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Anterior Contralateral Cervical Microdiscectomy at C7-T1

Okan KAHYAOGLU[1], S. Meltem CAN[1], Halit CAVUSOGLU[1], Ismail YUCE[2], Yunus AYDIN[2]

[1]Acibadem Health Group Fulya Hospital, Clinic of Neurosurgery, Istanbul, Türkiye
[2]Acibadem Health Group Taksim Hospital, Clinic of Neurosurgery, Istanbul, Türkiye

Corresponding author: S. Meltem CAN ✉ smeltemc@yahoo.com

ABSTRACT

AIM: To retrospectively review the patients who had disc herniation at C7-T1 level and were treated using the senior author's anterior contralateral simple microdiscectomy without fusion technique.

MATERIAL and METHODS: From January 2000 to December 2021, 27 patients underwent surgery for C7-T1 disc herniation, all of which were performed by the same neurosurgeon. Clinical and radiological data were collected before surgery and at 3 and 24 months after surgery. The Short Form-36 and Neck disability questionnaire were used to assess the quality of life.

RESULTS: All patients presented with radiculopathy. There were 16 male and 11 female patients, with an average age of 40 years. The average follow-up period was 9.7 years. The postoperative Short Form-36 and Neck Disability Index scores were significantly different from the preoperative scores. Overall scores at the postoperative 24th month did not differ significantly from those obtained at the postoperative third month.

CONCLUSION: We propose that patients with symptoms of disc herniation at C7-T1 level benefit from an anterior contralateral microdiscectomy without fusion.

KEYWORDS: Anterior cervical microdiscectomy, C7-T1 disc herniation, Cervicothoracic junction, Contralateral approach

ABBREVIATIONS: AF: Annulus fibrosus, **C:** Curette, **CTJ:** Cervicothoracic junction, **HD:** Herniated disc, **LCM:** Longus colli muscle, **MCS:** Mental component score, **MRI:** Magnetic resonance imaging, **NCSS:** Number cruncher statistical system, **NDI:** Neck Disability Index, **PCS:** Physical component score, **PLL:** Posterior longitidunal ligament, **SF-36:** Short Form-36

INTRODUCTION

The C7-T1 level, known for its unique anatomical and biomechanical characteristics as well as imaging difficulties, continues to pose a challenge for surgeons due to the differences in therapeutic approach. The herniation at this level makes up 1.11% to 8% of all cervical disc herniations (1,2,4,11,14,16-18). This level marks the transition of the spine from a highly mobile cervical segment to an immobile thoracic segment. Because it is both a cervical segment level and the cervicothoracic junction segment, it is often referred to as a member of the thoracic segment.

The absence of the Luscka joint, which allows for axial rotation and flexion-extension movements, is the most important anatomical feature that distinguishes the cervicothoracic region and its important member C7-T1 level from the upper cervical levels, which are said to be biomechanically more similar to the lumbosacral junction when compared with other junction regions (12). This anatomical difference has a significant consequence; herniations almost always cause symptoms and signs of lateral-radiculopathy because they weaken the annulus laterally than centrally (9,11,13,14,16-18).

The anterior contralateral microdiscectomy for the treatment of cervical disc hernias is based on the principle of relieving the

Okan KAHYAOGLU : 0000-0002-9510-3509
S. Meltem CAN : 0000-0003-3769-5873
Halit CAVUSOGLU : 0000-0003-1877-7611
Ismail YUCE : 0000-0002-7385-9137
Yunus AYDIN : 0000-0003-4141-9556

pressure on the neural elements without causing instability by employing different approaches and instruments developed by the senior author, which differ from classical methods. Because of the anatomy of the C7-T1 level, anterior accesses present a challenge for surgeons. The technique we have described is equally applicable to the C7-T1 distance as it is to higher levels. In this study we present retrospective analyses of our unique contralateral microdiscectomy technique at the cervicothoracic junction (CTJ).

MATERIAL and METHODS

Between January 2000 and December 2021, a total of 694 patients were treated for cervical disc herniation with the contralateral simple microdiscectomy technique. Twenty-seven patients presented with such a disease at the C7-T1 level. This study included patients who met at least one of the following criteria:

1) The presence of motor weakness indicating radiculopathy, 2) correlation between clinical and magnetic resonance imaging (MRI) findings, 3) failure of conservative treatment for at least three weeks, and 4) no prior surgery for cervical pathology.

