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Original scientific paper

Calculating Lumbar Puncture Depth in Children

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A B S T R A C T

Lumbar puncture was performed in 195 children and the depth of needle was recorded. Our results show that the depth of lumbar puncture necessary to obtain uncontaminated cerebrospinal fluid correlates best with the child's weight. The simple formula: mean depth of insertion (cm) = 1.3 + 0.07 x *body weight (kg), can be used to estimate the depth of lumbar puncture of children older than 3 months. The depths of lumbar puncture of children younger than 3 months are mostly 1.0–1.5 cm.*

Key words: *anthropometrics, lumbar puncture, depth, children*

Introduction

It has been shown that anthropometric investigations in large groups of children can provide a multitude of valuable data on standard measurements and expected variation that are helpful to clinicians in their clinical practice[1–4]. Lumbar puncture is the technique learned by the student first through observation then performance under supervision by a physician who has mastered the technique. It is a difficult medical procedure, because success is not only dependant on the skill of the physician but also the size, anatomy and comfort of the patient[5]. Less experienced practitioner may cause traumatic or bloody lumbar puncture. Bloody cerebrospinal fluid (CSF) reduces the diagnostic value of the procedure and may worsen the outcome of patients[6]. The knowledge of how far the needle should be inserted may reduce unsuccessful attempts and potential complications.

The aim of this study was to provide a practical guide that would help estimate correct depth of insertion using child's age, height, weight and body surface area.

Patients and Methods

Lumbar puncture was performed during a routine evaluation of an acute or

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chronic illness at the Departments of Pediatrics and Neurology of the University Hospital Center in Zagreb, Croatia. Of 195 studied patients, 15 were less than 1 month of age, 21 were 1 to 3 months, 49 were 4 to 12 months, 38 were 13 to 24 months, 32 were 2 to 6 years, and 40 were older than 6 years (age range 1 day to 19 years).

Lumbar puncture was performed by positioning the child in the right lateral decubitus position, maximally flexed at the waist and neck. The spinal needle was inserted in the L–4 to L–5 vertebral interspace. When CSF was obtained, the needle was marked at the skin before being removed and the depth to which needle had been inserted was measured. For each patient the authors recorded age, weight, height, body-surface area and depth of needle insertion. Patients were excluded from the study if there were macroscopic traces of blood in the CSF.

Results

The experimental data were fitted in the least-squares sense by the polynomials of the second-degree (quadratic function) and the first-degree (straight line). If $\{x_i\}$ denotes the input variable (age, height, body surface area or body mass), $\{y_i\}$ denotes the corresponding set of the lumbar puncture depth and

$$p(x;c_0,\ldots,c_N) = \sum_{n=0}^{N} c_n x^n \qquad (1)$$

is a polynomial of degree N with the coefficients $\{c_n\}$, then the least-squares criterion can be written as

$$E(c_0,\ldots,c_N) = \sum_{i=1}^{I} \left[y_i - p(x_i; c_0 \ldots\ldots c_N) \right]^2 \qquad (2)$$

where we wish to minimize the function $E(c_0,\ldots,c_N)$[7]. The polynomial regression is performed in MATLAB® software package by using the function POLYFIT[8] (Figure 1).

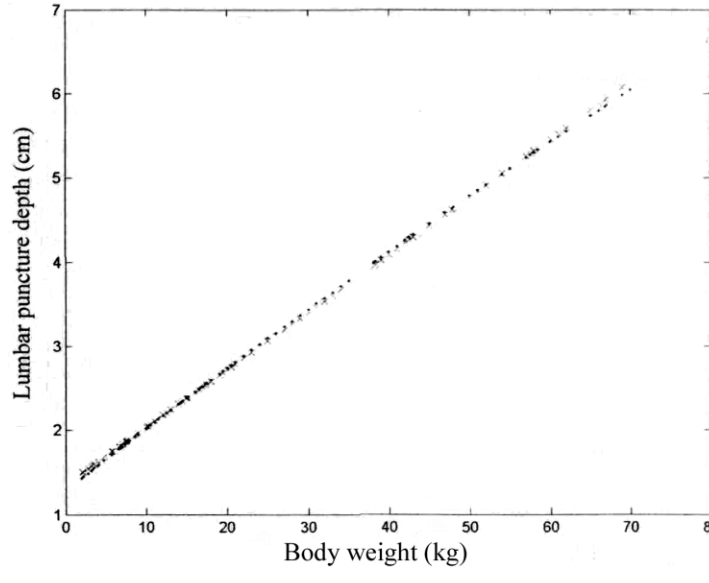

Fig. 1. Relation of the depth of lumbar puncture to body weight as the second degree and the first degree polynomial.

