

Retrospective evaluation of the surgical treatment and rehabilitation of patients with idiopathic scoliosis using the 'bone-on-bone' surgical technique

Retrospektywna ocena leczenia operacyjnego i rehabilitacji u pacjentów z idiopatyczną skoliozą operowanych metodą „kość na kość”

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Key words

scoliosis, 'bone on bone' method, quality of life

Abstract

Introduction: The aim of this study was the retrospective evaluation of the results of the surgical treatment with the 'bone on bone' method, and the rehabilitation of patients for a period of 3 years after the operation.

Materials and methods: The study included 102 patients (91 women, representing 89.2%; and 11 men, 10.8%) aged between 11 and 34 years, with an average age of 16 years. An analysis of the medical documentation covered a period of three years after the surgery. Further information on the patients' daily life was obtained through a survey conducted 5-6 years after the surgery. The research results included data from hospital records collected during check-ups, which were used to obtain information about changes in the primary angular curvature of the spine, the body shape, preoperative and postoperative rehabilitation, as well as medical recommendations and complications. In addition, a survey was conducted among the patients that included the SF-36 Quality of Life questionnaire.

Results: The minimum angle of curvature in the studied group, as determined by Cobb's method was 32°, and the maximal angle was 102°. On average, the correction angle of the curvature in the primary segment amounted to 59.2% during the operation. The patients were divided into 3 groups. In the first group, the angle of curvature of the primary arc decreased during the observation period. Conversely, the second group showed a continuous increase of the angle from the surgery to the end of the observation period. The third group showed changes in the angle during each observation period. The survey was completed by 48 respondents, amounting to 47% of the study group. The most common form of home rehabilitation was posture control, in which was undertaken by 30 respondents (62.5%). After the operation, 30 of the respondents stated that their posture was average (62.5%); 12 persons considered it attractive (25%); 6 (12.5%) very attractive; and only 1 person considered it unattractive. Among the 48 people who filled in the SF-36 questionnaire, the average number of points achieved was 66. The most common complications that appeared after the operation were back pain, tingling, and nerve pain in the upper and lower limbs. The screws loosened in some patients, and in 1 case, the fusing material broke.

Conclusion: 1) The anterior spinal fusion of scoliosis using the 'bone on bone' method allows for a quick correction, with a stiffening of the short spine; thus, mobility is maintained in the other segments. 2) Preoperative rehabilitation (through muscle stretching and breathing exercises) is important – the better the preparation, the greater the potential correction of the curvature and the faster the patient will return to independence after surgery. Patients 5-6 years after the surgery evaluated their quality of life as good. 4) Asymmetry and changes in the body shape during the postoperative period resulted from the correction of the curvature during the operation. The operation changed the functioning conditions of the musculoskeletal and joint systems. These changes were gradually compensated, and the application of corrective exercises and postural control accelerated this process. 5) In the majority of the respond-

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ents, the angle of curvature of the spine increased within three months after the surgery, after which it either stabilised or decreased. With time, the number of subjects with an increasing angle also decreased.

Słowa kluczowe

skolioza, metoda „kość na kość”, jakość życia

Streszczenie

Wstęp: Celem badań była retrospektywna ocena wyników leczenia operacyjnego i rehabilitacji u pacjentów operowanych metodą „kość na kość” według Gainesa w okresie do 3 lat od zbiegu.

Materiał i metoda badań: Badaniem objęto 102 pacjentów, w tym 91 kobiet, co stanowi 89,2%, oraz 11 mężczyzn, czyli 10,8%, w wieku od 11 do 34 lat, ze średnią 16 lat. Analiza dokumentacji medycznej obejmowała okres 3 lat po operacji. Informacje na temat życia codziennego uzyskano za pomocą ankiety przeprowadzonej 5-6 lat od zabiegu operacyjnego. Wyniki badań obejmowały dane z dokumentacji szpitalnej zebranej podczas kontroli lekarskich. Na ich podstawie uzyskano informacje o zmianach kątowych skrzywienia pierwotnego kręgosłupa, sylwetki ciała, rehabilitacji przedoperacyjnej i pooperacyjnej, zaleceniach oraz powikłaniach. Dodatkowo wśród badanych została przeprowadzona ankieta zawierająca m.in. Kwestionariusz Jakości Życia SF-36.

