REVIEW ARTICLE

Methylphenidate and growth in ADHD children

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Abstract

Attention deficit hyperactivity disorder (ADHD) is a group of developmental disorder characterized by developmentally-inappropriate levels of over activity, inattention and impulsivity. The most common treatment of ADHD is medication with stimulants, by specific methylphenidate which has been shown to improve attention and behavior. The treatment by stimulants may be accompanied by side effects from among decrease of appetite or changes in body development as growth suppression and loss of weight. Many studies describe growth or weight changes only associated with medical treatment of children ADHD. However changes in development and growth can also appear independently on medication. The authors of this paper review the relation of methylphenidate and growth in ADHD children in the current scientific literature.

Introduction

Attention-Deficit Hyperactivity Disorder ADHD is one of the most common disorders among school-aged children, with a prevalence of 3–7% in the general population (Paclt 2008). It is a group of disorders characterized by developmentally inappropriate inattention, concentration, excessive activity and impulsivity. These symptoms appear early in a child's life, some of them persist to the adult age.

ADHD is a complex disorder influenced by genetic and environmental factors, characterized by various symptomatology, etiology and heterogeneous development (Barkley *et al* 1999; Barkley & Macias 2005; Foltinova *et al* 2007, 2010; Geier *et al* 2008; Matejcek 2003; Paclt 2008). Genetic researches of candidate genes (DRD4, DAT, DRD5, DBH, 5HTT, HTR1B and SNAP25) brought consistent results, confirming the heredity of ADHD syndrome (Crawford & Salmon 2002; Drtilkova *et al* 2008; Kopeckova *et al* 2006, 2008; Paclt *et al* 2009, 2010; Sery *et al* 2006).

Biochemical (Bulut *et al* 2007; Paclt *et al* 2005, 2006), endocrinological, neurological (Cormier 2008; Schubiner & Katragadda 2008; Kariyawasam *et al* 2002) and even neuroanatomical changes (Garrett *et al* 2008; Uhlikova *et al* 2007) often appear in children with ADHD. Specific changes in brain development of ADHD children may be caused by the disorder itself, or it can be caused by other non-related factors. In this connection and according to current studies, children with ADHD show probable changes in growth and development (Lam & Yang 2007; Ptacek *et al* 2008, 2009a, 2009b; Waring & Lapane 2008).

Literature on growth in ADHD children is sparse and historically has focused mainly on the potential for growth suppression associated with the use of stimulant medication (Zachor *et al* 2006).

The most common treatment of ADHD is psychosocial treatment (behavioral or cognitive-behavioral treatment), stimulant treatment (mostly methylphenidate) and their combination, which seems to be the most effective (Jensen 2009). However single use

of stimulants is the most frequent treatment method in common clinical practice (Barkley & Macias 2005; Poulton 2005). Positive effects of methylphenidate are supported by numerous studies (e.g. Poulton 2005; Poulton & Nanan 2008) and the improvement appears to influence most of the core symptoms (Paclt 2008, Poulton & Nanan 2008). Although positive effects are well documented the treatment by stimulants may be also accompanied by different side effects – i.e. decrease of appetite (Kramer *et al* 2000; Paclt *et al* 2005; Poulton & Nanan 2008, McAfee *et al* 2008), insomnia, irritability, sadness (Prihodova & Nevsimalova 2006) and also serious neurological problems (Altafas 2002; Barkley *et al* 1999; Barkley & Macias 2005; Lam & Yang 2007). It was also reported that long period use of stimulants can seriously influence growth (Setoodeh & Teleffson 2007). In this context, most of the available studies confirmed high initiatory growth deficit after beginning of the treatment (Poulton & Nanan 2008).

Early and recent studies reported that methylphenidate may influence decrease of growth hormone secretion (Paclt 2008), but due to the fast metabolic elimination, the influence may not be considered as significant. These conclusions have not been definitely confirmed yet because not many longitudinal studies were done to describe properly this problematic.

Growth changes in methylphenidate treated children

It is known that methylphenidate may cause short time growth retardation and weight loss. Although many studies have been done, the methodology and observed variables are very heterogeneous and inconsistent. The studies do not lead to definite conclusions. They found that the treatment with methylphenidate in childhood may reduce expected height and weight. Although these effects attenuate over time, ultimate adult growth parameters are according to current opinions probably not affected. In correspondence to findings in following studies, changes of height are approximately 1cm/year less than norms (Poulton 2005).

