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Case report

Recovery of bone mineral density and fertility in a former amenorrheic athlete

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Abstract
Inadequate dietary intake and prolonged amenorrhea in women athletes can lead to bone loss, particularly at the spine, which may be irreversible. This report presents the case of a woman endurance runner, followed prospectively over 6 years after presenting with the female athlete triad. Bone mineral density (BMD) and body composition were assessed by dual-energy X-ray absorptiometry. At baseline, lumbar spine (LS), total hip and total body (TB) BMD Z-scores were -2.2, -0.5 and -0.3 respectively. At 6 years, following a recovery plan of cognitive behavioural therapy (CBT), weight gain, improved dietary intake and reduced training load, the athlete regained menstrual function and BMD. LS, TB and hip BMD Z-scores improved to -0.6, -0.1 and 0.1 respectively. Restoration of fertility was indicated by pregnancy, following only 4 months of regular menstruation. This case report suggests that bone density and fertility may not be completely jeopardised in formerly amenorrheic and osteopenic athletes, providing recovery through diet, weight gain, and return of menstruation is achieved within the third decade. Longitudinal studies tracking bone changes in women with amenorrhea and low BMD are required and would have important implications for the treatment of the female athlete triad.

Key words: Female athlete triad, runner, bone density, recovery.

Introduction

The female athlete triad of disordered eating, loss of menstrual function (amenorrhea) and low bone mineral density (BMD) is a major medical concern that presents most commonly in sports emphasising leanness as an attribute for success (ACSM, 1997; Cobb, et al., 2003; Drinkwater, et al., 1984; Hind, et al., 2006). Women runners with low BMD (Z-score <-1.0) are also more likely to suffer stress fractures, which can limit athletic performance and end athletic careers (ACSM, 1997; Cobb, et al., 2003; Hind, et al., 2006). It has been suggested that the decrease in bone mass in amenorrheic athletes may be permanent (Braam, et al., 2003; Keen and Drinkwater, 1997) and it is not yet clear whether the skeletal deficits can be reversed, due to a lack of longitudinal research. In addition, there is the potential risk for infertility arising from chronic amenorrhea or even less severe forms of menstrual dysfunction. This case study documents the recovery of BMD and fertility in a former, amenorrheic long distance runner, presenting with the female athlete triad.

Case report

At the time of her first appointment, the athlete was aged 21.7 years and 27.5 years at her most recent appointment. There was no family history of osteoporosis, use of corticosteroids, the oral contraceptive pill or hormone replacement therapy.

Descriptive data concerning the menstrual status, training load, dietary habits, and injury occurrence were recorded 3 times over a period of 6 years. Further analysis of the athlete’s training diary provided weekly running distance (averaged over 3 months, 3 occasions over 6 years).

BMD in the total body, lumbar spine (L2-L4) and total hip were measured by dual energy X-ray absorptiometry (Lunar Prodigy, GE Healthcare, UK). All scans were conducted by the same trained operator on the same machine. Coefficients of variation for lumbar spine and hip BMD are 0.6 % and 1.5 %. Machine calibration checks were carried out on a daily basis and its performance was followed with our quality control protocol, which showed no significant machine drift during the study. BMD measurements have been presented as Z-scores which are appropriate for assessing bone status in premenopausal women. Percent body fat was also assessed using DXA of the total body, on the same 3 occasions. Height was measured using a stadiometer (SECA, Birmingham, UK) and recorded to the nearest millimetre. Body weight was measured with calibrated electronic scales (SECA, Birmingham, UK) and recorded in kg to the nearest 0.1 kg. Body mass index (BMI) was calculated as body mass / (height) ^{2} ($kg \cdot m^{-2}$).

The recovery plan for the athlete as advised by a clinician included cognitive behavioural therapy (CBT) to encourage recognition and change, increased dietary intake, reduced training and weight gain. The recovery plan began in December 2000 with 20 weeks of CBT (one hour session per week). The athlete was also encouraged to improve dietary intake and gain weight, with guidance from a state registered dietician who was specialised in sports nutrition, and support from her coach and family.

