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The quality of life after Anterior Cervical Discectomy and Fusion

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Abstract

Cervical discopathy is commonly associated with pain in the cervical spine which may affect patients' quality of life. If conservative treatment fails to relieve the pain for at least 6 months and/or if neurological deficit progresses, the surgical treatment is taken under consideration. The aim of this study was to evaluate health-related quality of life (HRQOL) and disability of patients after single- and multi-level anterior cervical discectomy and fusion (ACDF) with standalone polyetheretherketone (PEEK) cages. The study evaluated how ACDF influenced particular aspects of patients' quality of life in the context of radiological outcome. The study included 30 consecutive patients with single- or multi-level cervical disc herniation. Patients underwent clinical and radiological evaluation before and one year after the ACDF procedure. For each patient, we assessed the severity of cervical pain with a numerical rating scale (NRS)

and filled the neck disability index questionnaire (NDI). The health-related quality of life was assessed with the Polish version of 36-Item Short Form Survey (SF-36). A significant decrease in all NDI aspects indicates a significant improvement after surgery. The quality of life in all aspects assessed with SF-36 scale was also improved. A moderate decrease in cervical spine mobility coexisted with a good outcome of the neurosurgical procedure. In the opinion of patients, the most important aspect after the cervical spine surgery is the reduction of pain severity. ACDF surgery is an effective method to reduce the severity of pain in patients with degenerative disc disease. ACDF improves the quality of patient's life. According to the study results the physical role improved most significantly; the least improvement was noted in role-emotional aspect. Up to 83% of patients achieved a reduction of the NDI index by 5 or more points after surgical treatment which proves the high effectiveness of the surgical treatment. No statistically significant difference was noted between patients with single and multi – level discopathy. Up to 97% of patients who underwent ACDF reported a significant decrease in pain severity measured with NRS.

Key words: Quality of life, Anterior Cervical Discectomy and Fusion, Cervical discopathy

1. Introduction

Pain localized in the cervical spine is a common clinical problem with significant social importance, affecting the quality of patient's life. The common cause of symptomatic pain is cervical discopathy - a result of degenerative changes in the intervertebral disc and uncovertebral joints. Irritation and compression of spinal nerve root is a consequence of spondylosis: usually degenerated and displaced intervertebral disc, but also osteophytes arising from uncovertebral joints.

If conservative treatment fails to relieve the pain for at least 6 months and/or if neurological deficit progresses, the surgical treatment is taken under consideration, especially if the signs of myelopathy are present.

Anterior cervical discectomy and fusion (ACDF) was first introduced by Smith and Robinson and Cloward as a treatment of the cervical disc degeneration disease (DDD). ACDF is a widely accepted surgical method of the treatment of symptomatic cervical radiculopathy and myelopathy, providing an excellent long-term clinical outcome [1,2]. ACDF consists of the removal of the dislocated nucleus (discectomy) and decompression of nerve structures relieving the pain and other symptoms.

ACDF have been widely performed since 1958. Historically, after removal of the interval disc, autologous bone was used to restore disc height. An interbody cage is used as a substitute of a bone graft and is effective for the restoration of disc height. Cage subsidence in the vertebral body after ACDF, reduces the foraminal height and cervical alignment. The rigid fixation of an anterior plate eliminates micromotion between the graft and body interface.

The aim of the surgical treatment is the reduction of cervical pain. ACDF provides high recovery rate, pain reduction and improvement in neurological status. In the literature there is substantial data from randomized control trials on cervical disc arthroplasty with patients undergoing 1 and 2 level ACDFs which evaluated neck-related physical function and quality of life outcomes [3,4,5]. The results of procedure are overall good but the biomechanical effects on the discs and vertebra after the procedure remain largely unclear. Some authors have reported a moderate correlation between disability and patient satisfaction and some weak relationship between the severity of the pain and patient satisfaction [6,7]. Therefore, all these variables should be assessed separately when evaluating the effect of any form of treatment for the neck pain.

