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Active self correction of child's posture assessed with plurimeter and documented with digital photography

Aktywna korekcja postawy ciała dziecka oceniona za pomocą plurimetru Rippstein'a i udokumentowana za pomocą fotografii cyfrowej

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S u m m a r y

Introduction. Body posture is the position in which a person holds the body upright in a spontaneous standing position. It is externally manifested by the mutual spatial alignment of body parts and by the person's figure. The posture may be spontaneous, so-called habitual, or actively corrected by the child, referred to in the literature as "actively corrected". The aim of the study was to evaluate the manner of posture correction by school children instructed with the "stand straight" command.

Material and methods. 126 primary school pupils, 60 girls and 66 boys, aged 7.0 to 13.0 years (9.1 ± 1.6), were examined in standing position twice: in a relaxed posture and in actively corrected posture (after the "straight the back" command). Children were not instructed what corrected posture means. Sagittal clinical angles: C7-T12 (total thoracic kyphosis, TTK), C7-T6 (proximal thoracic kyphosis, PTK), T6-T12 (distal thoracic kyphosis, DTK), T12-S1 (lumbar lordosis, LL) and sacral inclination (SI) were measured with Rippstein plurimeter. The study included also a photographic documentation of the body to show visual changes of the movement. Significance of difference of the means was checked with paired t-test.

Results. The TTK, PTK, DTK, LL and SI angles in relaxed versus corrected posture were as follows: 38.7° ± 9.0° versus 27.6° ± 10.5° (difference significant), 32.4° ± 5.3° versus 29.3° ± 6.8° (difference significant), 6.6° ± 7.8° versus -2.3° ± 8.2° (difference significant), 34.8° ± 8.0° versus 33.6° ± 8.3° (not significant) and 23.5° ± 5.9° versus 25.8° ± 5.5° (difference significant), respectively.

Conclusions. Plurimeter measurement and digital photography documentation allowed for a qualitative and quantitative assessment of children's posture and its changes following a verbal stimulus. Children reacted to the "stand straight" command by changing their posture, which meant creating a pathological lordosis in the lower thoracic spine. The "stand straight" command given to children in order to correct their posture should be preceded by appropriate instructions in order to avoid improper correction patterns.

Key words: active self correction, child's posture, Rippstein plurimeter, digital photography

S t r e s z c z e n i e

Wstęp. Postawa ciała jest pozycją, w której dana osoba przebywa w wyprostowanej spontanicznej pozycji stojącej. Objawia się poprzez przestrzenne usytuowanie wzajemnych części ciała w jego budowie. Postawa ciała może być spontaniczna, tzw. swobodna lub czynnie skorygowana przez dziecko, o którym mowa w literaturze jako „aktywnie skorygowana". Celem pracy była ocena sposobu wykonania ruchu czynnej korekcji postawy przez uczniów po komendzie „wyprostuj się".

Materiał i metody. 126 uczniów szkół podstawowych, 60 dziewcząt i 66 chłopców w wieku od 7,0 do 13,0 lat (9,1 ± 1,6), badano w pozycji stojącej dwa razy: w postawie swobodnej i aktywnie skorygowanej (po komendzie „wyprostuj się"). Dzieci nie były instruowane, co oznacza prawidłowa postawa skorygowana. Kąty kliniczne w płaszczyźnie strzałkowej: C7-T12 (globalnej kifozy piersiowej, TTK), C7-T6 (górnej kifozy piersiowej, PTK), T6-T12 (dolnej kifozy piersiowej, DTK), T12-S1 (lordozy lędźwiowej, LL) i nachylenia kości krzyżowej (SI) zmierzono Plurimetrem Rippsteina. Badania składały się również z dokumentacji fotograficznej postawy ciała, aby w sposób wizualny pokazać wpływ ruchu na postawę. Zmienność statystyczną różnic sprawdzono za pomocą sparowanego testu t-Studenta.

Wyniki. Kąty TTK, PTK, DTK, LL i SI odpowiednio w postawie swobodnej w porównaniu z czynnie skorygowaną były następujące: 38,7° ± 9,0° w porównaniu do 27,6° ± 10,5° (różnica istotna), 32,4° ± 5,3° w porównaniu do 29,3° ± 6,8° (różnica istotna), 6,6° ± 7,8° w porównaniu do -2,3° ± 8,2° (różnica istotna), 34,8° ± 8,0° w porównaniu do 33,6° ± 8,3° (różnica nie istotna) i 23,5° ± 5,9° w porównaniu do 25,8° ± 5,5° (różnica istotna).