Wyniki: W grupie badanych minimalny kąt skrzywienia, wyznaczony metodą Cobba, wyniósł 32°, a maksymalny 102°. Średnio korekcja kąta skrzywienia w odcinku pierwotnym wyniosła podczas operacji 59,2%. Badanych podzielono na 3 grupy. W grupie pierwszej kąt skrzywienia w łuku pierwotnym malał w trakcie okresu obserwacji. Grupa druga charakteryzowała się ciągłym wzrostem kąta od momentu zabiegu do końca okresu obserwacji. Grupa trzecia prezentowała zmiany kąta podczas każdej kontroli w okresie obserwacji. W ankiecie wzięło udział 48 badanych (47%). Najczęściej wykonywaną formą rehabilitacji domowej była kontrola postawy ciała, co dotyczyło 30 badanych, czyli 62,5%. Po operacji 30 ankietowanych uważało swoją sylwetkę za przeciętną (62,5%), 12 osób (25%) jako atrakcyjną, 6 (12,5%) jako niezbyt atrakcyjną i tylko 1 osoba za nieatrakcyjną. Wśród 48 osób, które wypełniły kwestionariusz SF-36, średnia liczba punktów uzyskanych wyniosła 66. Najczęstsze powikłania, jakie pojawiły się u operowanych osób, to zespoły bólowe kręgosłupa, mrowienie oraz nerwobóle w kończynach górnych i dolnych. U kilku z nich stwierdzono obluzowanie śrub, a u 1 złamanie materiału zespalającego.

Wnioski: 1) Metoda spondylodezy przedniej metodą „bone on bone” pozwala na szybką korekcję przy usztywnieniu krótkiego odcinka kręgosłupa, dzięki czemu zachowana jest ruchomość w pozostałych odcinkach. 2) Duże znaczenie ma rehabilitacja przedoperacyjna – rozciągnięcie mięśni przykurczonych, ćwiczenia oddechowe – im lepsze przygotowanie, tym możliwa większa korekcja skrzywienia oraz szybszy powrót do samodzielności we wczesnym okresie po zabiegu. 3) Pacjenci 5-6 lat po zabiegu oceniają poziom jakości swojego życia jako dobry. 4) Asymetria oraz zmiany w sylwetce w okresie pozabiegowym wynikają z korekcji skrzywienia podczas operacji, która zmienia warunki funkcjonowania układu kostno-stawowego oraz mięśniowego. Zmiany te ulegają stopniowej kompensacji, a zastosowanie ćwiczeń korekcyjnych i kontroli postawy ciała przyspiesza ten proces. 5) U większości badanych kąt skrzywienia kręgosłupa wzrastał w okresie do 3 miesięcy po operacji, następnie ulegał stabilizacji lub malał. Wraz z upływem czasu grupa badanych, u których kąt nadal rósł, stawała się coraz mniejsza.

INTRODUCTION

Scoliosis is a postural disorder characterised by a three-dimensional spinal deformity. The structural changes induced by scoliosis occur in the frontal plane as a lateral curvature; in the sagittal plane as a disorder in the physiological thoracic kyphosis or the lumbar lordosis; and in the transverse plane where there is a rotation of the vertebrae. Therefore, scoliosis is a condition that affects the patient's everyday life and the functioning of the whole body^{1,2}.

The bone-on-bone (BOB) surgical technique was introduced by Gaines in 2001³. In Poland, the first treatments using this method were carried out in 2002 at the Department of Orthopaedics and Rehabilitation of the University Hospital in Zakopane.

Surgery applying the BOB technique, performed via an anterior approach (extraperitoneally or using thoracotomy), involves immobilising several motor segments of the spine in the area of the primary curvature (arc). During the operation, the intervertebral discs are removed without being further replaced with bone

grafts. This is one of the most important stages of the treatment, since the resection of the discs whose shapes determine the physiological curvature allows for a quick correction^{3,4}.

The subsequent lack of discs results in contact between the surfaces of adjacent vertebral bodies and their fusion (spondylodesis). In this technique, rods are secured to the vertebral bodies on a lateral surface of the bodies with three to six screws, and therefore the heads of the ribs need to be cut out.

A short range spondylodesis, which occurs when the BOB technique is used, and a good correction of the curvature will contribute to a relatively quick recovery of the patient, and a significant increase in their quality of life as compared to the level prior to the operation³.

