Prevention of Pelvic Stress Fractures in Female Army Recruits

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In 1991-1992, a pelvic stress fracture incidence of 11.2% was recorded in a cohort of 143 female Australian Army recruits. An incidence of 0.1% was recorded in a cohort of male recruits trained in the 1992-1993 year using a nearly identical program. A number of preventive strategies were instituted in an attempt to reduce the high incidence of injury in female recruits. Route march speed was reduced from 7.5 to 5 km/h, running occurred on softer surfaces, individual step length was promoted instead of marching in step, march and run formations were more widely spaced, and interval-running training replaced traditional middle-distance runs. Pelvic stress fracture incidence decreased significantly to 0.6% in an immediately subsequent cohort of 161 female recruits ($\chi^2 = 15.12$ for 1 df; $p < 0.001$). It is likely that the preventive strategies reduced bone strain by reducing the frequency and forces of impact during the training period.

Introduction

Pelvic stress fractures in female recruits undertaking basic training have been a source of concern to the Australian Army and other military institutions. The Australian Army’s 1st Recruit Training Battalion (1 RTB) has trained both female and male recruits using a regimented 13-week training program. From 1990 to early 1992, pelvic stress fractures were frequently and consistently recorded in female recruits but rarely in male recruits. The training program was replicated for each platoon of recruits and incorporated a progressive and intensive regimen of lower-limb activities, such as route marching, running, and drill. Each platoon consisted of 30 to 40 recruits, and male and female recruits trained in separate platoons. Most pelvic stress fractures were located in the inferior pubic rami at the adductor origin. In some cases, a stress fracture of the superior pubic ramus was noted. In all cases, the diagnosis of stress fracture was confirmed by bone scan after provisional diagnosis by the regimental medical officer.

Stress fractures of the pelvis have been known to take nearly 3 years to heal fully, and all require extensive rehabilitation. The severity and incidence of pelvic stress fractures was a concern of the staff at 1 RTB, and the physical training instructors attempted to address the problem by changing the manner in which female recruits were trained. The aims of this paper are to record that process and to report the incidence of pelvic stress fractures in recruits at 1 RTB both before and after the intervention.

Methods

Subjects

From July 1991 to September 1992, 143 female army recruits were trained at 1 RTB. These recruits provided baseline injury statistics and thus acted as an historical control group. A further 161 female army recruits were trained at 1 RTB from October 1992 to September 1993. This second group was trained under an altered physical training regimen, and postintervention injury statistics were obtained for these female recruits. From September 1992 to May 1993, 1,093 male army recruits were followed through training at 1 RTB, all under the original, unaltered physical training regimen. The incidence of pelvic stress fractures in male recruits was obtained from this group. These male recruits were part of a prospective cohort study reported previously and were drawn from 1,130 male recruits who enlisted during that time on the basis that they provided informed consent to participate in the cohort study.

The only exclusion criteria applied to subject selection for each sample were failure to meet army enlistment criteria, meaning that the individual was not enlisted, and, in the case of males, failure to provide informed consent to participate in the cohort study mentioned above. All other recruits were included provided that they enlisted within the given times. Inclusion criteria for each sample thus consisted only of army enlistment criteria and enlistment during the sampling times. In every case, army enlistment criteria included an absence of any history of significant injury, good general health (both assessed by preenlistment medical screening), age between 17 and 35 years, and psychological suitability (assessed by paper-and-pencil aptitude tests). If more applicants were available than places in training, individuals were selected on the basis of aptitude test results. As far as the author could ascertain, there were no marked differences in the demographic characteristics of recruits enlisted in the second female group compared with the first, and there were no changes in recruitment policies or procedures within the study period.

Data Collection

The current study was retrospective and observational in nature. The baseline pelvic stress fracture incidence for female recruits was determined from bone-scan reports relating to the 143 female recruits in the historical control group. Postintervention pelvic stress fracture incidence was determined from bone-scan reports relating to the 161 female recruits who trained after the intervention in the physical training regimen. The pelvic stress fracture incidence for male recruits under the original training regimen was determined from bone-scan reports relating to the 1,093 male recruits who trained between September 1992 and May 1993. Copies of all bone-scan reports were forwarded to the physiotherapists (one of whom is the author) as soon as they became available. The medical officer referred for bone scan all recruits who developed signs and symptoms of groin strain that met the clinical diagnostic criteria for pelvic stress fracture and did not resolve with several days of rest and physiotherapy treatment.

The clinical diagnostic criteria for a pelvic stress fracture included tenderness over the inferior pubic rami, pain on
resisted hip flexion and adduction, a history of at least 2 weeks of increased lower-limb physical training, and exclusion of simple muscle strain, inguinal hernia, or likely referral from the lumbar spine. Additional criteria that were often, but not always, present included antalgic gait and aching in the groin region when resting. These diagnostic criteria are consistent with previous observations.1-3

Regular communication between the physiotherapists and platoon staff ensured that no likely cases of pelvic stress fracture were missed. All recruits presenting with symptoms of groin pain that lasted more than 3 days were reviewed by the doctor and referred to the author or his colleague, both physiotherapists, before a bone scan was ordered. Discussion between the doctor and the physiotherapist determined whether recruits met the primary diagnostic criteria listed above. All recruits who met the criteria were sent for bone scan, but others were not. This routine was strictly adhered to in all cases. Both physiotherapists were present at 1 RTB for the entire study period, ensuring that patterns of referral for bone scan were consistent across the three samples. Approximately 60% of all recruits sent for bone scan on the basis of these clinical criteria are found to have pelvic stress fracture (unpublished data from 1 RTB).