All patients underwent clinical examinations and MRI scans before surgery. A neuroradiologist interpreted MRI scans of the cervical spine taken 24 months after surgery. The Neck Disability Index (NDI) and Short Form-36 (SF-36) questionnaires, which are patient-rated instruments, were used to evaluate each patient's surgical outcome before surgery as well as 3 months and 24 months later. The NDI includes 10 items that assess the outcome of neck pain in daily life (19). SF-36 is a 36-item questionnaire that measures primarily two components made up of eight variables: physical component score (PCS) and mental component score (MCS) (21).

All procedures in studies involving human participants were carried out in accordance with the ethical standards of the Local Ethics Committee (Project No. 2024/4397) as well as the 1964 Helsinki Declaration and its subsequent amendments or comparable ethical standards. All individual participants in the study provided informed consent.

The study data were analysed statistically using the Number Cruncher Statistical System (NCSS) 2007 Statistical Software package (Utah, USA). In addition to descriptive statistics (mean and standard deviation), the Shapiro–Wilk normality test was used to examine the distribution. For time comparisons of normally distributed variables, paired one-way analysis of variance was used, and subgroup comparisons were made using the Newman–Keuls multiple comparison test. The statistical significance was set at $p<0.05$.

Surgical Technique

The operation is performed in a similar fashion to the previously described anterior simple discectomy, but it is performed on the contralateral side of the radiculopathy with some modifications. The head is held in a neutral position with a towel roll under the neck, preserving the cervical lordosis. The entire procedure is carried out using an operating microscope. A 2-cm transverse skin incision is made just on the median of the medial border of the sternocleidomastoid muscle. After splitting the platysma muscle longitudinally, finger dissection is used to separate the areolar tissue between the carotid sheath and the tracheoesophageal bundle down to the vertebral bodies' anterior surface. Because the automatic retractors are too large to fit through a small incision, a 15-mm-wide mini-size Zenker hand retractor is used to retract the skin, trachea, and esophagus medially. A C-arm scope verifies the proper level. In contrast to the conventional technique, the longus colli muscles are not stripped. The anterior longitudinal ligament between the longus colli muscles is incised in a rectangular shape just next to the ipsilateral muscle's medial border, with a scalpel. The disc material is removed with micro-curettes and punches down to the posterior longitidinal ligament (PLL) without the use of a spreader, taking care not to remove cartilaginous endplates. However, it is not intended to remove the lateral portions of the annulus fibrosus aggressively. The lateral border of the annulus fibrosus on the intervention side and the ventrolateral part on the opposite side remain intact. If there are posterior osteophytes associated with the disc herniation, they are removed with micro-curettes and/or an air drill to decompress the spinal canal, taking care not to remove cartilaginous endplates. Following PLL excision, the epidural space, foramen, and nerve root are monitored for free sequester. The contralateral approach used in this procedure provides an additional benefit of direct microscopic visualization of the target area (Figure 1). Since 2012, 20 of all patients have undergone an interbody fat graft. The operation is complete once decompression is confirmed by direct inspection under a surgical microscope.

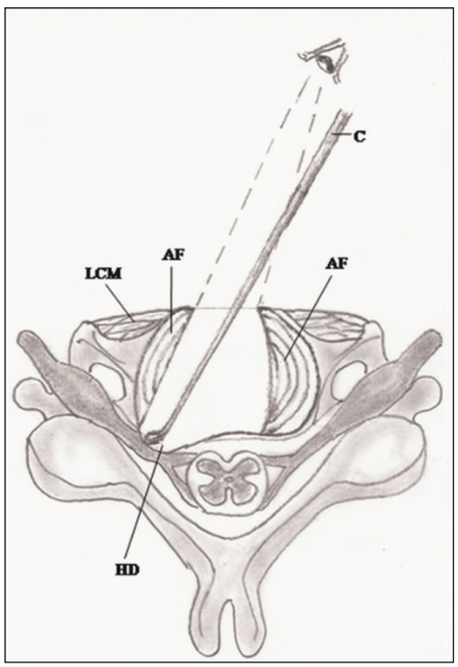

Figure 1: Illustrative drawing of anterior contralateral approach showing a wider angle of exposure to the foramen for cervical microdiscectomy. **AF:** annulus fibrosus; **C:** curette; **HD:** herniated disc; **LCM:** longus colli muscle.