At the age of 20 years, the athlete was medically diagnosed as having an eating disorder and this continued until the age of 23 years. Between 19 years and 24 years, the athlete competed at elite level over distances of 3000m to 10km, running at least 5 days per week, averaging 70 and 114 km. Between the years 2005 and 2007 training was reduced to 3 days per week, averaging 16-24 km.

The athlete presented with secondary amenorrhea (0-3 menstrual cycles per year) for 6 years between the ages of 18 and 25 years, then became oligoamenorrheic (4-9 cycles per year) aged 25-26 years. In September 2005, after 4 months of regular menses, the athlete became pregnant, breastfeeding for 4 months (June – September 2006). The athlete suffered a stress fracture of the

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Table 1. Changes in descriptives and bone mineral density in a woman endurance runner over 6 years.

	1 (2001)	2 (2003)	3 (2007)
Age (years)	21.7	23.6	27.5
Height (cm)	163.2	163.2	163.2
Body mass (kg)	44.3	48.7	54.7
BMI ($kg \cdot m^{-2}$)	16.7	18.3	20.5
Body Fat (%)	5.9	13.9	23.0
Weekly running distance ($km \cdot wk^{-1}$)	88.0	104.0	22.4
Lumbar spine (L2-L4) Z-score	-2.2	-2.1	-0.6 *
Total hip Z-score	-0.5	-0.6	-0.1 *
Total body Z-score	-0.3	-0.4	0.1 *

* $p < 0.05$.

left sacrum in September 2001 and a metatarsal (3rd metatarsal, right foot) stress fracture in 2003. Both were diagnosed by MRI.

Table 1 presents the results of the measurements over 6 years from 2001 to 2007 and the changes in Z-score at the lumbar spine are illustrated in Figures 1. Lumbar spine low BMD (Z-score <-1.0) was observed at age 21.7 years and this had improved to normal (Z-score >-1.0) by the age of 27.5 years. Lumbar spine BMD had increased by 18.4% since baseline (0.934 $g \cdot cm^{-2}$ to 1.104 $g \cdot cm^{-2}$). By the age of 27.5 years, total hip BMD had increased by 4.1% since baseline (0.945 $g \cdot cm^{-2}$ to 0.985 $g \cdot cm^{-2}$), despite a reduction of 1.6% in BMD at this site when the patient was 23.6 years. Total body BMD had increased by 7.9% since baseline (1.094 $g \cdot cm^{-2}$ to 1.187 $g \cdot cm^{-2}$).

Discussion

This case report illustrates the reversal of low BMD in a formerly amenorrheic endurance runner. Whilst presenting with a lumbar spine Z-score of -2.2 at baseline, the patient's BMD increased by 18.4% over 6 years to reach a normal Z-score of -0.6. The greatest increase was observed over the last 4 years if this time period (+16.2%). This BMD gain was concurrent with a medically diagnosed full recovery from disordered eating at age 23 years, a steady increase in body mass and in body fat, a reduction in training volume and frequency, and the resumption of menstruation.

The reversal of lumbar spine low BMD and the increase in bone density at the hip and total body appears to be attributed to the recovery from disordered eating, a reduction in training, an increase in body mass and of body fat to normal levels, and the resumption of regular menstruation, confirming reports elsewhere (ACSM, 1997; Braam, et al., 2003; Cobb, et al., 2007; Fredrickson and Kent, 2007; Keen and Drinkwater, 1997) and supporting established recommendations for the initial treatment of the female athlete triad (ACSM, 1997).

Although body mass and body fat increased between the ages of 21 and 23 years, BMD increases were only slight at the lumbar spine and total body (2.1% and 0.3% respectively) and BMD decreased by 1.6% at the hip. At this time, the athlete had increased training from 88 km to 114 km per week, had not regained menstruation, and had only just recovered from an eating disorder at the latter end of this period. Over the following 4 years, the athlete continued to increase body mass and body fat, markedly reduced weekly running volume to 22 km, regained menstruation, became pregnant and gave birth. The further gains in body mass and body fat would reflect

