CASE REPORT

Nutritional Rickets in a Pediatric Athlete Presented With Left Wrist Pain: A Rare Occurrence

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ABSTRACT

The case report aims to describe nutritional rickets in a professional pediatric gymnast with wrist pain. This 13-year-old professional national gymnast presented with atraumatic left wrist pain. The X-ray showed metaphyseal plate tearing, indicating distal radial epiphysiolysis and subsequent testing revealed low 25-hydroxyvitamin D (42 nmol/L), high serum parathyroid hormone (7.37 pmol/L), normal calcium (2.24 mmol/L), elevated phosphate (1.37 mmol/L), and alkaline phosphatase (259 U/ She was diagnosis as nutritional rickets. MRI of the wrist showed metaphyseal plate fraying and epiphyseal growth plate increase. She received calcium and vitamin D supplements. After a month in a wrist brace, she gradually resumed training as her pain and range of motion improved. Vitamin D deficiency can cause unusual rickets presentation in a young athlete. Clinical, blood, and radiographic findings determine diagnosis. Medical management, graded rehabilitation, nutritional intervention, and sun exposure are the main treatments for this athlete.
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INTRODUCTION

Vitamin D promotes skeletal mineralisation, which is essential for normal calcification of the growth plate and mineralisation of osteoid on trabecular and cortical bone surfaces. Thus, vitamin D deficiency leads to the development of rickets. In Malaysia, research on 1361 adolescents age found that 78.9% had a vitamin D deficiency; 1.5% were severely deficient (1). This is a result of skin type (melanin), choice of clothing and sun-avoidant lifestyles among the Malaysian population (1). This case aim to report a case and outline its management for nutritional rickets in athletes, presented as acute wrist pain, in professional pediatric age group gymnasts.

CASE REPORT

A 13-year-old girl who has been a professional national gymnast for four years and has not yet attained menarche presented to the sports medicine clinic with left wrist pain for three weeks. The pain is located over the dorsoradial area and is associated with limited range of motion and worsens with wrist extension, pronation and supination, affecting her training and performance. There is no history of trauma or swelling in the wrist. The patient denies rheumatological symptoms such as joint swelling, stiffness, deformity, rashes, or mouth ulcers. Her training involves activities that require repetitive wrist movements. Her coach closely monitors her training and ensures she receives adequate rest for recovery. She denies feeling fatigue, experiencing chest pain, shortness of breath, palpitations, reduced performance, or having a history of stress fractures, which could suggest underlying relative energy deficiency syndrome (RED-S). She also denies having an obsession with food or calorie intake, body image disturbance, or an intense fear of gaining weight. Anthropometric assessments reveal a height of 152 cm, weight of 42 kg, body mass index of 18.2 kg/m2, skeletal muscle mass of 17 kg, and body fat percentage of 13.8%. X-ray of the wrist shows irregularity of the metaphysis (Figure 1). The patient was initially treated with distal radial epiphysiolysis and was prescribed a short course of NSAIDs, a below elbow back slab for two weeks with the range of motion