RESULTS

Our cohort consisted of 16 males and 11 females with ages ranging from 29 to 52 years (mean ± standard deviation, 40.48 ± 5.76). Twenty-four of them had one level of herniation, while three had two. No patient had any signs of myelopathy. The primary complaint was the neck pain, that spread through the forearm to the fourth and fifth digits, accompanied by numbness and tingling. Twenty-two of the patients demonstrated motor weakness in their intrinsic hand muscles.

The follow-up period varied from 2 to 21 (mean=9.7) years. All 27 patients recovered immediately after the operation, with no radicular pain and a normal range of motion in their neck. No patient had hoarseness, however, six patients complained of minimal transient dysphagia immediately after the operation.

Within 4 weeks of being discharged, 17 of the 22 patients with radicular motor weakness, had returned to normal. The weakness of the involved muscles did not improve in the other five patients with neurological deficits lasting more than 6 months, necessitating the use of physical therapy.

The SF-36 and NDI scores are shown in Tables I-III. Postoperative SF-36 and NDI scores were significantly different from the preoperative values. Except for physical role functioning, there was no statistically significant difference in overall scores at the third and 24th months after surgery. Figure 2A, B shows the sagittal and axial T2-weighted MRI scans of a 51-year-old female with left C7-T1 herniation. Control MRI scans at the 24th month showed healing without fusion and good alignment (Figure 3A, B). During the follow-up period, no recurrences were observed in all patients. In the late postoperative period, no fusion was observed at the operated level in all patients.

Table I: Short Form 36 (SF-36) and The Neck Disability Index (NDI) Scores of Patients

		Preop.	3rd Month	24th Month	p-value*
SF-36 PCS	Physical Functioning	66.67±8.55	90.19±4.90	89.42±4.32	**0.0001**
	Physical role functioning	44.41±17.49	89.81±12.52	99.87±4.69	**0.0001**
	Pain	31.67±14.58	86.76±6.75	89.23±2.72	**0.0001**
	General health	49.26±11.99	67.96±8.00	66.92±9.17	**0.0001**
SF-36 MCS	Vitality	51.48±14.60	71.11±7.89	71.73±7.74	**0.0001**
	Social functioning	41.67±12.50	95.37±11.58	96.64±10.34	**0.0001**
	Emotional role	66.68±20.68	92.60±14.11	88.47±16.16	**0.0001**
	Emotional well-being	73.67±7.08	83.70±5.08	84.15±5.82	**0.0001**
NDI		28.15±8.21	8.19±2.40	7.81±2.58	**0.0001**

**One way ANOVA.*

Table II: Results of Newman Keuls Multiple Comparison Test for Subgroup Comparisons for SF-36 Physical Component Scores

	SF-36 PCS			
	Physical functioning	**Physical role functioning**	**Pain**	**General health**
Preoperative / 3rd Month	0.0001	0.0001	0.0001	0.0001
Preoperative / 24th Month	0.0001	0.0001	0.0001	0.0001
Postoperative 3rd Month / 24th Month	0.134	0.001	0.100	0.271

Table III: Results of Newman Keuls Multiple Comparison Test for Subgroup Comparisons for SF-36 Mental Component Scores and NDI

	SF-36 MSC				NDI
	Vitality	**Social functioning**	**Emotional role**	**Emotional well-being**	
Preoperative / 3rd Month	0.0001	0.0001	0.0001	0.0001	0.0001
Preoperative / 24th Month	0.0001	0.0001	0.0001	0.0001	0.0001
Postoperative 3rd Month / 24th Month	0.691	0.265	0.256	0.490	0.057