Neck and back pain may strongly impair the patient's functioning. Affective disorders, such as depression, anxiety and dysfunctional pain-related behaviors are associated with worse outcomes in patients undergoing cervical spine surgery. Discopathy of cervical spine connected with pain and disability inevitably leads to decreased quality of patient's life.
The Neck Disability Index (NDI) is a tool measuring patient's disability connected with the neck pain. It is adopted for evaluation of the effects of ACDF procedure. Questions concern activities of daily living: concentration, personal care, headache, lifting, work, driving, sleeping, intensity of pain and recreational activity. A higher NDI score indicates higher level of disability. The minimal clinically important difference is 5 or 10% [8].
The Numeric Rating Scale is an 11-point scale for patient self-reporting of pain. The pain score is measured on a scale 0-10. No pain at all results in a score of 0, while 10 indicates the worst pain imaginable [9].
The Polish version of Short Form 36 (SF-36) enables the assessment of the outcome in the means of general health comparing patient's functioning in the social, mental and physical sphere [10]. In translated and culturally adapted Polish version, higher scores in SF-36 scale demonstrate better functioning.

2. Methods

The study included 30 consecutive patients with single- or multi-level cervical disc herniation who underwent ACDF with anterior approach to cervical spine. Surgical approach at the neck was performed through an anterior, oblique, skin incision as in Cloward procedure, but instead of bone graft, the procedure was modified by usage of standalone PEEK cages.
The local Bioethics Committee of the Medical University of Bialystok Poland (R-I-002/40/2013) approved the study protocol. All methods were performed in accordance with the relevant guidelines and regulations. Written, informed consent was obtained from all subjects.
The patients with single- or multi-level cervical spine disease (C3 to C7) presented radiculopathy that failed to respond to conservative treatment and/or had progressing neurological deficit (including myelopathy). All patients' diagnosis was confirmed with MRI. Exclusion criteria were: previous cervical spine operations, posttraumatic conditions, spine deformities, malignancy, infectious or metabolic diseases. Mean duration of follow-up was 12 months. No patients required additional surgery for recurrence of symptoms. All patients remained in the study during the follow-up period and completed the study in full schedule.

a. Patient demographics

Sixteen men (53.3%) and fourteen women (46.7%) were included into the study group. The mean age of the patients was 56 years old. The age range was from 27 to 67 years. In the group of women the mean age was 53 years (41-60 years), while in the group of men the mean age was 55 years (27-67 years).
The studied patients represented a varied level of education, although people with vocational and secondary education dominated, which constituted 86.7% of the respondents (50% of patients had secondary education; 36.7% of patients had vocational education). People with higher education accounted for 10% of patients, most of whom lived in cities. 1 patient (3.3%) had primary education.
The majority of the studied patients were professionally active (60%). According to the interview data, patients describing themselves as manual workers constituted 76.7% (23 patients), and patients describing themselves as white-collar workers constituted 23.3% (7 patients).
The most common risk factors were low physical activity and a sedentary lifestyle. These factors were observed in 23 patients (76.7%). The mean value of the BMI was 26.8 kg / m2 (18.7-45.2 kg / m2). Excess body weight was found in 21 patients (70%). Overweight (BMI

25-29.9) was found in 40% of patients, class 1 obesity (BMI 30-34.9) in 20% of patients, class 2 obesity (BMI 35-39.9) in 6.7% of patients, class 3 (BMI ≥40) in 3.3% of patients.
Before the ACDF and one year after the procedure, all participants were admitted for thorough clinical and radiological evaluation. Clinical evaluation consisted of physical and neurological examination, the assessment of pain severity with a numerical rating scale (NRS) and completion of the neck disability index questionnaire (NDI). Quality of life was assessed with Polish version of 36-Item Short Form Survey (SF-36) by RAND.
The SF-36 is a tool used for assessment of HRQOL. It consists of the Physical Component Score (PCS) and the Mental Component Score (MCS). Results were tagged for —vitality (VT), physical functioning (PF), bodily pain (BP), general health perceptions (GH), role physical (RP), role emotional (RE), social functioning (SF), and mental health (MH). Sums of scores were converted to values 0 to 100.

b. Surgical methods

Procedures were performed at Department of Neurosurgery, Medical University of Bialystok by single senior neurosurgeon. Patients underwent anterior cervical microdiscectomy with fusion (ACDF) using Cloward anterior approach and modification with standalone PEEK implant. Removal of intervertebral disc gives an access to anterior aspect of spinal canal and allows to remove any compression: bulging disc, osteophytes or thickened ligament. Last step of the procedure is insertion of an implant- C- plus PEEK LFC in all cases- filled with allograft material enhancing bony fusion.
The surgical exposure involved an access to the operating site with retraction of the tissues using minimal instrumentation. The implant insertion was performed with trial spacers with maximal care to restore natural height of the space. C-Plus PEEK LFC System with Anti-migration teeth was used. The inner cavity of the cage was filled with β-tricalcium phosphate. The correct device's placement and height was checked intraoperatively with fluoroscopy. The anatomic restoration of patient's lordosis of about 7˚ was done. No plate fixation was used to strengthen intervertebral union. After the procedure, it was recommended to use a Schantz soft collar for 4 weeks.