Wnioski. Pomiar plurimetrem i dokumentacja za pomocą fotografii cyfrowej pozwoliła na jakościową i ilościową ocenę postawy ciała i jej zmianę po bodźcu słownym. Dzieci zareagowały na komendę „wyprostuj się" poprzez zmianę ich postawy, wytwarzając patologiczną lordozę w dolnym odcinku kręgosłupa piersiowego. Polecenie „wyprostuj się" wydawane dzieciom w celu skorygowania ich postawy powinno być poprzedzone odpowiednim instruktarzem wykonania prawidłowej czynnej korekcji, aby uniknąć nieprawidłowych wzorców ruchowych.

Słowa kluczowe: czynna korekcja postawy, postawa ciała dziecka, plurimetr Rippsteina, fotografia cyfrowa

INTRODUCTION

Body posture is the position in which a person holds the body upright in a spontaneous standing position. It is externally manifested by the mutual spatial alignment of body parts and by the person's figure (1). The posture may be spontaneous, so-called habitual, or actively corrected by the child, referred to in the literature as "actively corrected" (2). Even though body posture has been evaluated for a long time, there is no standardised definition of what the correct posture is and what is not (3), which may be due to the considerable variability of posture in time (1, 4). It seems justified to introduce normative values for the examined posture parameters for the given age groups.

One of the elements which are key for increasing the effectiveness of corrective actions is developing the ability to assume and then maintain a properly corrected posture throughout daily activities (5). Posture correction may be enforced by giving a relevant command. Most frequently used commands, both in the therapeutic context (corrective gymnastics, physical therapy, medical instructions) and in everyday situations, include "stand straight", "straighten your back", "keep it straight".

AIM OF THE STUDY

The aim of the study was to evaluate the manner of posture correction by schoolchildren instructed with the "stand straight" command.

MATERIAL AND METHODS

The study covered a group of 126 primary school pupils (66 girls and 60 boys) aged 7.0 to 13.0 years (9.1 ± 1.6), grade 1 to 6. Children were not previously instructed on how to properly perform the posture correction movement. The examination included the measurement of upper and lower spine curvatures (thoracic kyphosis and lumbar lordosis) using Rippstein plurimeter (6) and a photographic record of the figure (7). A digital camera, CANON Power Shot A590 IS 8.0 Mega pixels, was used for the study. The children's parents signed their consent for study participation and for the figure of their child to be documented by means of photography. The Bioethical Committee of the Poznan University of Medical Sciences granted its permission for the study.

A non-toxic skin marker was used to mark orientation points identifying spinous processes of the seventh cervical vertebra (C7), sixth thoracic vertebra (Th6), twelfth thoracic vertebra (Th12) and first sacral vertebra (S1). The angular parameters of spine curvatures in the saggital plane were assessed using the Rippstein plurimeter, following the methodology suggested by Gerhardt et al. (6). The assessment also included an evaluation of the upper thoracic kyphosis (including thoracic spine between the 1st and 6th thoracic vertebra – Th1-6) and lower thoracic kyphosis (between the 6th and 12th thoracic vertebra – Th6-12).

The plurimeter was set so that the pointer indicated zero degrees (zero position) while the device was positioned parallel to the ground (fig. 1A). Next, the plurimeter was placed at the first sacral vertebra, and the lumbosacral angle (L/S angle) was measured (fig. 1B). The plurimeter was reset at this height and it was placed in the thoracolumbar junction at Th12/L1 (fig. 2A), the angle of lumbar lordosis was taken (LL angle) (fig. 2B). The next measurement focused on the distal thoracic spine: the plurimeter was set in "zero" position at the thoracolumbar junction (fig. 3A) and then placed at Th6/Th7 to take the angle of the lower thoracic kyphosis (fig. 3B). In the next step the value of the proximal thoracic kyphosis was measured: the plurimeter was set in "zero" position at Th6/Th7 (fig. 4A) and then it was placed at C7/Th1 to take the angle of the proximal thoracic kyphosis (fig. 4B). The final measurement included the measurement of the angle of the total thoracic kyphosis: the plurimeter was set in "zero" position at Th12/L1 (fig. 5A), and then it was placed at C7/Th1 (fig. 5B) and the angle of the total thoracic kyphosis was taken. All the measurements in were taken twice in every child: in the spontaneous and in the actively corrected posture. The results were noted on the individual chart of the subject, where a plus sign (+) signified a kyphotic posture, and a minus sign (-) – a lordotic posture of the analysed part of the spine.