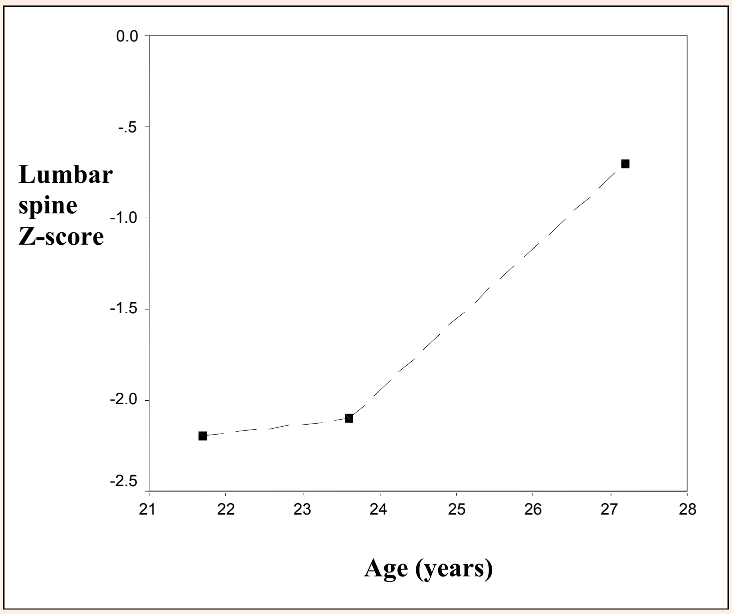

Figure 1. Changes in lumbar spine BMD Z-score over 6 years.

the increase in energy availability, accordingly with recovery from disordered eating and regained menstruation. Concurrently and regardless of 4 months lactation, BMD at the lumbar spine, total hip and total body had increased marginally, with lumbar spine BMD reverting from osteopenic to normal. Energy availability has been demonstrated to be pivotal in menstrual function and bone metabolism and may offer a potential mechanism (Ihle and Loucks, 2004; Zanker and Swaine, 1998).

In this case report, the athlete had never used any pharmaceutical intervention, yet substantial bone mass deficits were recovered to a normal level through weight gain, improved nutrition and a resumption of menses. The evidence for the efficacy of the oral contraceptive pill to improve bone mass is inconclusive (Cobb, et al., 2007; Gibson, et al., 2003), yet this is a commonly prescribed intervention. There is also an increasing trend for osteopenic, amenorrheic athletes to be prescribed post-menopausal bone drugs such as hormone replacement therapy and bisphosphonates despite the lack of long term research investigating the safety and efficacy of these drugs in this population. Treatment with bisphosphonates and other bone drugs maybe premature. This current and other case report evidence (Fredrickson and Kent, 2007) would suggest that recovery through improved nutrition and regain of normal menses, may take several years to unfold. In addition, it appears that CBT may be a useful technique to begin a recovery plan in athletes presenting with the female athlete triad, although cases may vary individually. It is important to note that the length of time for bone recovery in this athlete was longer than most longitudinal studies which have followed women recovering from the female athlete triad. Thus, reports concluding that the bone loss observed in formerly amenorrheic athletes is irreversible may have been premature.

In addition to recovery of bone mineral, another important detail was the ability of the athlete to become pregnant despite 6 years of amenorrhea, and following only 4 months of regular menstruation. The effects of previous amenorrhea on the future fertility of women athletes requires further work, but the results of this case suggest that reproductive system can successfully revert to fertility after years of dysfunction.

Conclusion

In conclusion, this case report indicates that peak bone mass accrual and fertility may not be completely jeopardised in formerly amenorrheic athletes, providing recovery through diet, weight gain, and return of menstruation is achieved in the third decade. The potential for CBT to change behaviour in these athletes in terms of diet, training and lifestyle, requires further research. There is a need for longitudinal studies tracking bone changes in women athletes with amenorrhea and osteopenia. It would be anticipated that such work would have important implications for the treatment of the female athlete triad.

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Key points

- Peak bone mass and fertility may not be completely jeopardised in women athletes providing recovery is attained in the third decade.
- Recovery from the Female Athlete Triad in this case involved weight gain, improved diet and a return of menstruation, and appeared to be encouraged by cognitive behavioural therapy (CBT).
- Further longitudinal studies are warranted to inform on prognosis and to aid in the identification of strategies for recovery from the Triad.

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