THE AIM OF THE STUDY

The purpose of the study is to evaluate the effectiveness of the surgical treatment for idiopathic scoliosis using the BOB technique for three years after the operation. The analysis encompasses postoperative angular changes in the

spine and complications after the surgery, as well as changes to the patients' quality of life and functioning in everyday life. The following research questions were formulated:

1. How has the Cobb angle changed on the corrected arc?
2. How do the patients assess their quality of life after spinal fusion surgery using the BOB technique?
3. Is there any relationship between the Cobb angle measurements and the evaluation of the quality of life among the patients after their surgical treatment for idiopathic scoliosis?

MATERIAL AND METHODS

The study involved 102 people, including 91 women (representing 89.2% of the participants) and 11 men (constituting 10.8%), who were diagnosed with idiopathic scoliosis of the spine and underwent anterior spinal fusion surgery using the BOB technique in 2007-2008. All the participants were patients at the Department of Orthopaedics and Rehabilitation of the University Hospital in Zakopane.



The average age of the participants was 16 years old (min. age 11, max. 34), while the average body mass was 54.7 kg (34-95 kg).

A primary curvature of the lumbar spine was diagnosed in 18 people, who constituted 17.6% of the participants; while a primary curvature of the thoracic spine was diagnosed in 84 patients, representing 82.4%.

In the group of patients, the minimum angle of curvature prior to the surgery (measured with the Cobb method) was 32°; whereas the maximum angle was 102° – with an average of 64°. Some patients eligible for surgery reported ailments connected with the nervous system that were recognised as complications induced by the idiopathic scoliosis. The most frequently reported complications included: neuralgia, tingling sensations, decreased muscle strength and muscle atrophy.

During the preparatory period, the patients underwent rehabilitation aimed at the flexibilisation of the paraspinal soft tissues, increasing fitness and learning proper breathing techniques. These tasks were carried out by means of general rehabilitation exercises, breathing exercises, the use of a traction table or classes in a swimming pool.

Analysis of the medical records

The first stage of the study involved an examination of the patients’ medical records covering the preoperative period of 10-14 days that was intended to prepare the patients for the operation. The second stage of the study was an analysis of the documentation gathered during the patients’ hospitalisation after the surgery until their discharge from the hospital, as well as during their postoperative check-ups. Every patient’s condition was examined after 3, 6, 9 (or 12), 24, 36 and 48 months. During these check-ups, the doctor measured the angle of curvature with the Cobb method in the anteroposterior radiograms, assessed changes in the patient’s body shape and recorded any problems that had occurred since the surgery.

Changes in the body shape

The patient’s body shape after surgical treatment for idiopathic scoliosis is characterised by: an asymmetry of the triangles of the waist line, the hip line and the shoulder line; a protruding shoulder blade; a lack of alignment;

a rib hump; and a lumbar prominence. Gradually, a compensation, reduction or even a withdrawal of these changes can be observed. During the medical check-ups, the progress of the changes in the patient’s body shape was monitored and described by the doctor, and the moment of the body’s alignment and its quality were recorded in the documentation.

Survey

The last stage of the study involved a survey that was distributed among the patients. The survey contained questions about the forms of rehabilitation that were applied after the surgery, the patient’s level of activity, their performed sports (also in the form of recreation), their self-esteem, as well as questions about any ailments they experienced and their impact on the patient’s daily functioning. The information gathered in the survey allowed for the determining of the level of limitations faced by these people following the surgical treatment.

The SF-36 Health Survey is used to subjectively assess a person’s quality of life⁵. The scoring scale includes 11 questions, containing 36 statements that allow researchers to specify the following eight indicators for the quality of life:

- physical functionality,
- limitations in functional roles due to physical health,
- bodily pain,
- general health perceptions,
- vitality,

- social role functionality,
- limitations in functional roles due to emotional problems,
- mental health perceptions.

The maximum score is 171. According to the Polish version, lower scores correspond to higher levels of quality of life⁵.

Complications

Any ailments reported by the patients (spinal pain syndrome, tingling in the upper or lower limbs, decreased muscle strength, neuralgia) were recorded during the check-ups. This documentation also included information on any complications associated with the instrumentation used (loose or broken screws, displaced rods, etc.).

The relationships between the variables were analysed with Spearman’s rank correlation coefficients. Values of $p < 0.05$ were considered statistically significant in the study.

RESULTS

Angle of the curvature

On average, the angle correction of the primary curvature amounted to 59.2% during the surgery. The measurement was calculated on the basis of an average of the individual percentage values of the correction in each patient (Table 1).