For statistics we used StatSoft Statistica 10.0. Values are presented as minimum and maximum values, standard deviations, means and medians. Wilcoxon test was used for comparison of NDI scores. Non-parametric Kruskal-Wallis test was used to assess the mobility of the spinal segments. Value of $p<0.05$ indicated statistical significance.

3. Results

a. The assessment of the quality of life with the Polish version of SF-36 questionnaire by RAND.

There was a statistically significant difference ($p <0.001$) between preoperative and postoperative sum of points in the SF-36 questionnaire in the study group (fig 1).

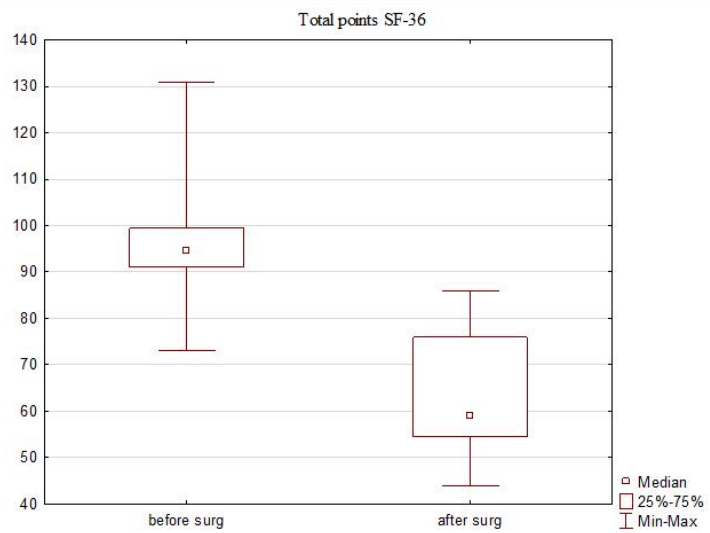

Fig. 1. Total sum of points based on SF-36 questionnaire before and after surgical treatment.

The health-related quality of patient's life (HRQOL) according to Polish version of 36-Item Short Form Survey (SF-36) by RAND improved significantly in all patients. The total sum of points ranged from 73 to 131 ± 10.85 points, average 95.32 points, median 94.5 points before the surgical treatment. After the surgical treatment, the total sum of points ranged from 44 to 86 points ± 12.24 points, average 63.6, median 59 points.

The assessment of the physical functioning (PF) ranged from 14 to 48 ± 6.8 points, before the surgery. After the treatment, the PF value ranged from 9 to 34 ± 5.57 points. The statistically significant ($p < 0.001$) difference in PF was found in 96% (27 out of 28) patients (fig 2).

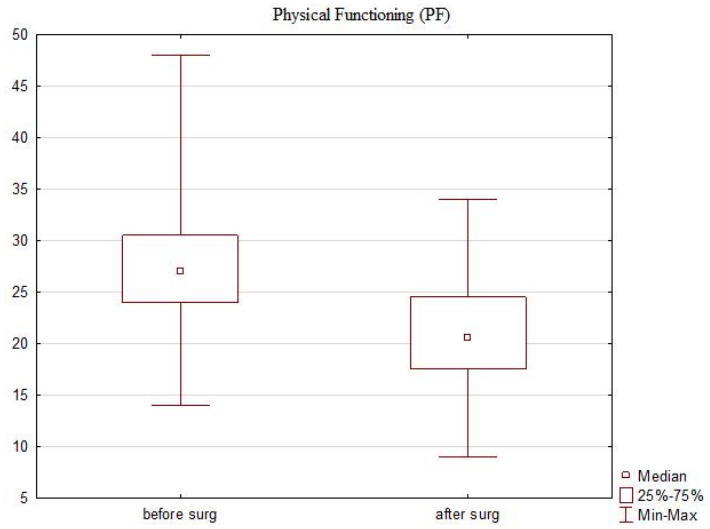

Fig. 2. Total sum of points based on assessment of physical functioning (PF) before and after surgical treatment.