Statistical analysis was performed using the GraphPad software, the Kolmogorov-Smirnov test was applied for normal distribution, and paired t test for comparison of the means. The level of significant differences was adopted by p = 0,05.

Fig. 1A. Rippstein plurimeter in the "zero" position.

Fig. 1B. Measurement of the lumbosacral angle at L5/S1.

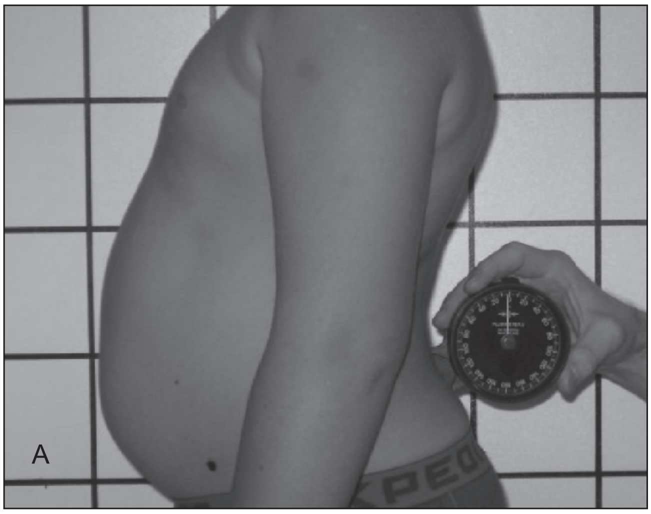

Fig. 2A. Measurement of lumbar lordosis angle – initial position with plurimeter in "zero" position at L5/S1.

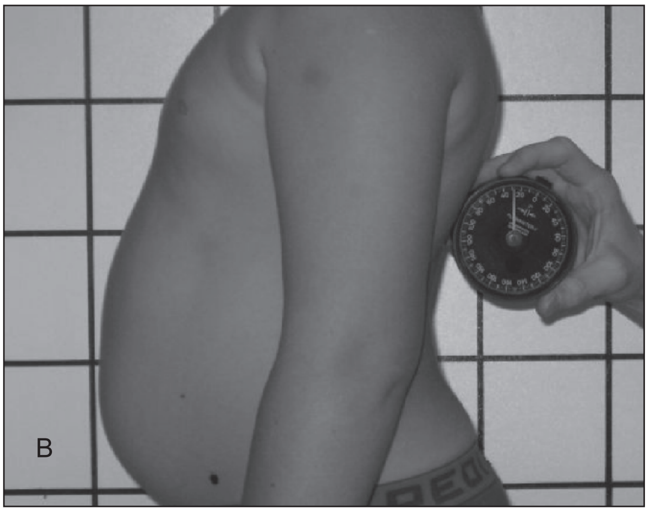

Fig. 2B. Measurement of lumbar lordosis angle – final position with lumbar lordosis angle at Th12/L1.

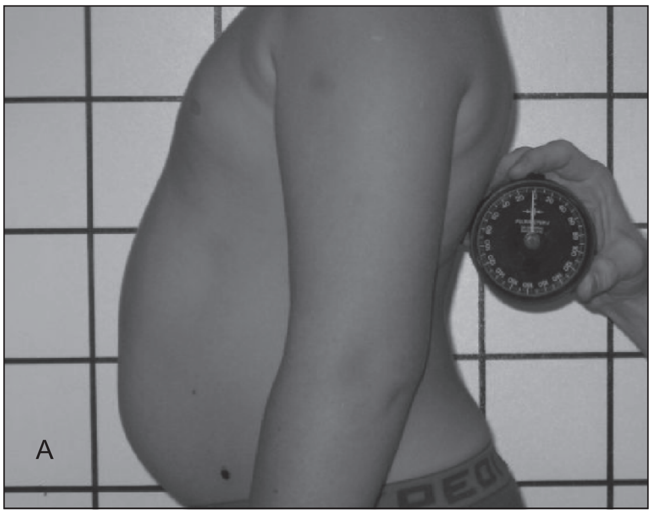

Fig. 3A. Measurement of distal thoracic kyphosis angle – initial position with plurimeter set at "zero" at Th12/L1.

