ORIGINAL ARTICLE

Navicular stress fractures: outcomes of surgical and conservative management

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Objective: To compare the long term outcomes of the two treatment options for navicular stress fractures: non-weightbearing cast immobilisation and surgical fixation.
Design: Retrospective case study.
Participants: Subjects aged 18 years and older who had been treated for a navicular stress fracture more than two years previously.
Main outcome measures: Questionnaire based analogue pain score and function score; tenderness on palpation; abnormality detected on computed tomography (CT).
Results: In all, 32 fractures in 26 subjects were investigated. No significant differences were found between surgical and conservative management for current pain ($p=0.984$), current function ($p=0.170$), or abnormality on CT ($p=0.173$). However, surgically treated patients more often remained tender over the ''N spot'' ($p=0.005$), even after returning to competition for two years or more.
Conclusions: Surgical fixation of navicular stress fractures appears to be as effective as conservative management over the longer term. However, there remains a small but measurable degree of pain and loss of function over this period. The value of using ''N spot'' tenderness as the sole clinical predictor of treatment success requires further investigation, as some patients remained tender despite successful completion of treatment and return to competition.

Navicular stress fractures were only relatively recently described in human subjects.[1] They were thought to be uncommon, accounting for between 0.7% and 2.4% of all stress fractures in an athlete population.[2] However, a more recent prospective study[3] found that navicular stress fractures accounted for 15% of all stress fractures. They are more common in running and jumping athletes, in one recent study making up 73.1% of stress fractures in track and field athletes.[4]

On examination, neither swelling nor discolouration is visible.[5] Instead, clinical suspicion is raised when tenderness is elicited over the proximal dorsal portion of the navicular—the ''N spot''.[6] Tenderness is strongly associated with navicular stress fractures.[6 7] Computed tomography (CT) is a very useful tool in the diagnosis of navicular stress fracture. It allows differentiation between stress fracture and stress reaction and also enables accurate fracture definition.[5 8]

Treatment options for navicular stress fractures, at this stage, have been investigated in only one large scale trial.[7] Currently, there are three major treatment options. Two of these—non-weightbearing cast immobilisation and surgery—are recommended as primary treatment. The role of auxiliary treatments, such as bone stimulation, remains controversial.

In a study by Khan *et al*,[7] non-weightbearing cast immobilisation was found to have excellent results, with 86% of patients initially treated in this manner returning to sport within 12 months. Non-weightbearing cast immobilisation is the currently recommended management for navicular stress fractures.[2]

The data on surgical treatment are less precise. However, Khan *et al*[7] reported that 83% of patients initially treated with surgery had a successful outcome. Saxena *et al*[9] proposed that surgical treatment (open reduction and internal fixation) may allow patients to return to sport faster than conservative management (3.1 months *v* 4.3 months), but it is yet to be confirmed that surgery is more effective than conservative treatment.

The results of longer term treatment are underrepresented in published reports. In particular, we need to know the most effective treatment for patients with recurrent injuries and the effectiveness of internal fixation as a long term treatment option.

METHODS

The study was retrospective. Patients over the age of 18 years who had been treated for a navicular stress fracture, including bilateral navicular stress fractures, more than two years previously were eligible for inclusion. Ethics committee approval was granted. Subjects were recruited from those previously enrolled in a navicular stress fracture study, and also from sports physicians in Melbourne. Initial contact was made by mail, with a plain language statement and a questionnaire. Subjects then presented for examination and radiological investigation at a radiological clinic in Melbourne.

Because of the radiation involved in CT, subjects who were pregnant, or who may have been pregnant, were excluded from the CT component of the study.

The questionnaire used was adapted from the Midfoot Scale, developed and validated by the American Orthopaedic Foot and Ankle Society.[10] However, a separate study specifically validating the modified scale for this project was not completed.

If a subject had bilateral stress fractures, a questionnaire was completed for each foot. Subjects were asked to evaluate foot pain (using a visual analogue scale) and function, for both the injured and the non-injured side. Data were collected regarding the initial injury and the state of function at the time of follow up, though not for the intervening period.