The assessment of the aspect of physical role (RP) ranged from 0 to 20 ± 4.56 points before the surgery. After the treatment, the RP value ranged from 0 to 20 ± 6.5 points. The statistically significant ($p < 0.001$) difference in RP was found in 57% (16 out of 28) of the patients (fig 3).

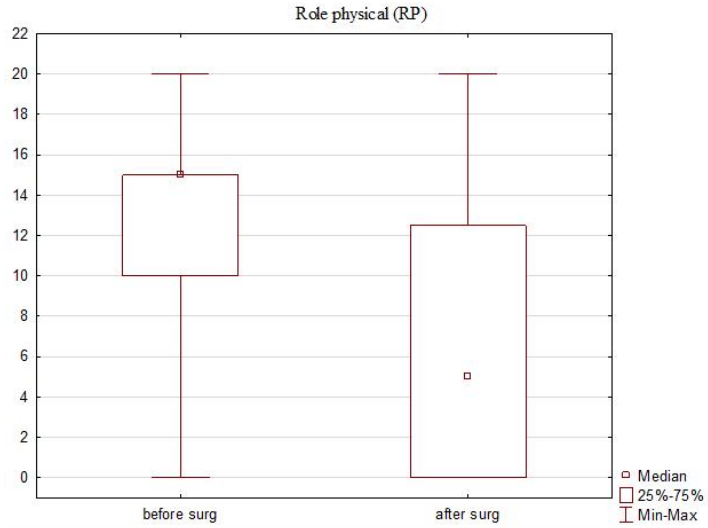

Fig. 3. Total sum of points based on assessment of physical role (RP) before and after surgical treatment.

The point value of the aspect of role emotional (RE) ranged from 0 to 10 ± 3.72 points, before the surgery. After the treatment the RE value ranged from 0 to 10 ± 3.35 points. The statistically significant ($p < 0.001$) difference in RE was found in 27% (6 out of 28) of the patients (fig 4).

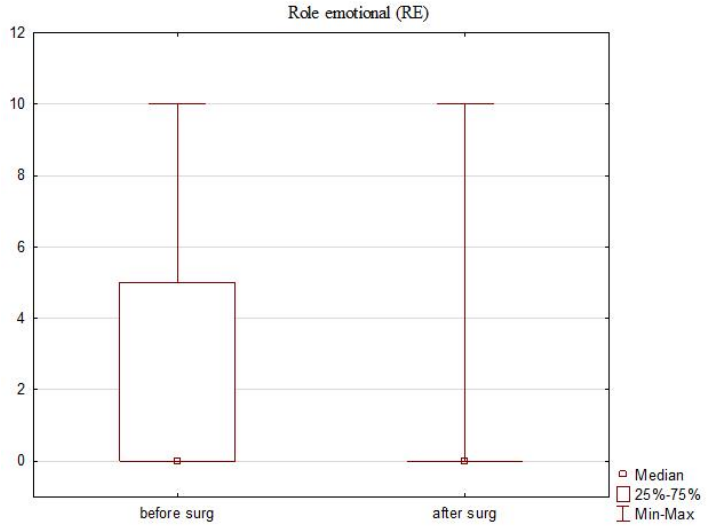

Fig. 4. Total sum of points based on assessment of role-emotional (RE) aspect before and after surgical treatment.

The assessment of the vitality (VT) ranged from 6 to 15 ± 2.6 points, before the surgery. After the treatment the VT value ranged from 1 to 12 ± 2.28 points. The statistically significant ($p < 0.001$) difference in VT was found in 93% (26 out of 28) of patients (fig 5).