Depth of needle insertion ranged from 0.8–7.4 cm and correlated best with body weight. Linear regression performed for body weight revealed the following relation:

Depth of insertion (cm) =
1.3 + 0.07 x body weight (kg).

Discussion

Our results showed that the depth of lumbar puncture necessary to obtain uncontaminated CSF correlates best with child's weight. The simple formula (1.3 + 0.07 x body weight (kg)) that we devised can now be used to estimate the depth of lumbar puncture of children older than 3 months. The depth of lumbar puncture in children younger than 3 months is mostly 1.0–1.5 cm. Previous studies have produced formulas for calculating the depth of needle insertion required based on surface area[9], or height of children[10]. The disadvantage of these studies is the fact that height is more difficult to measure than weight in a child, especially when the child is critically ill. The height measurement could also be quite imprecise in infants. About 75% of children involved in those studies were infants, while in our study age range was wider, including proportional share of infants, but the older children were also included. The age of patients ranged evenly from newborns to teenage children (19 years).

Traumatic lumbar puncture could result from several misguided maneuvers, like insertion of the needle too deeply. In such cases, contamination with blood may impair accurate analysis and occurrence of post-dural puncture haedache[11]. Failure to obtain CSF when needle is inserted further than indicated suggests that it is offline. In that case, a needle should be withdrawn and second attempt made, with attention to correct needle orientation and proper positioning of the patient.

Lumbar puncture is a commonly performed procedure that can be difficult to perform on children. We hope that using formula produced by this study might increase the chance of successful lumbar puncture.

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REFERENCES

1. KATIĆ, R., Coll. Antropol., 27 (2003) 351. — 2. ŽIVIČNJAK, M., N. SMOLEJ NARANČIĆ, L. SZIROVICZA, D. FRANKE, J. HRENOVIĆ, V. BIŠOF, Coll. Antropol., 27 (2003) 321. — 3. KUVEDŽIĆ, H., A. TUCAK, N. PERIĆ, D. PRLIĆ, I. ZORIĆ, R. GALIĆ, Coll. Antropol., 27 Suppl. 1 (2003) 71. — 4. PROKOPEC, M., Coll. Antropol., 27 Suppl. 1 (2003) 1. — 5. ROOS, K. L., Semin. Neurol., 23 (2003) 105. — 6. HOWARD, S. C., A. J. GAJJAR, C. CHENG, S. B. KRITCHEVSKY, G. W. SOMES, G. K. RIVERA, J. E. RUBNITZ, J. T. SANDLUND, A. J. DE ARMENDI, C. H. PUI, JAMA, 288 (2002) 2001. — 7. POLLARD, J. H.: A handbook of numerical and statistical techniques. (Cambridge University Press, Cambridge, 1979). — 8. PALM, W. J.: Introduction to MATLAB® for engineers. (WCB/McGraw-Hill, Boston, 1998). — 9. BONADIO, W. A., D. S. SMITH, M. METROU, B. DEWITZ, N. Engl. J. Med., 319 (1988) 952. — 10. CRAIG, F., J. STROOBANT, A. WINROW, H. DAVIES, Arch. Dis. Child., 77 (1997) 450. — 11. JANSSENS, E., P. AERSSENS, P. ALLIET, P. GILLIS, M. RAES, Eur. J. Pediatr., 162 (2003) 117.

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IZRAČUNAVANJE DUBINE LUMBALNE PUNKCIJE U DJECE

S A Ž E T A K

Lumbalna punkcija učinjena je u 195 djece pri čemu je zabilježena dubina uvedene igle. Rezultati su pokazali da dubina lumbalne punkcije potrebna za dobivanje nekontaminirane cerebrospinalne tekućine najbolje korelira s težinom djeteta. Za izračunavanje potrebne dubine lumbalne punkcije u djece starije od 3 mjeseca može se koristiti jednostavna formula koju smo razvili temeljem vlastitih rezultata: prosječna dubina (cm) = 1,3 + 0,07 x tjelesna težina (kg). Potrebna dubina lumbalne punkcije u djece mlađe od 3 mjeseca je najčešće 1,0–1,5 cm.