Decreased Bone Speed of Sound in Children with Growing Pains Measured by Quantitative Ultrasound

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ABSTRACT. ***Objective.*** The most common cause of recurring childhood musculoskeletal pain is termed growing pains (GP). We hypothesized that GP may represent a local overuse syndrome and therefore may be associated with decreased bone speed of sound (SOS) measured by quantitative ultrasound (US).

Methods. We studied 39 children with GP. Bone SOS was measured by US in both mid-tibial and radius bones according to a validated protocol. Unpaired Student t test was used to compare patients and norms of healthy controls.

Results. Tibial SOS was significantly reduced in children with GP compared to controls (Z score –0.546 for boys and –0.891 for girls; $p = 0.004$, $p < 0.001$, respectively). Radius SOS was significantly reduced only in girls with GP (Z score –0.692, $p = 0.006$). No correlation was found between bone SOS and various demographic and clinical factors besides the child's ethnicity and body mass index.

Conclusion. Bone SOS was significantly reduced in children with GP, especially in painful tibial regions. GP may represent a local overuse syndrome. (J Rheumatol 2005;32:1354–7)

Key Indexing Terms:
CHILDREN GROWING PAINS OSTEOPENIA QUANTITATIVE ULTRASOUND

The most common cause of recurrent childhood musculoskeletal pain is termed "growing pains" (GP)[1-7]. The etiology is unknown. We recently reported that children with GP have a decreased pain threshold compared to controls matched for age and sex[8]. However, we could not explain why GP primarily affect the lower extremities.

Recently, quantitative ultrasound (US) measurements of tibial speed of sound (SOS) were developed for the evaluation of bone strength[9]. Quantitative US measurements are correlated with dual-energy x-ray absorptiometry measurements in adults and children[10,11].

Since GP usually occurs late in the day and is often reported on days of increased activity, GP may represent a relative local overuse (stress) syndrome. We hypothesized that GP may be associated with decreased bone strength. Our objective was to determine bone SOS in children with GP and to compare findings with normal values in age and sex matched children.

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MATERIALS AND METHODS

Patients. Children with GP were recruited from pediatric rheumatology and child community health clinics. GP was confirmed by a pediatric rheumatologist based on typical clinical characteristics after exclusion of other causes for the pain[8]. The study was approved by the hospital's Helsinki Committee and informed consent was obtained from parents.

Clinical data collected included age, sex, ethnicity, weight, height, prior health status, and the clinical manifestations of GP.

Habitual physical activity questionnaire. Subjects categorized the level of their physical activity, as below average (no regular physical activity); average (regular participation in school sports); or above average (participation in sports after school or intense activity for more than 12 hours a week).

Calcium intake. A 24-hour dietary recall of calcium-enriched products was administered and validated by an experienced dietitian. Calcium intake was assessed as portions per week, calculated according to guideline of the Israeli Ministry of Health. The recommended calcium intake was based on recent dietary reference intakes[12].

Bone strength measurement. Bone SOS US was measured using a Sunlight Omnisense™ (Omnisense, Tel Aviv, Israel) according to a validated protocol. Measurement sites were the midpoint between the apex of the medial malleolus and the distal patellar apex, and the midpoint between the distal phalanx of forefinger and the olecranon; the probe searched for the site with maximal reading. The nondominant extremity was measured unless a previous fracture was reported in that extremity. Means of 3 measurements performed by the same physician (OF) were analyzed. Our measured coefficient of variance was 0.2–0.35, similar to the instrumental precision in the reference study for the tibia and fibula, 0.25–0.47[13]. Results were compared to normograms based on SOS values of 595 female and 490 male healthy children who were born in and lived throughout Israel[13]. The mean SOS Z-score was the actual SOS minus mean SOS for age/standard deviation.

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Statistical analysis. Student's t test was used to compare data of patients and the population norms. Pearson correlations, linear regression, and ANOVA tests were performed to evaluate the relationship and the contributions of GP duration, GP frequency, locality of pain, sex, ethnicity, body mass index (BMI), calcium dietary intake, and level of physical activity to the bone SOS.

RESULTS

Thirty-nine children with GP, 15 girls (mean age 8.5 ± 3.3 yrs, range 4–15) and 24 boys (mean age 7.9 ± 2.1 yrs), were studied (Table 1).