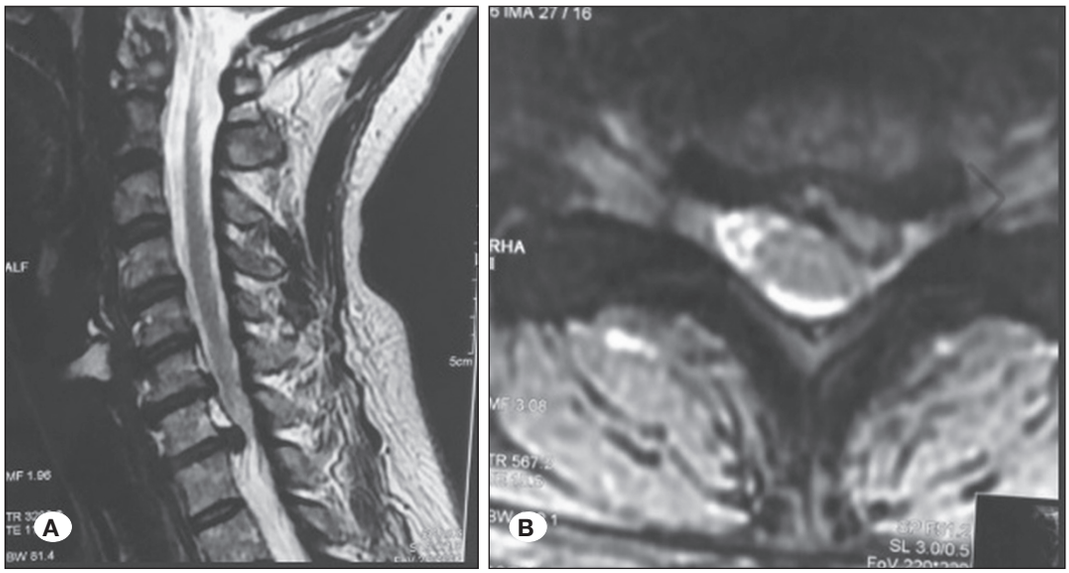

Figure 2: Preoperative sagittal **(A)** and axial **(B)** T2-weighted magnetic resonance imaging scans of a 51-year-old female with left C7-T1 herniation.

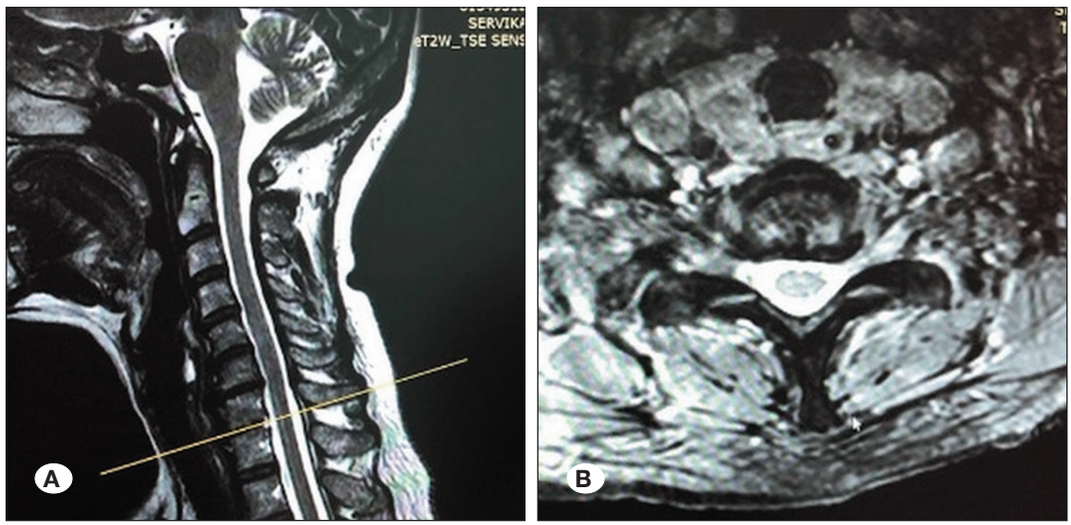

Figure 3: Sagittal **(A)** and axial **(B)** magnetic resonance imaging scans taken at postoperative 24 months, showing healing without fusion and good alignment.