exercises, strengthening exercises for the wrist and grip, and pulsed electromagnetic field therapy. However, despite compliance with the treatment, there has been no improvement in her symptoms. Therefore, we proceeded with further investigations including blood tests and an MRI of her wrist. Blood tests revealed a low levels of 25-hydroxyvitamin D; 42 nmol (NR<75 nmol/L), elevated serum parathyroid hormone; 7.37 pmol/L (NR 1.58-6.03 pmol/L), normal calcium levels ; 2.24 mmol/L, elevated phosphate levels; 1.37 mmol/L, and elevated alkaline phosphatase; 259 U/L (NR 35-104 U/L). MRI of her wrist revealed fraying of the metaphyseal plate and an increase in the epiphyseal growth plate which confirmed a diagnosis of Salter-Harris Type 1 (Figure 2). Following discussions with the orthopaedic and endocrine teams, it is believed that this fracture is likely a manifestation of rickets due to her Vitamin D deficiency. Additional assessments by a nutritionist reveal inadequate protein and energy intake, as well as gaps in knowledge regarding nutrition. This is to prevent any further weight gain that would affect her skill performance. She underwent nutritional intervention, including calcium intake of 1000mg twice daily and weekly vitamin D supplements of D-cure 25,000 IU. She also had a period of relative rest from training. Her treatment plan focused on maintaining her cardiorespiratory fitness through treadmill and cycling exercises. The back slab was replaced with a thermoplastic splint, and wrist extension was limited for four weeks. Following this, her range of motion was gradually increased, and she was prescribed isometric strengthening exercises for grip, wrist flexion, extension, pronation, and supination. Additionally, she received physiotherapeutic modalities such as pulse electromagnetic waves and TECAR©. Once she achieved a full pain-free range of motion, isotonic strengthening exercises for the wrist and proprioception of the upper limb were introduced. The rehabilitation process lasted for three months, during which repeated blood tests showed an increased serum vitamin 25-hydroxyvitamin D level (63.1 nmol/L), normal serum parathyroid hormone (5.84 pmol/L), normal calcium level (2.19 mmol/L), elevated phosphate level (1.82 mmol/L) and alkaline phosphatase (294 U/L). The details of her rehabilitation journey are outlined in Tables I and Table II.

Table I: The patient's rehabilitation journey for return to sports (Physical fitness component)

FITNESS COMPONENT					
Phase	**Goal**	**Cardio-respiratory fitness**	**Range of motion**	**proprioception**	**strengthening**
1	Relative rest Promote bone healing Prevent disuse atrophy	Allow moderate to high intensity exercise	Prevent extension, pronosupination of wrist Allow other range of motion	Allow proprioception and balance exercise of lower limb	Hand grip strengthening exercise
2	Full pain free range of motion Reactivation of wrist strength	Allow moderate to high intensity exercise	Gradual range of motion exercise of wrist Proprioceptive Neuromuscular control Joint mobilization	Allow proprioception and balance exercise of lower limb	Isometric exercise of wrist flexion, extension, pronation, supination
3	Neuromuscular training of wrist Progression of wrist strengthening	Allow moderate to high intensity exercise	Maintain full pain free range of motion	Closed kinetic chain exercise Wall push up Floor push up Ball push up	Isotonic exercise of wrist flexion, extension, pronation, supination
PROGRESS TO SKILL COMPONENT					

Table II. The patient's rehabilitation journey for return to sports (skill component)

SKILL COMPONENT					
PHASE	**Vault**	**Uneven Bar**	**Balance Beam**	**Floor**	**Tumble Track**
1	Handstand hops and blocking drills on the floor	Hanging on bar 10 -60 s	Cat wheel and handstand	Push up with shoulder shrug	Round off
2	Handspring and Tsuk timer	Tap swing on bars	Front and back walkover	Push up position rock forward and backward	Back handsprings
3	Flipping handspring and Tsuk vaults	Glide and long hand kips	Standing back handspring on the line	Free standing handstand Cat wheel on the floor	Front handspring
4	Flipping Yurchenko vaults	Cast handstand and back giant	Round off and back handspring	Press to handstand Front and back walkover	Standing back handspring
5		Clear hip and stalders	One arm skills	Round off Pirouetting skills	
6		Front giants Pirouetting skills		Round off Back handspring	
7		Release skill Eagle giants		Standing back handspring	

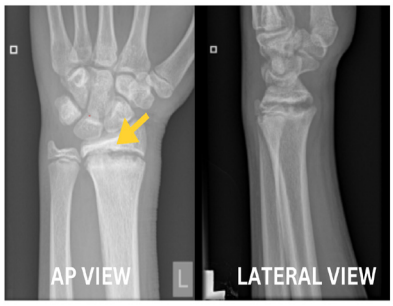

Figure 1: Xray of the wrist AP view (image on the left) showing fraying of the metaphyseal plate of distal radius (yellow arrow).