It is recognized that individuals with pelvic stress fractures who do not adequately reduce their training load will not achieve healing and will suffer ongoing pain and disability with further training.3 Given the progressive nature of army basic training and the close communication between the platoon staff and physiotherapists during the study period, it is doubtful that any true cases of pelvic stress fracture would have been missed. It should also be noted that bone scans were performed according to skeletal region. This meant that signs and symptoms consistent with lower-leg stress fracture, for example, did not result in coincidental findings at the pelvis, because the pelvic region was not scanned. Furthermore, no bone scan was considered diagnostic of a pelvic stress fracture unless it was preceded by clinical signs and symptoms. These procedures were consistent across all three study samples.

Details of the training regimen intervention were documented exactly as described by the physical training instructors, who decided on and applied the intervention. The information was checked through informal discussion with female recruits from these platoons, who confirmed that these changes were in fact instituted. It should be noted that the author played no role in initiating or planning the specific training changes but simply documented the changes and observed the pelvic stress fracture incidence as these changes took place.

<table>
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<tr>
<th>Male and Preintervention Female Physical Training Regimens</th>
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From July 1991 to September 1992, route marches for female recruits were conducted at speeds of up to 7.5 km/h. The recruits were required to march in step and in close formation. No packs were worn by female recruits. Runs were conducted mostly on bitumen road surfaces. From September 1992 to May 1993, the physical training regimen for male recruits was identical to this, except that male recruits wore packs weighing up to 20 kg for some route marches.

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<tr>
<th>Postintervention Physical Training Regimen for Female Recruits</th>
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The physical training instructors sought to reduce the injury incidence of female recruits enlisting after September 1992 by instituting the following changes, most of which effectively reduced the training load:

1. the route march speed was controlled at approximately 5 km/h for all route marches, which were not altered in distance;
2. the female recruits were encouraged to march with their own comfortable step length, i.e., they were no longer required to keep in step;
3. the female recruits were encouraged to march and run in a more widely spaced formation to aid earlier awareness of upcoming obstacles;
4. running was conducted, wherever possible, on soft grass surfaces in preference to roads; and
5. wherever possible, running took the form of 800-m interval-training sessions instead of the middle-distance runs performed previously, so that total running distance was reduced.

No other components of the course were altered during the study period.

Statistical Analysis

The incidence of pelvic stress fractures in the female postintervention group was compared with that in the female control group using the \( \chi^2 \) test for goodness of fit,3 which was performed manually.

Results

The incidence of pelvic stress fractures in each group studied is presented in Table I for comparison. The incidence of pelvic stress fractures in female recruits subsequent to the intervention was much lower than that in the historical control group. The 20-fold reduction in pelvic stress fracture incidence for female recruits after the intervention was statistically significant \( \chi^2 = 15.12 \) for 1 df; \( p < 0.001 \). The odds ratio for pelvic stress fractures in the postintervention group compared with the historical control group was calculated to be 0.050 (95% confidence interval, 0.019-0.129). The mean week of training at diagnosis in female recruits was week 9, but the range was week

| TABLE I |
| PELVIC STRESS FRACTURE INCIDENCE FOR EACH GROUP OBSERVED |

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Recruits</th>
<th>No. Sustaining Pelvic Stress Fracture</th>
<th>Incidence [%]</th>
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<tr>
<td>Preintervention female (July 1991 to September 1992)</td>
<td>143</td>
<td>16</td>
<td>11.2</td>
</tr>
<tr>
<td>Postintervention female (October 1992 to September 1993)</td>
<td>161</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Male (no intervention) (September 1992 to May 1993)</td>
<td>93</td>
<td>0.93</td>
<td>10.9</td>
</tr>
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</table>
2 to week 12. Thirteen of the pelvic stress fractures in female recruits involved the left pubic rami. 3 involved the right pubic rami, and in 1 case the pelvic stress fractures were bilateral. One case involved the superior pubic ramus alone, 12 involved the inferior pubic ramus alone, and 4 involved both inferior and superior pubic rami. The one male case involved bilateral inferior pubic ramus stress fractures.

