Evaluation of bone mineral density in chronic glue sniffers

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SUMMARY: Dündaröz MR, Sarıcı SÜ, Türkbay T, Baykal B, Kocaoğlu M, Aydın Hİ, Gökçay E. Evaluation of bone mineral density in chronic glue sniffers. Turk J Pediatr 2002; 44: 326-329.

Although acute and chronic toxic effects of inhalant (glue) abuse have been well demonstrated on many organ systems, the effects on the skeletal system and bone mineral content of young people with this addiction have, to our knowledge, not yet been investigated by bone mineral density measurement. In the present study bone mineral density was measured by the dual-energy X-ray absorptiometry method in 25 children and adolescents with inhalant abuse and compared with that of a control group (n=30) to detect whether there was any delay in bone development or any decrease in bone mass. Chronological age, height and weight, serum calcium, phosphorus and alkaline phosphatase levels of the study group were not significantly different from those of the control group ($p>0.05$), whereas bone mineral density was significantly reduced in the study group ($p=0.001$). Teenagers with glue vapor abuse may carry an increased risk of future fracture even though the exact mechanism(s) responsible for the toxicitiy of glue vapor on bone metabolism remains to be determined. To ascertain the exact component of glue responsible for bone demineralisation may be of value in proposing a change in the composition of the glue. Education and/or rehabilitation programs currently have the greatest importance in preventing and overcoming the harmful effects of this public health problem which is so common in young children and adolescents.

Key words: addiction, adolescent, bone mineral density, children, glue, inhalant abuse.

Inhalant abuse is one of the most common problems of young children and adolescents in developing countries. Desired effects with intentional inhalation of a volatile substance appear to be euphoria, tranquillity, relaxation and hallucination. Glue/adhesive sniffing is the most common form of volatile substance abuses since these substances are different from other drugs in that they are not sold illegally[1].

There are significant morbidity and mortality, both organic and psychosocial, associated with inhalant abuse. Both acute and chronic toxic effects in neuropsychiatric, urological, hematological, cardiovascular, pulmonary and gastrointestinal systems, including death due to cardiac arrhythmia or pulmonary and cerebral edema, encephalopathy syndromes, cerebral damage, optic atrophy, peripheral neuropathy, muscle weakness, gastrointestinal disturbances, or hepatic and renal damage well have been documented[2-4]. However, toxic effects of inhalant abuse on the skeletal system and bone mineral content of young people with this addiction have, to our knowledge, not yet been evaluated by bone mineral density (BMD) measurement although childhood and adolescence are critical periods of bone mineralization and skeletal development.

In the present study, BMD was measured by the dual-energy X-ray absorptiometry (DXA) method in children and adolescents with inhalant abuse and compared with that of a control group to detect whether there was any delay in bone development or any decrease in bone mass.

Material and Methods

This study was performed between September 2000-May 2001 at the Government's Education and Rehabilitation Center of Children in

Ankara, where inpatient and outpatient chemical dependency treatment and prevention programs are conducted. The study group consisted of 25 boys whose ages were between 13 to 19 years (mean 14.9±2.5 years). These cases had overcome the habit at least one month previously (range 1 to 3 months, mean 2.3 months), and the duration of abuse before rehabilitation was between 2 to 5 years (mean 3.2 years). All the cases were smokers, and none took any antioxidant drugs (vitamin C, vitamin E, selenium, etc.) prior to or during the study. The parents and authorities were informed about the study and informed consent was obtained from the cases and/or their parents.

Thirty healthy volunteer adolescents of similar age (mean 15.1±2.9 years) without any addiction were chosen as the control for each case in the study and control groups, brief history was taken, and a complete physical examination was performed. Blood samples for complete blood count, serum calcium, phosphorus and alkaline phosphatase (ALP), and renal and liver function tests were obtained, and a urinalysis was performed. Cases with any signs or symptoms of any acute or chronic illness were excluded from the study.

Body weight and height measurements of the cases in the study were taken carefully by the same experienced personnel. BMD was measured by DXA method[5,6] at L2-L4 levels of lumbar vertebrae using the DXA Norland (Fort Atkinson, WI, USA) XR-36 densitometer. Spinal BMD was measured in supine position; the scan time ranged between 3 to 5 minutes, and results for spinal BMD measurements were expressed in g/cm^2.

Mann-Whitney U test was used in statistical analysis of the data.

Results

Chronological age, anthropometric measurements, serum calcium, phosphorus and ALP levels, and BMD measurements of the study and control groups are shown in Table I. Chronological age, height and weight, serum calcium, phosphorus and ALP levels of the study group were not significantly different from those of the control group ($p>0.05$), whereas BMD was significantly reduced in the study group ($p=0.001$) (Table I).