After the analysis of the medical records, the participants were divided into three groups. The first group consisted of patients whose postop-

Table 1

Angle of curvature in the primary arch	
	Value
Minimum angle before surgery [°]	32
Maximum angle before surgery [°]	102
$\bar{x} \pm SD$ before surgery [°]	64 ± 13.3
$\bar{x} \pm SD$ correction during surgery [%]	59.2 ± 17.0
\bar{x} – arithmetic mean; SD – standard deviation	

Tablea 2

Angular changes of the spine curvature in patients from Groups I and II		
	Continuous regression of the Cobb angle from the beginning to the end of the follow-up period	Continuous progression of the Cobb angle from the beginning to the end of the follow-up period
Number of people	9 people	14 people
$\bar{x} \pm SD$ [°]	4.77 ± 3.15	14.21 ± 6.36
\bar{x} – arithmetic mean; SD – standard deviation		



erative angle of the primary curvature gradually decreased over the follow-up period. In this group, a continuous angle regression was observed in 9 patients (representing 8.8% of the study group) and the angle of the curvature declined by an average of 4.77° after the follow-up period of 3 years.

The second group comprised patients whose postoperative angle of the curvature gradually increased over the follow-up period. An angle progression was noted in 14 people (13.7%) and the angle increased by an average of 14.21°, compared to the angle of the curvature that was obtained during the surgery (Table 2).

The third group encompassed patients whose postoperative angle of the primary curvature was different at each check-up over the follow-up period. The measurements presented below summarise the findings at each subsequent check-up among the patients characterised by constant angular changes. Due to the fact that some patients missed their check-ups, Table 3 only presents the group where such angular changes were analysed.

When assessing the measurements in this group, an angle progression by an average of 4.7° was observed in 45 patients (62% of this group) at the check-up after 3 months, while an angle decrease by an average of 4.15° was observed in 17 patients (23%), and the angle did not change in 11 of the patients (15%).

At the check-up after 6 months, a progression of the angle by an average of 2.71° was observed in 30 patients (43%), an angle regression by an average of 2.9° was observed in 9 patients, and the angle did not change in 30 of them.

The assessment of angular changes after 12 months showed that in comparison to the previous check-up, the angle value increased by an average of 3.33° in 22 patients (33%), while the angle decreased by an average of 4.18° in 25 patients (37%), and there was no angular change in 20 people (who accounted for 30% of the participants).

At the check-up after 24 months, a progression of the angle by an average of 3.19° was observed in 23 patients (39%), an angle regression by an average by 3.76° was observed in 13 patients (22%), and the angle did not change in 23 of them.

In the last period, three years after the surgery, the angle grew by an av-

erage of 2.68° in 14 patients (40%), while the angle decreased by an average by 4.25° in 11 of them (31%), and it did not change in 10 people (29%) (Table 3).

Survey

The survey was completed by 48 people, representing 47% of the patients studied. The respondents included 42 women (87.5%) and 6 men (12.5%), aged 17 to 32 (with an average age of 22.1). The survey results showed that among the various forms of rehabilitation, 30 patients (constituting 62.5% of the participants) worked on controlling their body posture, 26 of them (54.2%) did general rehabilitation exercises, 14 (29.2%) attended classes at a swimming pool, 5

(10.4%) used massages, 2 (4.2%) underwent physical treatments, while 9 (18.7%) only performed the activities of everyday life, without activities of a rehabilitative nature. The patients often applied more than one form of rehabilitation and 21 participants (43.7%) admitted that the exercise helped them to recover. Only 10 respondents (20.8%) received assistance from a physiotherapist in addition to their individual exercises (Table 4).

The asymmetry of the body shape remained for longer in 23 patients (47.9%). It was compensated in up to 3 months in 13 patients (27%), in up to 6 months in 5 patients (10.4%), was maintained for up to 12 months in 1 patient, and still could be observed in 6 patients (12.5%).