Clinical examination involved elicitation of navicular tenderness. While inverting and everting the foot, the talonavicular joint was located. The proximal-dorsal portion

Table 1 Questionnaire responses

	Conservative	Surgical	Non-injured foot
Pain*	51 (9.5)	51 (9.4)	59 (3.3)
Function†	25 (5.0)	28 (3.8)	29 (2.9)

Values are mean (SD).
*From a maximum score of 60.
†From a maximum score of 30.

of the navicular was palpated. This portion has been described as the ''N spot'' and is accepted in clinical practice as being the correct site for eliciting navicular tenderness.[6 7] Following manual palpation a force transducer was used to achieve a uniform pressure across the range of subjects. A force of 40N was applied to the N spot and any tenderness recorded.

Each subject had a simultaneous scan of right and left navicular bones on a GE Light Speed model CT scanner, using a bone algorithm. The slices taken were 2.5 mm thick, contiguous, and angled through the plane of the talonavicular joint. A dosage of 105 mA with time scan of 1 second was used. The radiographer was blinded to the treatment and clinical history. The CTs were read independently by a radiologist (ZSK) and a sports physician (PDB). Neither was made aware of the treatment method or the clinical history. However, some treatment options—most obviously internal fixation—may be apparent on CT. Each scan was assessed for presence and extent of the following: radiolucent cleft, cortical breach, sclerosis, and ossicles (fig 1). This result was then converted to a score out of 32 for each CT, with 0 showing no abnormality and 32 showing maximum abnormality in all categories.

Statistics

Statistical analysis was carried out using SPSS for Windows, version 11.0. As fewer than 30 stress fractures were examined for each treatment, normal distribution could not be assumed. A Q-Q plot was used to analyse distribution. If the distribution was normal, an independent *t* test was used to analyse the relation between treatment method and the measured variable. Non-parametric data were analysed using χ^2 and Mann–Whitney tests. A probability (p) value of <0.05 was considered significant.

RESULTS

Twenty six subjects participated in the study. Of these, 20 had a unilateral injury and six had bilateral stress fractures. Three subjects were unable to undergo CT and examination because of pregnancy ($n = 1$) or travel constraints ($n = 2$).

There were 13 male and 13 female subjects. The mean (SD) age of the male subjects was 34.7 (10.9) years and of the female subjects, 32.3 (9.6) years. The overall mean age of the subjects was 33.5 (9.6) years. Nineteen fractures were treated conservatively and 13 surgically.

The total mean time since injury was 10.3 (5.1) years. There was no significant difference in pain response ($p = 0.984$) or function response ($p = 0.170$) between the surgical and the conservative groups (table 1).

From the questionnaires, 73% of subjects returned responses of 50 (83%) or more from a maximum score of 60. No subject reported a score of less than 30 (50%), indicating consistent current pain. There was no statistical difference between surgical and conservative subjects for pain response ($p = 0.984$). However, the responses for the non-injured foot were significantly better than for the injured foot ($p<0.001$).

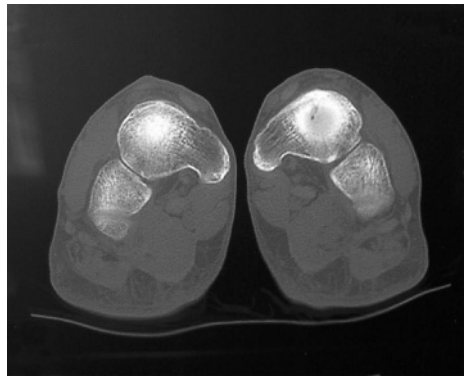

Figure 1 Navicular computed tomography. Scan from a patient who reported maximum function and no current pain on questionnaire. Despite having returned to full competition for years, and later retiring, a radiolucent cleft remains visible in the body of the left navicular.

Table 2 Palpation results

	Conservative	Surgical	Total
Tender	3/17	4/12	7/29
Non-tender	4/17	8/12	22/29

For function, 81% of subjects returned responses of 25 (75%) or more from a maximum score of 30. No subject reported a score of less than 15 (50%), indicating significant functional impairment.

There was no statistical difference between surgical and conservative subjects for function response ($p = 0.170$). However, the responses for the non-injured foot were significantly better than for the injured side ($p = 0.019$).