Tibia SOS was significantly reduced in both GP boys and girls, while radius SOS was significantly reduced only in girls (Table 2, Figure 1, Figure 2).

The tibia bone strength of 5 children (13%) was > 2 SD lower than control norms (Table 2)[14]. One child was of Arab Muslim and 4 of Jewish origin. Levels > 1 SD lower than norms were found in another 6 children (overall 28%). Four children had previous traumatic fractures in the forearm and leg (no correlation to bone strength). No significant correlations were found between bone SOS and sex, GP duration, GP frequency, location of pain, calcium intake, and level of physical activity.

The only factors found to significantly influence bone SOS were the ethnic origin and BMI of the child. Children of Arab/Druze origin had significantly increased SOS values compared to children of other ethnic groups ($p < 0.01$ and $p < 0.05$ for the radius and tibia, respectively). However, the SOS of both ethnic groups, when analyzed separately, was significantly lower than the population norms. Children with higher BMI percentiles had significantly increased SOS Z scores ($p < 0.01$).

Table 1. Clinical characteristics of patients with growing pains (GP, n = 39).

Ethnicity, n (%)	
Jewish	22 (57)
Arab Muslim	12 (30)
Druze	1 (3)
Other	4 (10)
BMI, kg/m^2, mean ± SD (range)	16.7 ± 2.4 (13.9–24.1)
BMI percentiles, n (%)	
< 85%	25 (64)
> 85%	8 (20)
No data	6 (16)
Location of pain, n (%)	
Legs	34 (87)
Arms	2 (5)
Both	3 (8)
Duration of GP, n (%)	
< 6 months	3 (8)
> 6 months, < 1 year	2 (5)
> 1 year, < 3 years	16 (41)
> 3 years	14 (36)
No data	4 (10)
Duration of GP, months, mean ± SD (range)	39.5 ± 28 (2–108)
Frequency of attacks, n (%)	
< 1/week	17 (44)
> 1/week, < 1/month	8 (20)
> 1/month	14 (36)
Use of acetaminophen, n (%)	
Yes	18 (46)
No	21 (54)
Physical activity, n (%)	
Above average	10 (26)
Average	19 (49)
Below average	8 (20)
No data	2 (5)
Calcium intake*, mg/day, mean ± SD	
Age 3–8 years	672 ± 230
Age 9–18 years	973 ± 627
Calcium intake, n (%)	
DRI or above	16 (41)
Below DRI	23 (59)

* Daily recommended intake (DRI): age 3–8 years, 800 mg/day; age 9–18 years, 1300 mg/day. BMI: body mass index, BMI cutoff for obesity: 85%.

DISCUSSION

This study is one of the first to investigate a possible pathogenesis of GP. We found that the bone density of some boys and girls with GP was significantly less than values for population norms of healthy children, especially in the painful tibia region. Most patients in this study participated in our previous study that showed low pain thresholds in children with GP[8]. GP may represent a local lower extremity overuse syndrome with bone fatigue in children with low pain thresholds. These children may experience more pain after physical activity.

We did not find an association in the literature between GP and an increased incidence of fractures. Therefore, it is difficult to determine the clinical significance of the decrease in bone strength. However, studies in adults indicate that a mild decrease in bone density is associated with medial tibia stress syndrome, even when not associated with fractures, increased scintigraphy uptake, or osteoporosis[15]. While relative overuse can help explain late-day pains, this theory cannot explain all features of GP such as the abrupt nocturnal episodes of pain or pain in the upper extremity in some patients.

Besides the ethnic origin and BMI we did not find factors associated with the decrease in bone strength. However, our measures of physical activity and calcium intake were limited, since they were based only on subjective questionnaires. Our population did not differ significantly from the BMI of the population from which the norms were derived[13]. Factors associated with possible ethnic differences were beyond the scope of this study.

We found that growth pain is associated with reduced bone speed of sound in some affected children, suggesting that reduced bone strength may be part of the pathogenesis of this syndrome. Further larger and genetically homogenous studies are required to determine whether these statistically significant findings have clinical implications.

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Table 2. Bone strength values of patients with growing pains compared to age and sex matched healthy population norms.