Table 3

Angular changes in the group of patients showing angle changes during each medical check-up					
Control	Regression of the Cobb angle: number of people	x ±SD	Progression of the Cobb angle: number of people	x ±SD	No angular changes: number of people
After 3 months	17 (23%*)	4.15 ±2.91°	45 (62%*)	4.7 ±4.08°	11 (15%*)
After 6 months	9 (13%*)	2.9 ±2.62°	30 (43%*)	2.71 ±1.93°	30 (43%*)
After 12 months	25 (37%*)	4.18 ±2.99°	22 (33%*)	3.33 ±2.25°	20 (30%*)
After 24 months	13 (22%*)	3.76 ±2.90°	23 (39%*)	3.19 ±2.35°	23 (39%*)
After 36 months	11 (31%*)	4.25 ±4.34°	14 (40%*)	2.68 ±2.80°	10 (29%*)

* Percentage of all the participants

Table 4

Forms of rehabilitation used after the surgery	
Rehabilitation form	Number of people
Posture control	30
General rehabilitation exercises	26
Classes in a swimming pool	14
Massages	5
Physical treatments	2
Everyday life activities	9

Table 5

The patients' self-evaluation of their physical appearance after surgery	
Self-esteem rating	Number of people
Attractive	12
Average	30
Not very attractive	5
Unattractive	1



The most common sports among the participants were swimming, cycling and volleyball. Beside these, the patients often chose to participate in running, training in the gym and fitness exercises, and walking.

When assessing their own level of attractiveness, the majority of the respondents considered themselves average after the surgery, which was declared by 30 of them (62.5%); 12 patients (25%) perceived themselves as attractive; 5 people (10.4%) as not very attractive; and only one person as unattractive (Table 5).

The SF-36 Survey

The average score obtained in the SF-36 survey was 66. Out of the group surveyed, only 1 person scored more than 100 points and 4 people gained below 30 points. As many as 11 patients (22.9%) scored in the range of 41-50 points. Slightly fewer, 9 of them (18.7%), were in the range of 31-40 points. A total of 6 patients scored in each range of 51-60, 61-70 and 71-80 respectively, constituting 12.5% of the participants; while 3 people (6.2%) scored from 81-90 points and 2 participants scored from 91-100 (Figure 1).

An attempt was also made to determine the relationship between the Cobb angle measurements two years after the operation and the results of the SF-36 survey. A statistically significant relationship between the studied variables was found, which means that the lower the Cobb angle measurements corresponded with lower results in the SF-36 survey (Table 6).

Complications

The outcomes indicate that the most common complications after surgery using the BOB technique were: spinal pain syndrome, which was reported by 34 patients (70.8%); tingling in the upper limbs, which occurred in 8 patients (16.6%); tingling in the lower limbs in 10 patients (20.8%); neuralgia in the lower limbs in 6 patients (12.5%); neuralgia in the upper limbs in 8 patients (16.6%); decreased muscle strength in 9 patients (18.7%); as well as pain in the area of the instrumentation. A total of 10 respondents (20.8%) did not complain about any ailments. Loosening of the joining screws was noted in 3 patients, repre-

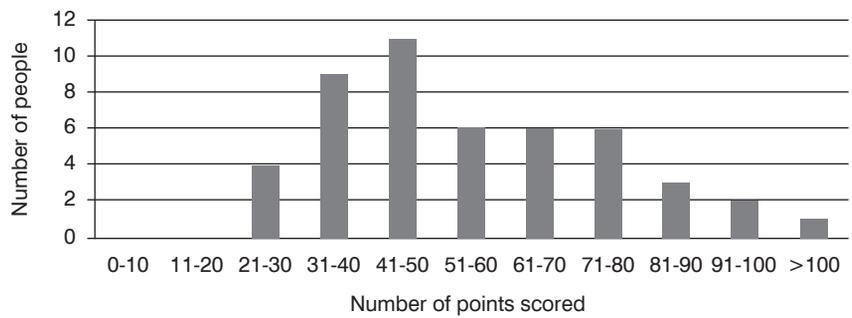


Figure 1
Results of the SF-36 Questionnaire

sented 6.2% of the participants; and a broken rod was noticed in the case of 1 person (2%) (Table 6).

DISCUSSION

Changes to many systems of the body occur in the course of scoliosis. For example, changes in the spine entail changes in the muscular system and the respiratory system^{4,6}. Idiopathic scoliosis is characterised by a gradual and long-lasting increase in the angle of curvature⁸, which is why rehabilitation plays an important role in counteracting the resultant changes and the deepening of the defects, both before and after surgery^{1,4,8,14,15}. Strengthening exercises, elongating exercises and control of body posture can slow the progression of the curvature angle of the spine, which can also reduce the defects in the body shape such as: a rib hump, a lumbar prominence, asymmetry of the waist triangles, a protruding shoulder blade and other changes resulting from the progression of the scoliosis^{2,8}.