Twenty nine stress fractures were examined for tenderness. Of these, seven were tender and the remaining 22 non-tender (table 2).

Compared using the χ^2 test, surgically managed subjects had a statistically significant higher percentage of tenderness on examination ($p = 0.005$).

Each CT received a score out of 32, with 0 being the ideal result, showing no abnormality, and 32 the maximum result, showing maximum abnormality. Mean (SD) CT results were 5.6 (3.7) for conservative management and 4.0 (2.4) for surgical management. There was no significant difference in CT result between the surgical and the conservative groups ($p = 0.173$).

DISCUSSION

Our results indicate that, although pain is at a low level and functionality high for the majority of subjects, a navicular stress fracture may continue to generate a small though measurable amount of discomfort and loss of function in the longer term.

Our study was retrospective and suffers from limitations related to study design. Importantly, it was not possible to make an accurate assessment of factors that may have influenced the pain and function reported, but which occurred between initial treatment and later follow up. However, because of the small pain scores and loss of function reported, we believe that these confounding variables did not influence the results significantly.

It is uncertain whether surgical treatment is attempted more often in more severe fractures, although anecdotal

evidence suggests this may be correct. If this is true then a larger number of severe fractures treated surgically may be masking a relative benefit.

There was no statistical difference in pain or function results between surgical and conservative management.

The sample size for this study was relatively small and a larger study may have revealed differences between the treatments that this study could not. However, the small differences in results for pain and loss of function and the consistency between these results and those of the landmark study by Khan *et al* in 1992[7] lend weight to the proposition that both conservative and surgical management are effective and comparable treatments over the longer term.

N spot tenderness is an important clinical sign of a navicular stress fracture and is probably the most commonly used clinical marker for the initial assessment of navicular injury. In this study the subjects had all recovered from their injury and returned to competition for the longer term (minimum two years).

There was a significantly higher proportion of surgically managed patients with navicular tenderness ($p = 0.005$). This may be for two main reasons. First, the presence of a screw in the navicular, or even the surgery itself, may produce slight inflammation or irritation of nociceptors in the bone, or more likely the periosteum. Palpation would therefore elicit mild tenderness. Second, the presence of scar tissue from surgery overlying the navicular may cause discomfort for patients on palpation and this may be interpreted incorrectly as navicular tenderness.

One important fact to consider is that all subjects had returned to sport, yet seven continued to have tenderness over the N spot. Tenderness remains an important clinical sign, and is used to assess clinical healing, particularly in determining whether the cast may be removed.[2] However, it appears that a percentage of patients may remain N spot tender over the longer term. This result raises questions over the validity of using N spot tenderness as the sole clinical indicator for follow up treatment—specifically for returning a patient to casting for two further weeks. It must be considered that some patients will remain N spot tender over the longer term despite returning to competition without recurrence of fracture.

Radiologically, 70% of subjects returned results of 6 (19%) or less from a maximum score of 32. No CT assessment gave a score greater than 16 (50%), indicating significant abnormality.

Of the non-injured feet, 53% had evidence of a previous fracture of less than 5 mm. This indicates that a large number of stress fractures may actually be bilateral but are not presenting as such clinically.

Additionally, in some patients who had returned to competition for years, had returned the maximum function score on questionnaire, and had reported no current pain, there was still a cleft visible on CT. It appears that in some cases complete clinical recovery is not matched radiologically (table 1). There was no statistical difference between surgical and conservative subjects ($p = 0.173$).

Since the landmark study by Khan *et al* in 1992, and a further study in 1994,[2 7] there has been a consistent push for greater recognition of navicular stress fractures. Although further study must be undertaken, there is evidence that physicians and, more importantly, athletes have an increased awareness of navicular stress fractures. It is hoped that this will lead to more injuries being picked up earlier, at the stress reaction stage, and to a greater compliance among athletes in reducing their training and competitive load when a stress reaction is found.