DISCUSSION

We used the simple microdiscectomy, which the senior author (YA) has constantly modified since the 1990s (2,3,7). A literature search for the simple microdiscectomy technique yields numerous publications with positive results before the generalization of the instrumented fusion techniques (4-6,8). For many years, the senior author has advocated for the use simple microdiscectomy, and he has also made some modifications to overcome the limitations of the traditional technique. Except for the left-handed surgeons, the majority of medical literature recommends a right-sided approach and incision site on the neck (4,6,8). Based on the preference of left-handed surgeons in the classical literature, the senior author described the contralateral approach: The incision site is on the opposite side of the brachialgia which corresponds to the site of disc extrusion (2,3,7). Given that C7-T1 disc herniations are typically found on the lateral-foraminal, providing a contralateral view is critical. It enables resection by directly visualizing the pathology, and by directly viewing the disc piece and foramen from the opposite direction.

The most significant change is the selection of retractor system, which eliminates the bulky automated equipment. The conventional Cloward hand held retractor system, designed in the pre-microscope era, has been replaced by the Zenker hand-held retractor, which is 10–12 mm wide and available in a variety of lengths. The assistant's Zenker retractor allows for instant and intermittent retraction of the esophagus and trachea and, unlike constant retractors, does not cause blood supply issues. When the assistant becomes tired or when retraction is no longer required, the Zenker retractor is released.

The surgical incision is typically made slightly lower in the index level checked by the C-arm and close to the midline. The incision site is localized after tangential retraction of the trachea-esophageal structure to prevent lateral retraction during surgery. This is critical for the contralateral technique

due to the use of a one-sided Zenker retractor. The incision measures 15–20 mm and does not allow the surgeon to use an additional retractor. The surgeon uses a suction tube to retract the lateral part.

The intervertebral cartilage has the shape of a convex roof and faces each other as a dome. Preventing postoperative collapse involves sparing the anterior borders of the vertebrae and remaining intradiscally by avoiding end plate violation. It is not advisable to clean the lateral parts of this cupola unless there are mobile, degenerated, or floating free fragments. The lateral parts of the annulus fibrosus remain relatively stable and behave like a washer, and the dome shape of the intervertebral surface helps to maintain the physiological alignment column. After achieving all of these during the operation, postoperative vertebral collapse and alignment issues, which are common after conventional simple microdiscectomy surgery, could be avoided, making this technique extremely minimally invasive. Microforceps designed for endoscopic procedures are also useful in our technique, particularly for the removal of foraminal fragments.

Osteophytic changes are common in chronic cervical disc herniations, accompanying soft protrusions. During the decompression process, the surgeon should not only clean up the degenerated nucleus pulposus but also remove any osteophytes. Removal of osteophytes should be done behind the open cancellous bone surfaces at the upper and lower vertebral corpus edges; otherwise, it may promote bone healing and result in spontaneous fusion. The idea behind putting a fat graft into the disc space is to treat pseudoarthrosis, which preserves the motion segment by preventing fusion between the corpus edges.

The preservation of the motion segment is the most important aspect of cervical total disc replacement, also known as cervical disc prosthesis application techniques. It has gained popularity and is widely used, but in the long run, it has risks of heterotopic ossification, which reduces (15,20).

A head-down position is required to adjust the surgical microscope light array. Being parallel to the intervertebral surface is critical to avoiding end plate injury and exposing the midline of the intervertebral level. This critical procedure allows the surgeon to approach the site of protrusion directly while also gaining lateral access.

Despite difficulties in axial imaging parallel to the disc, MRI remains the gold standard for displaying the disc at the C7-T1 level. If the neurological examination findings strongly indicate this level and the MRI does not help, we will try again with thinner sections. Computed tomographic imaging at the C7–T1 level is difficult due to axial image distortion caused by the majority of the shoulders. It is also challenging to see the C7-T1 level in lateral X-rays. We do not routinely perform tomography and X-ray examinations for C7-T1 disc herniation.