Fig. 3B. Measurement of distal thoracic kyphosis angle – final position at thoracolumbar junction .

Fig. 4A. Measurement of proximal thoracic kyphosis – initial position with plurimeter set at "zero" at Th6/Th7.

Fig. 4B. Measurement of proximal thoracic kyphosis – final position with the value of proximal thoracic kyphosis at C7/Th1.

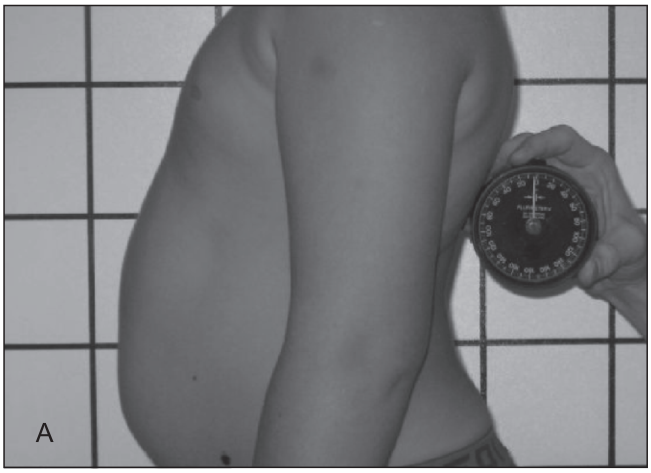

Fig. 5A. Measurement of the total thoracic kyphosis – initial position with plurimeter set at "zero" at Th12/L1.

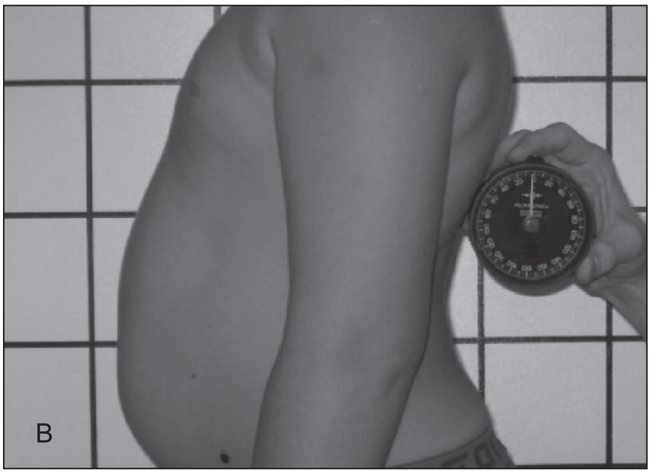

Fig. 5B. Measurement of the total thoracic kyphosis – final position with the value of total thoracic kyphosis at C7/Th1.

Directly after the measurements with Rippstein plurimeter, two photographic evaluations were performed, with the subjects in a standing position: in a spontaneous standing position (fig. 6A) and in an actively corrected position assumed after "stand straight" command (fig. 6B). Children were not previously instructed what corrected posture meant. Profile shots were taken of the children against a grid backdrop, while the children were looking forward. In order to demonstrate lumber lordosis more clearly, upper limbs were slightly flexed in the shoulder joint at an angle of approx. 20°. The movement of shoulder joint flexion was performed slowly to avoid a simultaneous movement of the trunk. The subjects stood in a hip-width stance, with their feet placed on longitudinal and crosswise lines marked on the ground, so that their lateral malleous were over the crosswise line, and feet were parallel to the longitudinal line (fig. 6A).

RESULTS

The results are given in tables 1, 2 and 3.