The patients who underwent the surgery using the BOB technique, performed via an anterior approach, obtained a good correction of the curvature and a gradual compensation of the defects in their body shape, with a short range of spondylodesis including only the section of the curvature. Such findings from the authors' study have been confirmed by the results of other researchers^{4,6,7,9}. Compensation for the changes in the body shape results from a natural process that takes place and is the effect of attempts by the Central Nervous System (CNS) to optimise the functioning of the body and to counteract the emerging changes⁸. The correction of a curvature using the described method allows for a substantial reduction in the angle of the curvature measured with the Cobb method.

In the course of scoliosis all sorts of complications may occur, most of which are neurological, such as: neuralgia, paraesthesia, decreased muscle strength, muscle atrophy and sometimes also pulmonary atrophy. Such complications may occur both before

Table 6

The Spearman correlation analysis between the results of the Cobb angle measurement and the SF-36 questionnaire					
Variable	x	SD	min.	max.	p
Cobb angle	32,92	10,31	10,00	53,00	0,049
SF-36	54,73	21,33	22,00	116,00	

Table 7

Complications	
Complication	Number of people
Spinal pain syndrome	34
Tingling in the upper and lower limbs	18
Neuralgia in the upper and lower limbs	14
Decreased muscle strength	9
Loose instrumentation	4



and after surgery. The bone-on-bone technique is characterised by a small number of complications^{4,10}, which has a beneficial effect on the patient's fitness and functioning in everyday life. As is shown in the results of the authors' study, the complications that occurred were mainly associated with pain in the spine. However, the spinal pain syndrome may result not only from the instrumentation used, but also from the overloading the spine in everyday life, as well as from the changes caused by scoliosis.

Surgery via the anterior approach remains the method of choice for thoraco-lumbar scoliosis and lumbar scoliosis¹¹. By using short instrumentation, a long section of the spine retains its mobility, the angle of curvature on the control radiograms is satisfactory, and a good cosmetic effect is obtained thanks to a short cut, which is a satisfying result for the patients^{1,12}.

The research conducted by the authors and by Ersberg et al.¹³ indicates that this is a technique after which the patients function well in their daily lives and their quality of life is classified at a good level. This is also maintained in the longer follow-up period. However, it is problematic to find studies that evaluate the quality of life and functionality among people operated on for scoliosis following a longer period of time (several years) after the surgery. Such knowledge is essential to determine the impact of the surgery on the patients' quality of life in the later stages of their lives. Nonetheless, as is demonstrated by the authors' research, in the course of time, when the angle of the curvature decreased the results assessing the patients' quality of life improved. Further changes in the angle of curvature, as well as emerging complications and limitations were directly linked to the well-being and self-esteem among the patients. Such factors should also be taken into consideration when assessing the effectiveness of the method.

It is also a challenge to find objective research on the influence of post-operative physical therapy on the progression of changes that occur in the months following surgery. Rehabilitation, for the patients who participated in the present study, was carried out according to a programme developed by the therapeutic team of the Hospital in Zakopane. On the basis of the study, it can be concluded that the patients often connected their well-being

and improvements in health after the surgery with their undertaking of regular exercise.

The authors' study and the analysis of the literature suggest that the BOB technique, which is used in the surgical treatment of idiopathic scoliosis, is an effective treatment method that gives positive results. However, there have been no reliable and unequivocal studies conducted over a longer period on a uniform and large research group. Based on such a study, a standardised programme of physiotherapy could be developed for patients after surgery for idiopathic scoliosis. Nevertheless, the results of the present study may be a starting point for further discussions on the subject.

CONCLUSIONS

1. Anterior spinal fusion surgery using the bone-on-bone surgical technique allows for a quick correction by immobilising a short section of the spine, thus retaining the mobility of other sections.
2. The asymmetry and changes in the body shape over a long period after the surgery result from the correction of the curvature during the operation, which changes the conditions in which the osteoarticular system and the muscular system function. Such changes were totally compensated in most of the participants.
3. The angle of the curvature increased over a period of up to three months after the surgery in the majority of patients, and then stabilised or decreased. Over time, the group of participants whose angle of curvature continued to grow became increasingly smaller.
4. Approximately half of the patients felt ailments up to three years after the surgery.

Conflict of interest: none declare

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