Tab. 1 reviews effect of methylphenidate on growth and weight. The results of the compared studies show that the treatment with methylphenidate in childhood may cause growth suppression. However the results do not lead to definite conclusions.

Tab. 1. Comparison of the studies – medication.

Study	Dose of methylphenidate (mg/day)	Growth/Values of Body Height	Weight
Safer *et al* 1972	±20	growth suppression	weight loss
Millichap & Millichap 1975	10-20	NSD	NSD
Kalachnik *et al* 1982	18.4	NSD	NSD
Klein *et al* 1988	< 60	NSD	NSD
Vincent *et al* 1990	NS	NSD	
Schertz *et al* 1996	NS	NSD	weight loss
Swanson *et al* 1998	14.2	growth suppression	NSD
Spencer *et al* 1998	19.8	growth suppression	NSD
Sund & Zeiner 2002	23.9	NSD	NSD
Biederman *et al* 2003	NS	NSD	NSD
Lisska & Rivkees 2003	10-80	growth suppression	NSD
Poulton & Cowell 2003	27 mg	growth suppression	NSD
MTA cooperative group 2004	34.4	growth suppression	NSD
Zhang *et al* 2005	27-64	growth suppression	NSD
Charach *et al* 2006	NS	NSD	weight loss
Zachor *et al* 2006	NS	NSD	weight loss
Pliszka *et al* 2006	NS	NSD	NSD
Faraone & Giefer 2007	NS	NSD	NSD
Swanson *et al* 2006	NS	growth suppression	weight loss
Ptacek *et al* 2008		NSD	NSD

NSD - **no significant differences**: the study showed no effect of the treatment on growth parameters; **weight loss**: the study showed statistically significant weight loss after medication; **growth suppression**: the study showed statistically significant growth suppression in medicated children; **NS**: nonspecified or not available.

According to other studies, children with ADHD show some changes in statue, growth and development independently on medication (Ptacek *et al* 2009a). It is possible that there are specific and in some cases significant differences in development and statue, especially height and weight, in children with ADHD but these characteristics may be more typical for the disorder than for the treatment as ***Tab. 2*** shows.

Differences have been found especially in weight and body mass index (BMI). According to studies compared in **Tab. 2**, non-medicated children with ADHD have higher BMI than norms. However the studies usually analyzed only BMI despite the fact that this is not very informative parameter in children. Connections between weight loss or growth suppression are not so clear and can not be explained only as a result of treatment. Some authors point on changes in eating behavior, such as binge eating on impulsive eating (Davis *et al* 2008; Strimas *et al* 2008). Treatment in children is also commonly associated with loss of weight that may be connected to the decrease of appetite (Paclt 2008) or decrease of impulsivity in eating. It means that the weight loss does not have to be direct result of a lower energy intake but also improvement of behavior.

Eating behavior may be some of the most important factors which cause weight changes in ADHD children. However none of the studies brought significant results or clearer insight into the question yet. So further studies with a complex design and proper psychiatric and anthropometric methodology are needed.

Conclusion and discussion

ADHD is a group of disorders which intervenes into almost every part of child's life and for that reason interdisciplinary approach is necessary. In ADHD children can appear not only psychical changes but also changes in body growth and development. These changes are mainly reported to using stimulants. According to studies medication causes growth suppression and weight loss due to decreasing of appetite as one of side effects of using stimulants. However present studies show that these changes are independent on medication. Reasons and the seriousness of these changes remain unclear.

It is very difficult to make conclusions because not many studies on changes in non medicated children have been done and their methodic is very heterogeneous. However it is clear that methylphenidate do not have such a serious effect on growth as it has been reported many times.

Further studies should include both medicated and non medicated children and compare them with population norms. Except of complex anthropometrical measurement they should include also important factor as socioeconomic status, feeding customs (Schubiner & Katragadda 2008). For further research is essential to include mentioned factors and to monitor possible long-term growth changes.

Tab. 2. Comparison of the studies measuring body mass index (BMI) independently on medication.

Study	value of body mass index (in comparison to norms)
McGee *et al* 1985	lower
Holtkamp *et al* 2004	higher
Altafas 2002	higher
Mustillo *et al* 2003	not significantly higher
Curtin *et al* 2005	not significantly higher
Lam & Yang 2007	no significantly higher
Waring *et al* 2008	higher
Hubel *et al* 2006	higher
Ptacek *et al* 2008	higher

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