DISCUSSION

Rippstein plurimeter was chosen as the simplest and most reliable measurement device, commonly used in clinical research. Szczygieł et al. (8) evaluated the mobility and shapes of spine curvatures in children with faulty postures using Rippstein plurimeter. Green et al. (9) used the Rippstein plurimeter to assess rotation, abduction and flexion in the glenohumeral joint; the team obtained satisfactory intra- and intergroup concordance in screening for shoulder pathology. Watson et al. (10), who analysed the position of the scapula in all ranges of shoulder abduction in the frontal plane, concluded that the plurimeter may be effectively used for measuring shoulder joint movements.

In this study, the results of plurimeter measurements revealed a problem of improper posture correction movement in children who were previously not demonstrated how to perform the corrective movement. The movement performed by the children consisted of an improper trunk hyperextension. Pathological thoracic

Fig. 6A. Photograph taken in the saggital plane against a grid background – spontaneous posture.

Fig. 6B. Photograph taken in the saggital plane against a grid background – actively corrected posture assumed after "stand straight" command.

Table 1. Angle of kyphosis/lordosis measured with Rippstein plurimeter in 126 children. The difference between spontaneous and actively corrected posture assessed with paired t-test.

Parameter	Spontaneous posture	Actively corrected posture	p value
thoracic kyphosis /Th1-Th12 angle/	38.7 ± 9.0 (15.0 ÷ 60.0)	27.6 ± 10.5 (0.0 ÷ 51.0)	p < 0.0001
proximal thoracic kyphosis /Th1-Th6 angle/	32.4 ± 5.3 (11.0 ÷ 48.0)	29.3 ± 6.8 (9.0 ÷ 48.0)	p < 0.0001
distal thoracic kyphosis /Th6-Th12 angle/	6.6 ± 7.8 (-12.0 ÷ 27.0)	-2.6 ± 8.2 (-22.0 ÷ 18.0)	p < 0.0001
lumbar lordosis /L1-L5 angle/	34.8 ± 8.0 (18.0 ÷ 55.0)	33.6 ± 8.3 (14.0 ÷52.0)	p = 0.0806
sacral slope /S1-horizontal angle/	23.5 ± 5.9 (7.0 ÷ 38.0)	25.8 ± 5.5 (13.0 ÷ 40.0)	p < 0.0001

The mean ± standard deviation are given, the minimum and maximum indicated in brackets.
All values expressed in degrees.

Table 2. Angle of kyphosis/lordosis measured with Rippstein plurimeter in 60 girls. The difference between spontaneous and actively corrected posture assessed with paired t-test.

Parameter	Spontaneous posture	Actively corrected posture	p value
thoracic kyphosis /Th1-Th12 angle/	38.8 ± 8.9 (19.0 ÷ 60.0)	28.6 ± 9.9 (9.0 ÷ 49.0)	p < 0.0001
proximal thoracic kyphosis /Th1-Th6 angle/	32.5 ± 5.0 (11.0 ÷ 44.0)	29.9 ± 6.8 (13.0 ÷ 48.0)	p = 0.001
distal thoracic kyphosis /Th6-Th12 angle/	6.4 ± 7.4 (-10.0 ÷ 22.0)	-2.5 ± 7.5 (-22.0 ÷ 18.0)	p < 0.0001
lumbar lordosis /L1-L5 angle/	36.0 ± 7.9 (18.0 ÷ 55.0)	32.6 ± 8.4 (14.0 ÷52.0)	p = 0.001
sacral slope /S1-horizontal angle/	27.8 ± 5.6 (13.0 ÷ 38.0)	25.8 ± 5.3 (13.0 ÷ 37.0)	p = 0.0943

The mean ± standard deviation are given, the minimum and maximum indicated in brackets.
All values expressed in degrees.

Table 3. Angle of kyphosis/lordosis measured with Rippstein plurimeter in 66 boys. The difference between spontaneous and actively corrected posture assessed with paired t-test.