	Location	SOS m/s	No. of Patients > 2 SD of Normal	No. of Patients > 1 SD of Normal	Z Score	p
Boys	Tibia	3614 ± 69	2	1	–0.546	0.004
	Radius	3731 ± 110			–0.233	NS
Girls	Tibia	3573 ± 109	3	5	–0.891	< 0.001
	Radius	3697 ± 120			–0.692	0.006

SOS: speed of sound, NS: not significant.

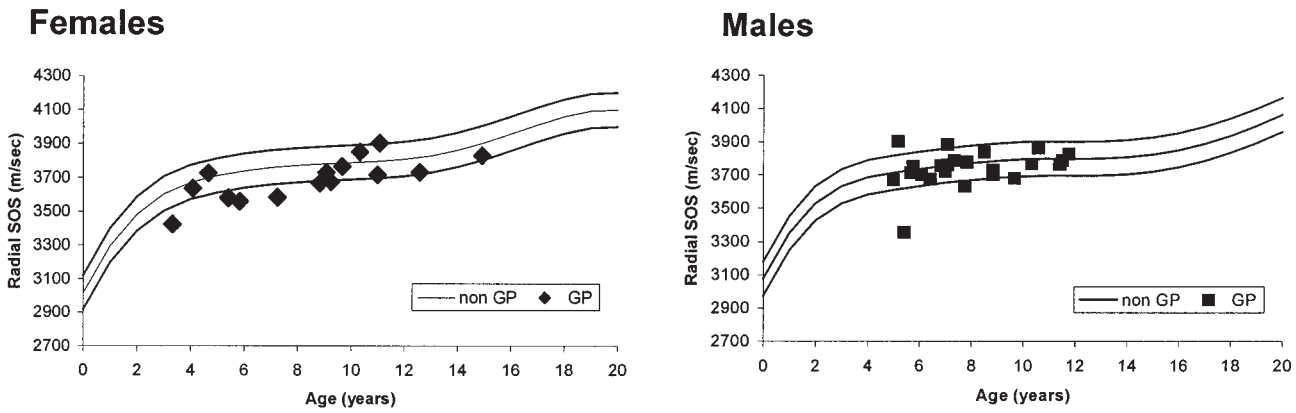

Figure 1. Tibia speed of sound (SOS) of growing pain (GP) in girls (left) and boys (right). Data are compared to age matched healthy population values (mean ± SD). Tibia SOS was significantly reduced in both boys and girls with GP.

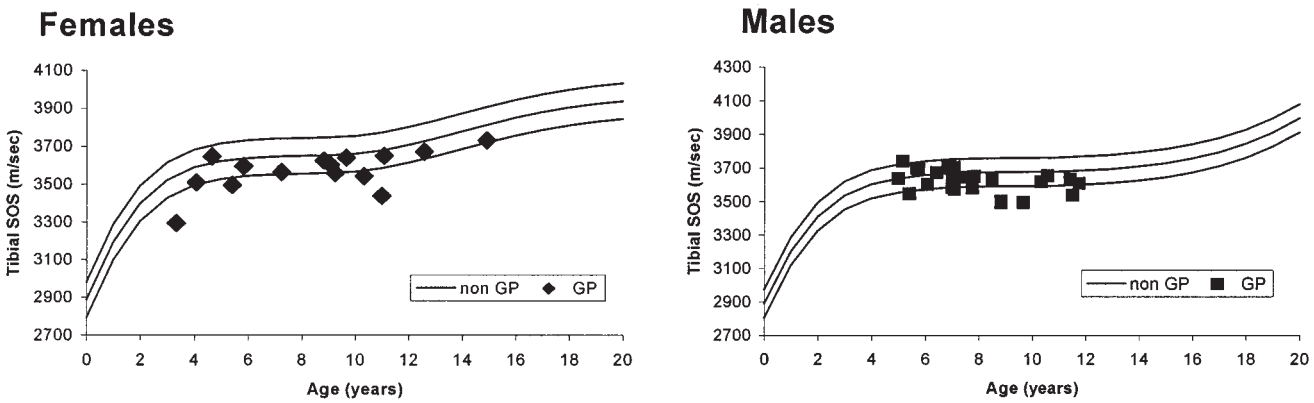

Figure 2. Radius speed of sound (SOS) of growing pain (GP) in girls (left) and boys (right). Data are compared to age matched healthy population values (mean ± SD) of control subjects. Radius SOS was significantly reduced only in girls with GP.

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