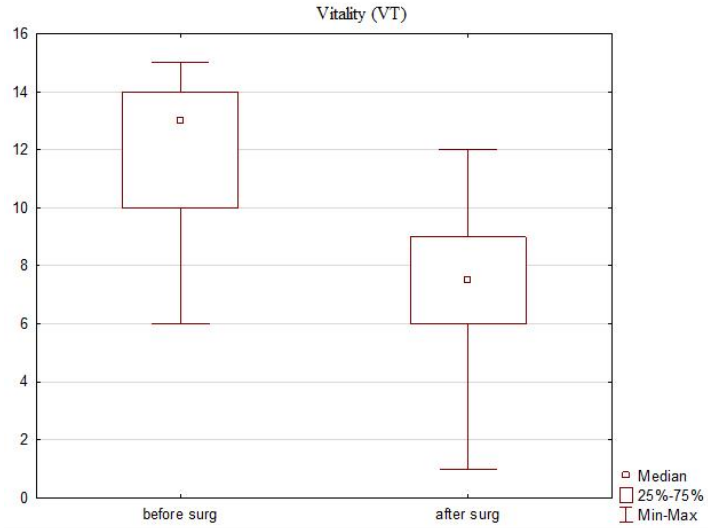

Fig. 5. Total sum of points based on vitality (VT) assessment before and after surgical treatment.

The point value of the assessment of mental health (MH), ranged from 7 to 19 ± 2.68 points, before the surgery. After the treatment the MH value ranged 5 to 13 ± 2.14 points. The statistically significant ($p < 0.001$) difference MH was found in 93% (26 out of 28) patients (fig 6).

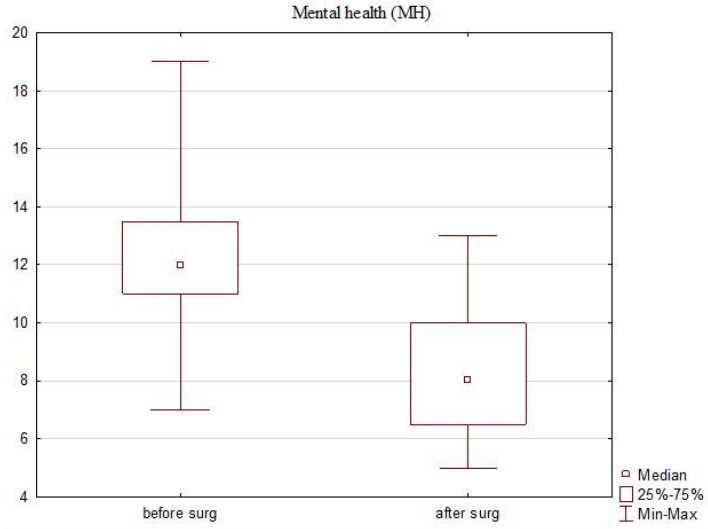

Fig. 6. Total sum of points based on mental health (MH) assessment before and after surgical treatment

The point value of the assessment of the social functioning (SF) ranged from 2 to 7 ± 1.32 points, before the surgery. After the treatment the SF value ranged 1 to 5 ± 0.94 points. The statistically significant ($p < 0.001$) difference in SF was found in 68% (19 out of 28) of the patients (fig 7).

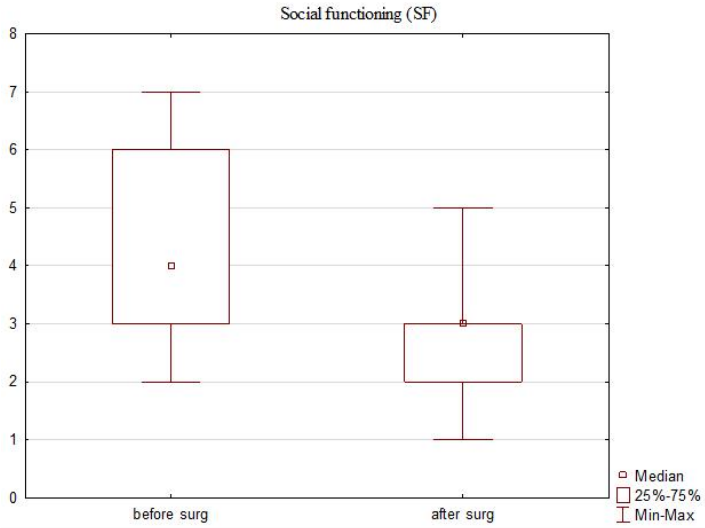

Fig. 7. Total sum of points based on social functioning (SF) assessment before and after surgical treatment

The total sum of points assessing bodily pain (BP) ranged from 2 to 8 ± 1.64 points, before the surgery. After the treatment the BP value ranged 2 to 8 ± 1.4 points. The statistically significant ($p < 0.001$) difference in BP was found in 89% (25 out of 28) of the patients (figure 8).