Parameter	Spontaneous posture	Actively corrected posture	p value
thoracic kyphosis /Th1-Th12 angle/	38.6 ± 9.3 (15.0 ÷ 58.0)	26.7 ± 11.0 (0.0 ÷ 51.0)	p < 0.0001
proximal thoracic kyphosis /Th1-Th6 angle/	32.2 ± 5.7 (20.0 ÷ 48.0)	28.8 ± 6.8 (9.0 ÷ 46.0)	p < 0.0001
distal thoracic kyphosis /Th6-Th12 angle/	6.6 ± 8.0 (-12.0 ÷ 27.0)	-2.7 ± 8.8 (-22.0 ÷ 16.0)	p < 0.0001
lumbar lordosis /L1-L5 angle/	33.7 ± 7.9 (18.0 ÷ 50.0)	34.4 ± 8.2 (17.0 ÷52.0)	p = 0.4672
sacral slope /S1-horizontal angle/	22.4 ± 6.0 (7.0 ÷ 36.0)	25.8 ± 5.7 (15.0 ÷ 40.0)	p < 0.0001

The mean ± standard deviation are given, the minimum and maximum indicated in brackets.
All values expressed in degrees.

lordosis (11) occurred in the lower part of the spine (negative angle value), figure 6B. Clinical importance of such improper correction pattern lies in the fact that thoracic spine deprived of the physiological kyphosis is rotationally unstable and it becomes susceptible to forces which lead to vertebral rotation. Characteristically, analogous image of distal lordosis in the thoracic spine is found in progressive idiopathic scoliosis (12).

In the literature there are no explicit norms of the thoracic kyphosis angle, and in particular of its distal part (Th6-Th12); however it is generally accepted that this part of the spine should assume a kyphotic shape (positive value of the Th6-Th12 angle). Żuk et al. (4) demonstrated that increased forward pelvis tilt increases, and decreased – decreases lumbar lordosis, thoracic kyphosis and cervical lordosis. Barczyk et al. (13), analysing body posture in 130 children aged 7-10 after a verbal stimulation given to correct posture, demonstrated statistically significant decrease of the angle of thoracic kyphosis. The authors did not assess kyphosis divided into upper and lower part. They found that verbal commands do not constitute a sufficient stimulus to achieve posture correction and it is necessary to make children aware of the correct body posture beforehand.

For the purposes of this study kyphosis was divided into the upper and lower part with the intention to separately measure the changes of the angle of kyphosis in the two parts of the spine. We should underscore that incorrect average values of the angle of kyphosis in the distal thoracic part occurred in children not only in the corrected posture, but also in the spontaneous posture. According to Kluszczyński (14), normative values in plurimeter measurement in spontaneous standing position of children aged 4-16 should fall between 24 and 36 degrees for thoracic kyphosis and lumbar lordosis. A similar norm range for thoracic kyphosis and lumbar lordosis, i.e. 30 ± 5 degrees, was proposed by Zwierzchowska et al. (15) who analysed the saggital plane in students aged 19-21 by using the Rippstein plurimeter to examine curvatures in the saggital plane. However, in the literature there are no normative values for the corrected posture, which may be the area of further analysis.

Owczarek and Bondarowicz (16) suggest that habitual good posture should be perpetuated not only during corrective gymnastics, buy also at home and at school. They believe that children should be constantly reminded about the necessity to maintain correct posture. Górecki et al. (1) believe that a crucial role in shaping posture is played by habits: being used to performing various activities in a specific manner, in this case – assuming a particular position, especially in daily activities.

Canales et al. (17) conducted an analysis of posture based on photographs of persons with depressive disorder, and demonstrated that it was possible to use digital photography to document the effects of the therapy. Canhadas Belli et al. (18) assessed body posture comparing the postures of children suffering from asthma. Neiva P et al. (19) used photographs to analyse the posture of mouth-breathing children. The photos presented children in a spontaneous posture. It seems justified to use digital photography to examine the actively corrected posture. Early results of an analysis of spontaneous and corrected posture based on photographs was presented by Stoliński et al. (20), who examined 1000 children aged 7-10 under the project "Poznan Chooses Health – Bad Posture Prophylaxis". Having noted the possibility to use digital photography as an objective measurement method, it is reasonable to use quantitative parameters assessing body posture. The introduction of reliable and repetitive methods of posture assessment by means of digital photography may help reduce the cost of posture examination, thus increasing the availability of such examinations.

CONCLUSIONS

1. Plurimeter measurement and digital photography documentation allowed for a qualitative and quantitative assessment of children's posture and its changes following a verbal stimulus.

2. Children reacted to the “stand straight” command by changing their posture, which meant creating a pathological lordosis in the lower thoracic spine.
3. The “stand straight” command given to children in order to correct their posture should be preceded by appropriate instructions in order to avoid improper correction patterns.

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