In the literature, a series of interventions at this level consists of either large cervical series or only the patient series related to this level, which are presented in this article. Ryu et al. reported 36 cases of disc herniations at the cervicothoracic junction. In 21 patients, they used the Smith–Robinson technique for the anterior approach, while 15 patients had a posterior foraminotomy with discectomy. This is the largest study to date looking into the characteristics, symptom duration, clinical course, and biomechanics of cervicothoracic junction disc herniation (17). In the series of Falavigna et al., in which they evaluated the radiological diagnosis, clinical appearance, neurological outcomes and surgical planning of the anterior approach to disc herniations at the C7 – T1 level, 19 patients were operated by the anterior approach mostly from the side opposite to the herniation to optimize visualization, and they concluded that a single cage was insufficient despite the discectomy and fusion, and recommended the use of an anterior cervical plate (9). Post et al. performed anterior cervical discectomy and fusion on 10 patients, focusing on their experience with operative management, especially in terms of clinical presentation, imaging, operative exposure issues, and neurological outcomes. They encountered no difficulties during the initial intervention (16). Ozer et al. described their experience with eight patients who had C7-T2 soft foraminal disc herniations (14). In their series, they operated on patients with anterior fusion and, at one level, partial corpectomy, and they examined preoperative and postoperative neurologic charts, surgical techniques, and clinical outcomes Lee et al. investigated the clinical characteristics of 13 patients with cervicothoracic junction disc herniation. In 10 of them, anterior intervention using the standard suprasternal Smith–Robinson approach was sufficient, while two patients required manubriotomy–sternotomy, and one patient was operated on at the incorrect level (11). Mostofi et al. operated on 21 patients, with 13 undergoing posterior simple discectomy and eight undergoing anterior discectomy with fusion (13). Except for the study by Takeuchi et al. (5), which included five patients (9,11,13,14,16-18), all of the reported series involving an anterior approach for C7-T1 disc herniation used bone fusion, cage replacement, and/or anterior instrumentation. They performed an anterior keyhole foraminotomy without fusion by drilling the C7 corpus; however, only the disc fragments or osteophytes compressing the nerve root were removed.

Most series agree that the anterior approach is sufficient, but the difficulties encountered during the anterior approach are highlighted (9,11,14,16,18). Thoracic kyphosis causes the vertebral bodies at the C7-T1 level to be deeply inclined away from the surgeon. This is more of an issue for short and obese patients. The “narrowed operative space” caused by vertebral bone occlusion makes vital anatomical structures such as large blood vessels, the esophagus, the trachea, and the recurrent laryngeal nerve difficult to access. To deal with this, turn the operating table upside down in Trendelenburg position and then raise it as we do at all levels, so that the microscope is in the same plane as the distance. In our series, the technique we used posed no threat to these risky anatomical formations; no sternotomy was required in any of our patients. Except for a short-necked obese patient, we encountered no difficulties during anterior route intervention, as did Post et al. (16). In this patient, we made an incision but did not show the level. Using the C6-7 marking as a reference for the C6-7 distance, we found that we were having difficulty because it remained above the level, so we had to use a modified Zen-

ker retractor. Again, keep in mind that there may be individual differences in bone anatomy.Some authors recommend a posterior approach to the CTJ due to the difficulty of accessing it anteriorly (1). Some studies combined anterior fusion or posterior intervention with microforaminotomy (13,17), while others only performed posterior intervention (1). It was stated that posterior intervention is also appropriate because the majority of herniations are foraminal. Posterior approaches provide limited surgical workspace and the possibility of entering the wrong level (1). Excessive resection of more than 50% of the facet joint can lead to instability and hypermobility (10). There is also the view that facet joint protection is not required due to other biomechanical features of the sternum and cervicothoracic junction, which argue the opposite (13).

CONCLUSION

We believe that the contralateral approach we use at the upper cervical levels, the anterior microdiscectomy technique without fusion and the fat graft procedure are equally beneficial at the C7-T1 level and are not different from other cervical levels. Because this minimally invasive technique does not compromise stability, no interbody fusion materials or anterior instrumentation are required, which may result in complications such as manubrium, mediastinum, and other injuries as well as subsidence, displacement, or improper placement of the intervertebral material

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Declarations

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Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: The authors declare no competing interests.

Informed consent: Informed consent was obtained from all individual participants included in the study.

AUTHORSHIP CONTRIBUTION

Study conception and design: OK, YA
Data collection: OK, SMC
Analysis and interpretation of results: OK, SMC, HC
Draft manuscript preparation: OK, SMC, YA
Critical revision of the article: OK, SMC, HC, IY, YA
Other (study supervision, fundings, materials, etc...): n/a
All authors (OK, SMC, HC, IY, YA) reviewed the results and approved the final version of the manuscript.

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