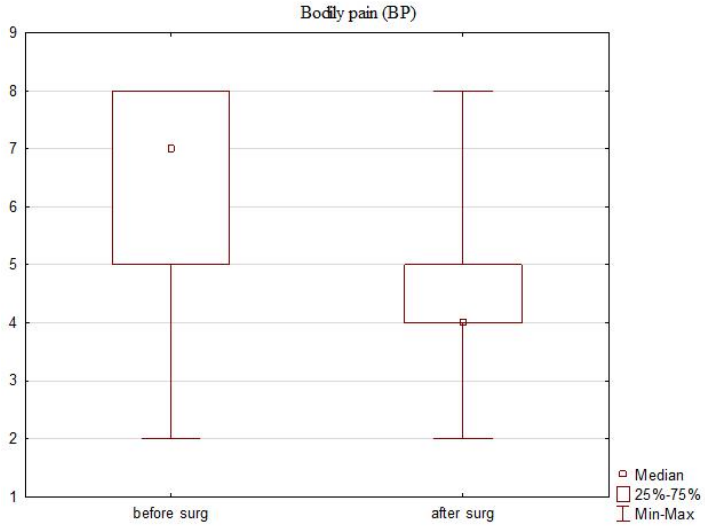

Fig. 8. Total sum of points based on bodily pain (BP) assessment before and after surgical treatment.

The total sum of points assessing general health (GH) ranged from 8 to 19 ± 1.64 points, before the surgery. After the treatment the GH value ranged 6 to 17 ± 2.66 points. The statistically significant ($p < 0.001$) difference in GH was found in 93% (26 out of 28) of the patients (fig 9).

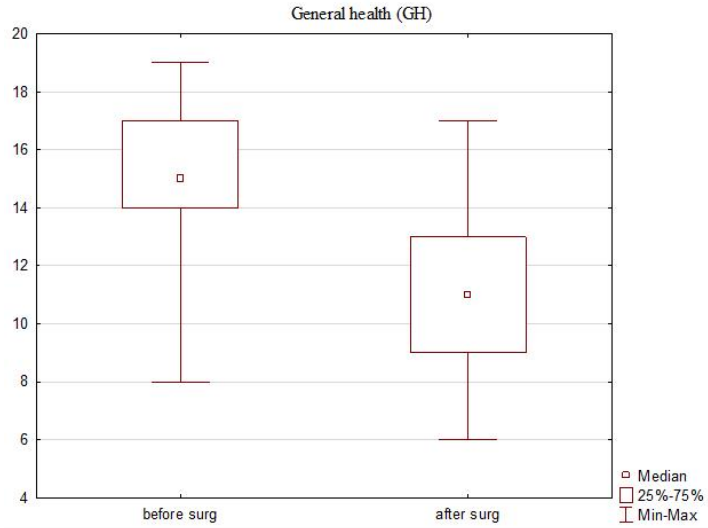

Fig. 9. Total sum of points based on general health (GH) assessment before and after surgical treatment.

b. Assessment of neck pain and disability before and after surgical treatment based on the NRS and NDI questionnaire.

Up to 97% of the patients who underwent ACDF reported a significant decrease in pain severity measured with NRS. The difference was statistically significant ($p<0.005$).

After surgical treatment, there was also a significant ($p<0.05$) reduction in the intensity of neck pain in all the patients.

There was statistically significant ($p<0.05$) reduction of pain correlated with the improvement in every-day personal care, such as washing and dressing, in up to 50% of patients after surgery measured with NDI. Before the surgical treatment, all patients had different limitations in self-care activities, and 16.7% of patients needed assistance during every-day personal care. After treatment, every-day activities were carried without help and were not causing an additional extra-neck pain. The difference was statistically significant $p<0.005$.

c. In other aspects of the NDI scale, the following results were obtained.

Up to 70% of patients undergoing ACDF reported significant ($p<0.05$) reduction of pain during lifting heavy weights.

A statistically significant ($p<0.05$) reduction of pain related to reading was observed after surgical treatment in 70% of patients.

Authors also have found significant ($p<0.05$) reduction of frequency of headaches in up to 50% of patients after surgical treatment. Moreover, a statistically significant ($p<0.05$) reduction of difficulty in concentrating was found in 50% of patients after surgical treatment.