Discussion

The effects and toxicity of various components of volatile substances on skeletal development and mineralization have been investigated in only a few studies, most of which have been performed on animals. Subchronic toluene exposure caused inhibition of skeletal growth (torso length, rump width) in weanling male rats which became relatively shorter in length and narrower in girth as they grew, compared to controls[7]. In mouse embryos and fetuses maternal exposure to toluene during pregnancy was associated with a higher incidence of the presence of 14 ribs, suggesting the teratogenic toxicity of toluene on the skeletal system[8]. In two other studies, delayed ossification of sternebrae after inhalation of benzene in rats[9] and skeletal variations due to oral or inhalational benzene exposure in mice and rabbits[10] were reported. In a study conducted at a forensic medical institute, where bone age measurement is routinely performed in determination of the identities of prosecuted glue vapor abusers, a significant bone age retardation has been demonstrated in this population when compared to healthy controls[11]. The present study is the first one

Table I. Comparison of the Data Obtained in the Study and Control Groups*

	Study group (n=25)	Control group (n=30)	p value
Chronologial age (years)	14.9±2.5	15.1±2.9	p>0.05
Height (cm)	162.3±11.2	165.1±10.8	p>0.05
Weight (kg)	53.3±8.9	54.7±9.4	p>0.05
Serum calcium (mg/dl)	9.41±0.7	9.35±0.5	p>0.05
Serum phosporus (mg/dl)	5.23±0.5	5.19±0.9	p>0.05
Alkaline phosphatase (mU/ml)	251±25	249±21	p>0.05
Bone mineral density (g/cm^2)	0.7065±0.116	0.8755±0.182	p=0.001

* Values are given as mean ± SD.

investigating the bone mineral content by DXA method and reporting a significantly reduced BMD in adolescents who chronically abused glue vapor. DXA is a new method that permits BMD to be measured accurately and directly. Lumbar spinal BMD measurements are preferred in this method. The spine is formed mainly of trabecular bone, which has higher surface-to-volume ratio and is more active metabolically than other regions of the skeleton. Because of the greater rapidity of bone turnover in the trabecular compartment than in the cortical one, the spine is thought to be a more sensitive site than the long bones of the upper and lower extremities for evaluating the effects of various stimuli on bone mineral status of the body[5,6,12].

Bone mineral content is influenced by genetic, hormonal and exogenous factors such as physical activity, diet, certain medications, and exposure to sunlight. Cases in both the study and control groups in our study had relatively the same degree of physical activity and were living in the same region, being exposed to relatively the same amount of sunlight, although we could not determine the objective degrees and/or amounts of these two parameters. Moreover, anthropometric measurements and serum calcium, phosphorus and ALP, which indirectly reflect growth, development and nutritional status, were not significantly different between the study and control groups in this study.

The other factors which might possibly affect bone mineralization in this study were alcohol consumption and smoking. However, there are some controversies about the effects of these habits on bone mineral density values. A detrimental effect of chronic alcohol abuse on the skeleton has been shown in two studies[13,14]. whereas two other studies[15,16] have suggested a beneficial effect of light-to-moderate alcohol consumption, and some other studies[17-19] have demonstrated no significant effects. Regarding smoking, some negative effects on the skeletal system have been reported[15,17], wehereas two other studies[18,19] found no obvious effects on bone mineralization. Most of the cases in our study group were smokers and consumed alcohol although we could not quantify amounts. Thus, to demonstrate the exclusive effects of glue sniffing on bone mineralization, it would certainly be more appropriate, if possible, to compare our study group with a control group consisting of cases who merely smoked and consumed alcohol but did not abuse any volatile substances.

Results of the present study indicate that teenagers with glue vapor abuse may be at risk for developing ostoopenia, possibly due to the toxic effects of glue vapor on the skeletal system. BMD peaks by the age of 20, makes a long plateau, and decreases after the age of 40. A lower peak bone mass in adolescence has been suggested to be associated with a greater risk of osteoporosis and fracture in the future[20,21]. Teenagers with glue vapor abuse, therefore, may carry an increased risk of future fracture even though the exact mechanism(s) responsible for the toxicity of glue vapor on bone metabolism remains to be determined. Commercially available glue products generally contain toluene, benzene, xylene, trichloroethylene, tetrachloroethylene, methylene chloride, trichlorethane, carbon tetrachloride, acetone, naphtha, and n-hexane. To determine the exact component of glue responsible for bone demineralisation may be of value in proposing a change in the composition of the glue. Education and/or rehabilitation programs currently have the greatest importance in preventing and overcoming the harmful effects of this public health problem which is so common in young children and adolescents.

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