the mental health component of the SF-36 improved from 39.0 (SD 3.9) to 55.4 (SD 6.3) with p < 0.001. After rehabilitation for a mean of seven months (4 to 10) 18 patients (82%) returned to their previous sporting activity.

A defect of the pars interarticularis is unique to man who, by virtue of being bipedal, transfers considerable weight through this part of the lumbar spine.1-3 The reported incidence of symptomatic defects of the pars varies between 15% and 47% in young athletes, which is significantly higher than in the general population.4-8

The treatment of spondylolysis depends upon the severity of the symptoms and the sporting activity of the patient.5 There is a lack of consensus regarding appropriate treatment. Operation is reserved for patients who do not respond to conservative measures.2 Several surgical techniques have been described to stabilise a spondylolytic defect in the lumbar spine. The most commonly used include the direct repair described by Buck,9,10 the Morscher hook screw, the Scott wiring technique and other screw-hook combinations.11-18 Several authors have analysed the effectiveness of various systems in small groups of patients.18-28 Hardcastle29 described good results after screw fixation in young fast bowlers. Our aim was to assess the outcome and return to sport of 22 young athletes who, having failed conservative treatment, underwent repair of spondylolysis using either a modified Buck’s fusion or the Scott wiring technique.

Patients and Methods

Between 1994 and 1999 we treated 22 young athletes for spondylolysis. There were 15 men and seven women with a mean age of 20.2 years (15 to 34). The mean duration of symptoms before surgery was 9.4 months (6 to 36). Low back pain of sudden onset occurring during sporting activity was the presenting complaint in 19 patients. The remainder had insidious onset of low back pain with radiation to the legs. All patients had been initially treated conservatively for a minimum of six months. This included absolute rest from sport and a formal trunk stabilisation programme supervised by a physiotherapist. Preoperative assessment included plain radiography, single positron-emission CT (SPECT) and reverse-gantry CT. In all patients the Oswestry disability index (ODI) and in 19 the Short-Form 36 (SF-36) scores were measured before operation and both were measured again two years later in all patients. Buck’s fusion was undertaken in 19 patients and Scott’s fusion in three. The postoperative radiographs were compared with those taken just before return to sport. Clinical outcome scores were analysed using the paired Student t-test with the...
aid of a commercially available statistical software package (SPSS version 10; SPSS, Chicago, Illinois). Statistical significance was taken when p < 0.001.

**Operative techniques.** Buck\(^9,10\) described the repair of a pars defect with a 4.5 mm stainless steel AO cortical lag screw. The defect was packed with cancellous bone graft. The senior author (JKW) modified this procedure slightly to include decortication of the lamina and the base of the transverse process before inserting screws across the defect. Once the screws were in place cancellous bone grafts were applied to the prepared area. The screws were tightened simultaneously to reduce the defect.

Postoperatively, patients were mobilised without support. A static isometric exercise programme incorporating spinal stabilisation was started at six weeks and a cardiovascular programme for strength and endurance at 12 weeks. This regime continued until the patient felt able to return to sport. A plain radiograph was taken at this point; if unchanged from the postoperative appearances and the patient was asymptomatic he or she was allowed to return to sport.

The Scott technique involved placing an 18-gauge stainless-steel wire around the transverse process bilaterally and tightening the wires in a figure-of-eight over the spinous process. In these patients a lumbosacral corset was worn for between six and 12 weeks. A plain radiograph was taken at 12 weeks and, if satisfactory, an exercise programme was started. Patients were reviewed at six months. A further radiograph was taken and if it was unchanged and if the patients were asymptomatic they were allowed to return to sport.

### Results

The mean duration of symptoms before surgery was 9.4 months (6 to 36). The defect was at L5 in 15 patients, at L4 in three and at L3 in three. One patient had defects at both L4 and L5 (Table I). At L5, 11 patients had bilateral and four unilateral increased uptake on SPECT imaging. Two patients with negative SPECT scans, but a high degree of clinical suspicion, had reverse-gantry CT which revealed a lytic defect. The mean width of the lysis was 3.5 mm (1 to 8); in eight patients (36%) it was 2 mm or less.

The mean preoperative and postoperative ODIs were 39.5 (SD 8.7) and 10.7 (SD 12.9), respectively. SF-36 scores were measured in 19 patients preoperatively and at two years after surgery. The mean score for the physical compo-
The mean score for the physical component of health improved from 27.1 (SD 5.11) to 47.8 (SD 7.75) (p < 0.001), and the mean score for the mental component of health (Fig. 1a) improved from 39.0 (SD 3.97) to 55.4 (SD 6.36) with p < 0.001.

The number of athletes who returned to sport is shown in Table II. Of the 19 patients who underwent a Buck’s fusion followed by a strict rehabilitation programme 18 returned to sport after a mean of seven months (4 to 10). Of the professional footballers, 12 returned to the same level at which they had been competing before the onset of their symptoms. Two with unilateral L5 defects returned to football six months after surgery (Figs 2 and 3). Two fast bowlers with mixed bowling actions were required to change their action before returning to cricket. Two other cricketers who had a Buck’s fusion returned to sport, but had further symptoms after two years with a new lysis at a different level (L3). These lesions both resolved after conservative management. One professional golfer who was treated by a Buck’s fusion which was soundly healed after one year, returned to golf. A female hockey player and sprinter who had repair of bilateral defects at L5 returned to hockey nine months after surgery (Figs 4 and 5). One patient who had a Buck’s fusion did not return to sport. Significant improvements were noted in both the ODI and SF-36. Reverse-gantry CT revealed a metal artefact, but confirmed sound union of the defect.