The assessment of professional activity is considered a valuable indicator of the treatment effectiveness. Authors have found statistically significant ($p<0.05$) improvement of working ability in up to 77% of patients after surgical treatment.

The next tested parameter was the ability to drive a car. Authors have found a statistically significant ($p<0.05$) improvement of ability to drive a car in up to 37% of patients after surgical treatment.

A common problem is insomnia accompanying chronic pain in cervical discopathy. Authors have found a statistically significant ($p<0.05$) reduction of sleeping problems in up to 70 of patients after surgical treatment.

The last aspect raised in the NDI questionnaire was recreation. After the surgical treatment, there was a statistically significant ($p<0.05$) reduction of impact of the neck pain on recreational activity in up to 90% of patients.

There was a statistically significant ($p<0.05$) difference between preoperative and post-operative total sum of points reached in NDI questionnaire in the whole study group.
Up to 83% of patients achieved a reduction of the NDI index by 5 or more points, after surgical treatment. No statistically significant difference was noted between patients with single and multi – level discopathy ($p>0.05$).

4. Discussion

ACDF is an effective method for the treatment of degenerative cervical disc disease [11,12]. Our study examined the clinical outcome and health-related quality of life of patients after ACDF procedure with stand-alone PEEK cage. Other authors report good or excellent clinical results [13] associated with the decompression of the nerve structures in 70-90% of patients [14]. Also, a correlation between the absence of fusion and the incidence of postoperative neck pain was previously reported. The lack of subsidence and stable intervertebral spondylosis after the surgical treatment in our patients, contributed to better clinical outcome regarding overall pain relief. No patient has developed a symptomatic pseudarthrosis that required surgery. This confirms that implantation of PEEK cages is safe and has high fusion rates and good clinical and radiological results [15]. Analysis of available literature shows possible correlation between alignment of the sagittal cervical spine and the quality of patient's life after ACDF. Some authors point that the recovering of the intervertebral disc height is less important. Poor cervical alignment correlates with higher incidence of neck and arm postoperative pain, as well as the need for redo surgery. The preservation of the cervical lordosis is important for clinical outcome. Lordotic alignment contributes to good motion and function of the cervical spine [16]. According to some authors, sagittal alignment was associated with cervical instability, pain and even unfavorable functional recovery [17,18].

Our analysis of biomechanics after ACDF showed postoperative reduction of mobility of the cervical spine of which patients did not complain. The data were published in the previous study [15]. The reduction of mobility of total cervical spine and the hypermobility of the segment above the level of operation, did not influence significantly the quality of life after surgical treatment. In our study, the clinical results and pain were assessed using NRS scores and the NDI index. The most important factor of the quality of patent's life is the relief of pain. In our survey, the quality of patient's life has improved greatly and significant relief of pain was confirmed by NRS and NDI questionnaires in up to 97 % of patients. The improvement of the neurological status significantly contributed to the subjective perceived improvement of the quality of life. There was also a statistically significant difference in the bodily pain measured by SF-36, in up to 89% of patients. Misterska et al. [19] validated the Polish version of the NDI questionnaire for the patients with degenerative changes of the cervical spine. One of the basic methods of evaluation performed by patient, is the self-assessment of treatment results (PRO, patient reported outcome). Parker et al. [20] defined the MCID (*minimal clinically important difference*) in patients undergoing ACDF surgery due to cervical radiculopathy. Based on the obtained results, the authors confirmed the clinical usefulness of the NDI questionnaire corresponding with the MCID results in about 17.3%. According to our observations significant reduction in all categories assessed with the NDI scale (pain intensity, personal care, lifting, reading, headaches, concentration, work, driving, sleeping, recreation) indicates the high effectiveness of the procedure in a selected group of patients. We can conclude, that single or multilevel ACDF in patients with degenerative cervical discopathy is an effective method of reducing the pain, reducing physical activity limitations and functional disability, and improving the quality of life.