Finally, there is anecdotal evidence that some sports physicians are modifying the cast immobilisation protocol to combat the reduced ankle dorsiflexion that is reported after six weeks in a cast. For patients who it is believed will be highly compliant, ''cam-walkers'' are used to immobilise the foot during the day. These can be removed at night for flexibility exercises, and also for non-weightbearing activities such as swimming. It is hoped that this will allow a faster return to sport and reduced loss of ankle dorsiflexion. However, further study must be undertaken.

What is already known on this topic

- Navicular stress fractures are relatively common, most effectively treated by either non-weightbearing cast immobilisation or surgical fixation, followed by a graded return to sport. These treatments appear equally effective over the short term.
- Tenderness on navicular palpation is an important method of assessing healing in the short term.

What this study adds

- Surgical fixation is as effective as non-weightbearing cast immobilisation over the longer term.
- The effectiveness of using tenderness on palpation as the sole clinical predictor of treatment success requires further investigation, as some patients remained tender despite apparently successful treatment and return to competition.

Conclusions

Navicular stress fractures have been underdiagnosed and may still be underrecognised by the medical community. With a history of poorly localised mid-foot pain associated with weightbearing activity, and tenderness over the N spot, an athlete should be considered to have a navicular stress fracture until proven otherwise. A positive bone scan with subsequent CT investigation should confirm the diagnosis. Athletes in higher risk sports such as sprinting or jumping should always be treated with a high index of suspicion.

When examining the long term treatment outcomes of navicular stress fractures we found no significant difference between the two predominant treatment modes—non-weightbearing cast immobilisation and surgical fixation. The long term outcomes for each treatment were encouraging, with positive results for pain and function questionnaire responses from both groups. However, there was still a small, though measurable, degree of pain and loss of function that was associated with the stress fracture in the long term.

The recommended treatment for navicular stress fractures has been non-weightbearing cast immobilisation, with a graded return to sport following cast removal. Surgical treatment, though increasingly common, remains underreported in the literature. Although the numbers of subjects were relatively small, the evidence from this study suggests that surgical fixation of navicular stress fractures is an equally effective treatment over the longer term.

These results require further validation in a larger study. Small subject numbers and limitations of testing may have obscured differences that could be unearthed upon later investigations. Ideally this study would be repeated on a larger scale, examining both the morbidity and the outcomes of treatment options.

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COMMENTARY

This paper is important as it looks at outcome measures of surgical versus conservative approaches to the management of navicular stress fractures. This has never been examined before and I agree with the authors that the next step is to do a similar study on a larger scale. Anecdotally, the morbidity of surgical intervention, when it occurs, is much more catastrophic than that of conservative treatment. A larger study would probably reflect this. This is, however, an important paper and will help clinicians make informed decisions regarding their treatment of these difficult stress fracture.

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ECHO

More endoscopists improve outcome for upper GI cancer

Please visit the *Quality and Safety in Health Care* website [www.qshc.com] for a link to the full text of this article.

More endoscopists may be the answer to better outcomes for upper gastrointestinal (GI) cancer, as recent improvement seems to owe more to the introduction of nurse endoscopists than the UK government's two week wait scheme for a specialist consultation, according to doctors in one cancer unit.

True enough, the odds of curative resection increased significantly (odds ratio 1.48) in their unit in the two years after the scheme was introduced compared with the two years before, and curative resections for early (stage 1 and 2) cancers rose from 47 to 58. But only two patients (5%) of 38 diagnosed with the cancer out of 623 referred under the scheme had early stage disease compared with 56 (27%) outside it. Furthermore, just over a third of patients with early stage cancer had symptoms consistent with the referral criteria in the scheme, but only two of them were referred under it.

When the scheme was implemented at Norfolk and Norwich University Hospital, in September 2000, it coincided with appointment of two full time nurse endoscopists, which reduced routine waiting times for endoscopy—and probably accounted for the improvement.

Under the scheme guidelines for urgent referrals for upper GI cancer were issued to general practitioners to ensure timely specialist evaluation. Detecting the cancer early is key to curative treatment, but symptoms can be unreliable. This may be why reducing times for routine endoscopy may be the best option.

The UK government has been under pressure to improve its poor record on upper GI cancer outcome in western Europe.

▲ Spahos T, *et al*. *Postgraduate Medical Journal* 2005;**81**:723–730.