The outcome in the three patients (one footballer and two hockey players) treated by Scott’s fusion was not satisfactory. Two had nonunion and underwent revision to a posterolateral fusion. Again, although there were improvements in both the ODI and the SF-36 scores, neither returned to sport. The remaining patient was a young footballer with bilateral pars defects at L3. There was no significant difference between the preoperative and postoperative ODI and SF-36 scores. At one year, reverse-gantry CT showed a sound union. He did not return to sport, but was able to carry out normal daily activities.

Fig. 2
Reverse-gantry CT showing unilateral spondylolysis at L5 (left) in a 17-year old football player.

Fig. 3a
Anteroposterior (a) and lateral (b) radiographs showing a unilateral modified Buck’s fusion two years after operation.
Discussion

Rossi and Dragoni\textsuperscript{4} reported that in a series of 390 patients 95\% of those with lumbar spondylolysis were sportsmen (weight-lifters, American footballers, gymnasts, wrestlers and tennis players). The condition may also be associated with cricket and other sports such as football and athletics.\textsuperscript{29-37} Of the 22 patients in our series 13 (59\%) were soccer players. This is the first reported series of spondylolysis in soccer players. The incidence of spondylolysis in English fast bowlers may be less than that in Australian cricketers since English wickets are softer. Alternatively, English bowlers may have benefited from advice regarding technique and overuse reported in earlier studies.\textsuperscript{30-33}

Spondylolysis most commonly occurs at L5 and is usually bilateral.\textsuperscript{2,5} A similar pattern was found in our study. It occurs less commonly in the upper lumbar spine, but stress during fast bowling may have a greater effect on the pars of the more proximal lumbar vertebrae.

Repair of the pars defect is an appealing option for symptomatic patients who have failed to respond to conservative measures since it preserves movement. MRI is required to exclude more proximal disc degeneration in this group.

After the description of the direct repair of the pars defect by Buck\textsuperscript{9} several small series of patients have been reported with satisfactory outcomes using different techniques. The success rate varied between 63\% and 100\% (Table III).\textsuperscript{3,10,11,13-15,17-23,27,29,39} Each series has been small and the repair of the defect did not always lead to symptomatic relief. Kip et al\textsuperscript{38} concluded from a biomechanical analysis that repair using a screw had the greatest strength. They suggested that any technique which could resist the extension forces across the pars should be able to stabilise the posterior segment and result in healing of the defect.

Buck’s fusion has been used for the treatment of fast bowlers in Western Australia and in this series nine of ten patients returned to cricket.\textsuperscript{29} In our study we had a successful outcome in 18 of the 19 patients undergoing a modified Buck’s repair, but all three patients who had a Scott’s fusion had a less successful outcome. Kip et al\textsuperscript{38} showed this simple wiring technique to be the least stable construct when tested against a flexion load and, for this reason, it is less likely to lead to sound healing across the defect. These two groups were dissimilar in respect of the level of the defect and the small sample size made meaningful conclusions impossible.
The predictors of successful surgical outcome are ill-defined. Suh, Esses and Kostuki suggested infiltration of the pars with local anaesthetic to be a prognostic test of surgical outcome. Wu, Lee and Chen followed this protocol in 93 patients with a mean age of 23 years who underwent surgery and reported success in 91.3%. It has been reported that a successful outcome is more likely to occur in younger patients. Since there is evidence of an increased incidence of disc degeneration in the general population above the age of 25 years, it is wise to select younger patients for surgery and reported success in 91.3%. It has been reported in 93 patients with a mean age of 23 years who underwent surgery and reported success in 91.3%. It has been reported in 93 patients with a mean age of 23 years who underwent surgery and reported success in 91.3%. It has been reported that a successful outcome is more likely to occur in younger patients. Since there is evidence of an increased incidence of disc degeneration in the general population above the age of 25 years, it is wise to select younger patients for surgery. The outcome was poor in one of our patients who was 33 years of age at the time of Buck’s fusion.

As the size of the defect increases there is a gradual progression of the slip in some patients with an increased risk of disc degeneration. Buck originally suggested that his technique was appropriate only in patients in whom there was lysis of less than 3 or 4 mm. Although in our series the mean size of the lysis was 3.5 mm, a successful outcome was achieved in three patients in whom it exceeded 4 mm.

A potential weakness of our study was the inability to correlate the clinical and radiological outcomes. Our practice was to use plain radiography postoperatively and, when the patients were asymptomatic, to repeat it just before return to sport. It is not always possible to be certain of sound healing on radiography. If the patient was asymptomatic at this stage and the radiograph was unchanged it seemed inappropriate to undertake reverse-gantry CT simply to prove that sound bony healing had occurred. On the other hand if patients were still symptomatic and unable to return to sport, which was the case in four of our patients, appropriate CT scans were obtained. There have been no breakages of screws in our series, perhaps because we use stainless-steel rather than titanium screws. Neither have there been any patients who have presented again with broken screws after their return to sport.

A successful outcome also depends on motivation. Professional athletes are highly motivated. In our study, the general health and the mental health SF-36 scores were high before surgery, and within one SD of the mean when compared with the normal population (Figs 1a and 1b). These patients had much higher SF-36 scores when compared with a mean group of patients who had low back pain. This may have contributed to the successful outcome in this group. Patients reported significant improvements in both physical function and pain at two years. An improvement of 20.7 points on the mean physical component of health score represents an improvement in physical health large enough to move from the 5th to 28th centile of the distribution of scores in the general population. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

**References**


### Table III. Comparative published results of the techniques used to repair spondylolysis

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*only two studies18,29 report on a sporting population*
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