Discussion

Pelvic stress fractures in female recruits have been a major concern at 1 RTB. With the introduction of simple preventive strategies, a reduction of pelvic stress fracture incidence from 11.2 to 0.6% was observed in female recruits. It is recognized that the study design carries some limitations. The use of an historical control group means that historical and other threats to the internal validity of the results cannot be entirely ruled out. However, the magnitude of the treatment effect (odds ratio, 0.050; 95% confidence interval, 0.019–0.129) and the temporal relationship between the intervention and the sudden reduction in injury incidence suggest that the intervention truly was effective in reducing the incidence of pelvic stress fracture. A simple regression to the mean is an unlikely explanation for the reduction because the incidence recorded in the female control group was similar to that recorded in the year before the study. It is also unlikely that the intervention and historical control groups differed much in terms of demographic characteristics or overall training influences given the fact that the intervention group trained immediately after the control group and that no changes in recruiting policies occurred from the time of one group being enlisted to the time of the other. Furthermore, the procedures leading to referral for bone scans and detection of pelvic stress fractures were identical for all groups.

Scully and Beiterman6 present a useful model of the bone remodeling process in army recruits and suggest that the incidence of stress fractures can be reduced by a combination of periodic rest and reduced frequency and forces of impact loading. It is likely that the intervention applied in the current study reduced the total bone strain at the adductor origin by reducing impact forces, reducing forces generated by the adductors, and reducing the number of contraction cycles required of the adductors in the course of training. The reduction in bone strain could then explain the reduction in the incidence of pubic ramus stress fractures. It should be noted that, although the revised physical training program reduced training load, there is no reason to believe that it was less effective in accomplishing training objectives. On the contrary, the physical training instructors perceived the revised training regimen to be more effective because it reduced fatigue and injury barriers to achieving objectives.

Only one previous study reports an attempt to prevent pelvic stress fractures in military personnel or athletes. Hill et al.1 reported that they observed a reduction in pelvic stress fracture incidence in British Army recruits after the required marching ride length was reduced from 30 to 27 inches for all marching except for that on the drill square. They did not, however, mention any potential confounding factors. Regression to the mean may have influenced the result because the intervention was applied after an unusually high incidence of pelvic stress fractures (6.3%) was recorded in a 4-month period. This unusually high incidence coincided with the introduction of mixed training of male and female recruits.

The incidence of pelvic stress fractures in female recruits recorded before the intervention in this study was also high (11.2%), but it was consistent with that recorded during the preceding year. Mixed-gender training was not an influence, because male and female recruits trained separately. The relatively low incidence of pelvic stress fractures recorded for male recruits (0.1%) is similar to that recorded for male recruits in the British Army,7 where the recruit training program involved 10 weeks of military skills training, drill, and progressive physical training.1 Further research is needed to determine possible reasons for the high incidence in female recruits, particularly because a reduction in training load was associated with a significantly reduced incidence in this study. Factors such as initial fitness and anatomical or anthropometric differences between male and female recruits should be investigated.

It is interesting that 80% of the pelvic stress fractures recorded in this study involved the left pubic rami. Further research is warranted to investigate whether this trend is consistent for a larger sample, and if so, to determine why this is the case. Hill et al.1 also reported a slightly greater number of left-sided cases than right-sided cases in British Army recruits. Ninety-five percent of cases in the current study involved the inferior pubic rami, and 25% involved the superior pubic rami. This finding is in contrast with the findings of Hill et al.,1 who reported that all cases in their British Army recruit sample involved the inferior pubic ramus only. This difference may be related to the fact that in most of the cases reported by Hill et al.,1 the diagnosis was confirmed by plain radiographs and not by bone scan. It is possible that if the inferior pubic ramus was the more stressed ramus, then lesser stress changes in the superior pubic ramus would have been observed only on bone scan. It is likely that the inferior pubic ramus is the more stressed ramus during military marching and running activities because of the larger adductor muscle mass arising from this ramus. The adductor magnus, adductor brevis, and gracilis muscles all arise from the inferior pubic ramus, whereas much less muscle mass arises from the superior pubic ramus.7

The mean week of training at diagnosis in the current study (week 9) was similar to that reported in British Army recruits,1 where week 8 was the mean under a similar training regimen. It is noteworthy, however, that Hill et al.1 found the mean week of onset of symptoms to be week 5 of training, indicating late reporting. At 1 RTB, it is common for recruits to experience minimal pain in cases of pelvic stress fracture. This finding has been noted previously8,9 with regard to femoral stress fracture. It is not uncommon for persistent muscle spasm or antalgic gait to be more prominent indicators of such stress fractures than pain. As a result, many recruits who suffer pelvic stress fractures find it hard to believe that they have one when informed. Stress fractures of the tibia or foot, in contrast, tend to be associated with quite specific pain patterns8-10 and are usually diagnosed relatively early in military recruit training programs.8 It is possible, then, that minimal symptoms in the presence of early pelvic stress fracture may lead to later reporting and diagnosis at a more advanced stage of injury, even though development may occur at a time similar to that for the development of...
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If this is so, then it is important to heed very early, minimal signs and symptoms consistent with pelvic stress fracture in female recruits, who are at risk. At 1 RTB, we adhere to this policy and rest the injured recruit with suspected pelvic stress fracture until a bone scan can be arranged if initial radiographs reveal no abnormality. We expect that early detection and proactive care in these cases will prevent long-term complications for the individuals concerned.

In conclusion, the results of this study suggest that reductions in physical training load can reduce the risk of pelvic stress fracture in female army recruits undertaking basic training without reducing training efficacy.

References