Massel et al. [21] showed better clinical results connected with reduction of neck pain and arm pain in patients with single-level ACDF compared to the two-level procedures (35% improvement to 26.5% improvement of NDI index respectively). The number of

operated levels usually negatively correlate with postoperative outcome, which is due to higher risk of post-operative spine instability. In our study, the number of operated levels did not influence the mobility of cervical spine. There was no statistically significant difference in NRS and NDI scores between groups of patients operated on one or two levels. 33 RCT (randomized clinical trial) analysis, performed by Jacobs et al. [22] comparing different stabilization techniques in one or two-level discopathy, showed similar clinical results in both groups. We observed similar results connected with neck pain and disability index in patients after one- or two-level surgery. According to our data, the operation at the next level was not associated with worse clinical outcome. The quality of life of our patients was measured with the Polish version of the SF-36 by RAND, before and one year after the procedure. We found a significant increase in all aspects of HRQOL in our patients ($p<0.001$). Reports from many authors clearly indicate an improvement in the quality of life of patients undergoing ACDF surgery. Shiban et al. [16] showed statistically significant short-term benefits such as pain relief and improvement in self-care aspects using the EQ-5D questionnaire in patients after ACDF. Several studies compare the EQ-5D with other questionnaires, including SF-36. It was found that EQ-5D questionnaire clinically correlate with SF-36. Schroeder et al. [23] performed a retrospective assessment of clinical outcomes in the group of 360 patients after ACDF, and confirmed the indicators of improvement including physical component summary (PCS) and mental component summary (MCS) of SF-12 questionnaire, which is a short version of SF-36. SF-12 improves the efficiency of collecting data, but has limitations due to the smaller amount of information collected about health status of the patient. Among our patients, the PF (physical functioning) aspect improved the most, the least although still statistically significant improvement was noticed in RE (role emotional) - limitation of regular daily activities, including work, because of emotional problems. Our results confirm that ACDF procedure enables improvement in HRQOL during one-year observation, which is one of the most important parameters that indicate the effectiveness of the treatment. According to patients, pain relief is the most important aspect in everyday functioning. Pain relief improved the comfort of life and enabled everyday activities. Carr et al. [24] divided patients undergoing ACDF surgery, after one level and two level ACDF, into two groups with different expectations. The first group consisted of patients expecting complete remission of pain symptoms after the procedure, the second group accepted post-operative pain of moderate severity. The average follow-up was about 3 years. The impact of mental health on clinical outcome and treatment satisfaction was assessed on the basis of the SF-MCS scale. Higher preoperative MCS SF-36 results in the second group of patients were associated with better clinical results (VAS scale, NDI index, SF-36 PCS scale). The results of the Mayo et al. [25] suggest that better preoperative mental health condition is associated with a lower perceived preoperative disability, but is not related to the severity of preoperative pain in the neck or shoulders. In our study, we did not investigate the correlation of the depression index with the improvement of clinical results after ACDF surgery during one year of observation.

The limitation of our study is the fact that all the scores used in our survey are assessed by the patient. Every patient has a different pain threshold, different fears before surgery and different expectations regarding surgery. In addition to the radiological and biomechanical improvement, it is important that the neurological deficits and myelopathy do not worsen. Lower costs of returning to functioning in the society, stopping medication and returning to work were seen by patients as important aspects of the effects of the treatment. Patients who were often dependent become self-reliant.

5. Conclusions

ACDF surgery is an effective method to reduce the severity of pain in patients with degenerative disc disease. ACDF improves the quality of patient's life. The physical role

improved most significantly; the least improvement was noted in role-emotional aspect. Our results indicate a significant increase in health-related quality of life (HRQOL) according to 36-Item Short Form Survey (SF-36) in all our patients ($p < 0.001$). Up to 83% of patients achieved a reduction of the NDI index by 5 or more points, after surgical treatment. No statistically significant difference was noted between patients with single and multi – level discopathy. Up to 97% of the patients who underwent ACDF reported a significant decrease in pain severity measured with NRS.

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Figure legend:

Fig. 1. Total sum of points based of short form 36 before and after surgical treatment.

Fig. 2. Total sum of points based of physical functioning (PF) before and after surgical treatment.

Fig. 3. Total sum of points based of physical role (RP) before and after surgical treatment.

Fig. 4. Total sum of points based of role-emotional (RE) before and after surgical treatment.

Fig. 5. Total sum of points based of vitality (VT) before and after surgical treatment.

Fig. 6. Total sum of points based of mental health (MH) before and after surgical treatment

Fig. 7. Total sum of points based of social functioning (SF) before and after surgical treatment

Fig. 8. Total sum of points based of bodily pain (BP) before and after surgical treatment.

Fig. 9. Total sum of points based of general health (GH) before and after surgical treatment.