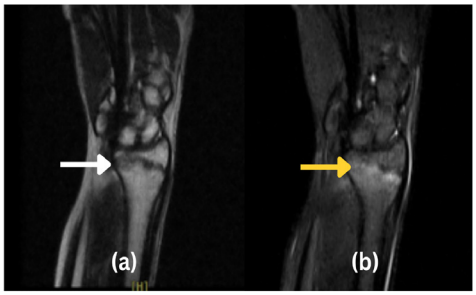

Figure 2: MRI of the left wrist. Image (a) is T1 weighted image showing fraying of fraying of the metaphyseal plate of distal radius (white arrow). Image (b) is T2 weighted image showing increase signal intensity at metaphyseal plate of distal radius indicating Salter Harris type 1 injury

DISCUSSION

Nutritional rickets are characterised by impaired chondrocyte development and osteoid mineralization, resulting from inadequate calcium intake and/or vitamin D insufficiency in children. This can lead to bone disorders such as stress fractures or growth plate injuries in growing athletes. In our case, it leads to Salter-Harris I metaphyseal plate injury. Vitamin D deficiency is prevalent among athletes (56%) as compared to age matched general population. Four theories to support the cause of vitamin D deficiency among athletes are (i) lack of sun exposure, (ii) dysregulation of liver and renal conversion of vitamin D, (iii) increased utilization of vitamin D, and (iv) problem with mobilization of vitamin D from its storage (2). Intense exercise, such as in athletes, increases the demand for vitamin D (2). A common presentation of rickets in the growing child were leg deformity, bony tenderness and bony pain. At the wrist, it can cause thickening of the wrist, and widening of the epiphysis (3). Diagnosis of nutritional rickets is made based on laboratory findings; raised alkaline phosphatase, raised parathyroid hormone, low serum calcium and phosphate and low vitamin D level . Imaging can be helpful in diagnosing rickets. The earliest sign in imaging is (i) appearance of radiolucent lines at the conjunction between epiphysis and metaphysis and (ii) widening of the epiphyseal plate (4). This is due to the accumulation of non-mineralized osteoid. However, these findings can be seen in gymnast wrist as well. To differentiate using imaging between gymnasts wrist (pseudoricket) and rickets, points towards the diagnosis of rickets includes rachitic changes (cupping, splaying and fraying), presence of osteopenia, and presence of rachitic rosary in chest imaging (4).

Treatment of nutritional ricket solely based on correcting normal vitamin D level. Vitamin D3 has superior bioavailability than vitamin D3/D2 (ergocalciferol therapy) (2). Current evidence recommend daily replacement dosing of Vitamin D3 2000 – 6000 IU daily (2). However, prolonged and disproportionate consumption can lead to vitamin D toxicity.

Specific rehabilitation for return to play in female gymnasts were outlined in this case. However, the rehabilitation process should be tailored based on the severity of injury, athletes' skills level and demands. Holistic approach should include multidisciplinary team, nutritionist, paediatric endocrinologist, physiotherapist and sports physician for optimum return to play. The most crucial one is to educate and involve parents and the coaches in her rehabilitation. Initial phase of rehabilitation focuses on the healing growth plate, while preventing contracture of the wrist. Ideally, wrist brace should be applied to allow gradual range of motion. However, risk of non-compliance is high. Thus, back slab or plaster of Paris application allows compliance and better chance of healing. Range of motion should be obtained gradually, aiming for full pain-free range of motion. To prevent disuse atrophy, hand grip strengthening exercise was prescribed. Once pain-free range of motion is obtained, strengthening exercises and skills rehabilitation is prescribed to retrain neuromuscular control. There are five main pillars; vault training, uneven bars, balance beam, floor, and tumble track (5). Each component is progressed gradually, ensuring athletes are pain-free or have minimal pain of less than two, 24 hours post-training (5). The athletes might progress to more challenging skills if the pain were minimal. The return to sports criteria guided by patients' symptoms, full pain-free range of motion, and pain free training at pre-competition level (5). Our athletes received strict follow up by nutritionist, and regular monitoring of vitamin D level.

CONCLUSION

Rickets should be considered in all athletes with gymnast's wrists. Bone profile examination includes serum calcium , vitamin D, serum phosphate, and serum parathyroid hormone should be considered. Treatment of rickets should be holistic in athletes, and main treatment solely involves correcting normal vitamin D levels through nutritional intervention. Gradual rehabilitation should be applied in gymnastics presented with a wrist injury, focusing on range of motion and skill training.

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