

EFFICACY OF HIGH SPEED DRILL FOR SAFE AND ADEQUATE NEURAL DECOMPRESSION IN ANTERIOR CERVICAL DISCECTOMY AND FUSION SURGERIES.

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ABSTRACT:

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Background: Risks of inadequate decompression or neural injury during conventional Anterior Cervical Discectomy with Fusion (ACDF) surgery is not uncommon specially in cases with large posterior osteophytes or migrating fragments. Usage of High-speed Drill instead of Curettes and Kerrison Rongeurs may has a role for safe and adequate decompression.

Aim: To assess the efficacy and safety of using high speed drill during ACDF surgery in comparison to conventional approach.

Design: A retrospective comparative study.

Methods: 60 Patients were divided into 2 groups; Group A, 30 patients who underwent Conventional ACDF surgery without using high speed drill, and group B, 30 patients underwent ACDF with the aid of high-speed drill.

Results: Postoperative VAS of neck pain and Upper limbs in both groups had nearly the same end results with no statistically significant difference. In Group A: the mean Postoperative Odom's criteria was 1.47 ± 0.629 SD, while Group B showed nearly the same values. As regards the Japanese Orthopedic Association score (JOA score), Group B showed better results with mean JOA score value equals 15.7 ± 1.02 SD, which showed statistically significant difference between both groups with p-value 0.015. In addition, Group B showed slightly better results as regards operation time and intraoperative Blood loss but with no statistically significant difference.

Conclusion: High speed drill is an efficient and safe tool that can be used in ACDF surgery for adequate neural decompression, with good clinical and radiological outcomes comparable to conventional methods, even with better neurological outcome and less operative time.

Key words: Anterior Cervical Decompression with Fusion (ACDF), cervical disc prolapses, posterior osteophytes, high speed drill.

INTRODUCTION:

Anterior Cervical Decompression and Fusion (ACDF) for cases of cervical disc prolapse associated either with radiculopathy or myelopathy, is a well-known successful and effective procedure. Although many

technological modifications have been reported since this technique was firstly described by Smith and Robinson; some patients may remain with residual symptoms afterwards due incomplete decompression^{1,2}.

Anterior cervical approach can deal with

anterior neural compression, restore cervical lordosis, and results in satisfying clinical outcome. Although strut grafts promote good fusion, they may result in many complications as migration, subsidence, and non-fusion mainly in multiple level surgeries. This prompted the development of synthetic cages anterior cervical plates for stabilization³.

In Patients with posterior cervical osteophytes (retro vertebral), or extruded disc fragment (cranially or caudally migrated); ACDF surgery may be suboptimal for adequate decompression of the neural elements. Spine surgeons may consider other extensive approaches as Anterior Cervical Corpectomy and Fusion (ACCF) for optimum decompression⁴.

Unfortunately, ACCF is considered a more complicated surgery with higher incidence of complications, such as spinal cord or nerve roots injury, excessive bleeding, displacement, or extrusion of the graft. Anterior plating may be associated with post-operative dysphagia, mainly due to irritation of the esophagus by the plate. This complication has been avoided by using stand-alone cervical cages on a wide scale. Nowadays, there are many commercially available types of cages for ACDF⁵⁻⁷.

Although outcomes of ACDF surgery are considered successful, major complications have been rarely reported, such as pseudoarthrosis and cage subsidence. Nonunion and pseudoarthrosis rates have been reported to range between 0% and 20% in ACDF operations^{8,9}.

Recently, high speed drill was introduced to ACDF surgeries aiming to avoid unnecessary manipulations. Neural and bony vertebral injuries were reported in these surgeries due to the thermal effect of high temperature that produced by high-speed drill. However, no studies have been concluded that whether the use of a high-speed drill affects fusion rates when endplate

or osteophyte surgical techniques are used^{10,11}.

AIM OF THE WORK:

In this retrospective study, we are aiming to compare the clinical and radiological outcomes of the conventional ACDF surgery in cases of cervical disc prolapse versus same approach using high speed drill for roots and cord decompression.

PATIENTS AND METHODS:

Our study is a Retrospective Comparative Study that included 60 patients with single or multiple levels cervical disc prolapse that underwent ACDF surgery in the period from January 2020 to December 2021, they were divided into two groups; Group (A) includes 30 patients who underwent Conventional ACDF surgery, and Group (B) which includes 30 patients who underwent ACDF Surgery using High speed drill. Patients included in our study are those with radiculopathy or myelopathy due to cervical disc prolapse or disc- osteophyte complex who received medical treatment for at least 6 months with no improvement, patients with single or multiple levels disc prolapse but not more than three levels. Included patient must had a complete registered clinical and radiological data for at least 12 months follow up period. We excluded recurrent cases from our study, and patients with associated cervical pathologies as; Fractures, infection, bony lesions, cord tumors, ...etc. There was no Age or gender restriction in our study's patients in both groups.

Ethical Consideration:

The protocol of our study obtained an approval from the research ethics committee of our institute, faculty of medicine at Ain Shams University (reference number FMASU R86/2023). Being a retrospective study, patients' consents for participation in the study and for publication were not

applicable.

Preoperative Evaluation

Clinical Evaluation: All included patients had complete registered data for full medical history, neurological assessment, and general examination. Preoperative evaluation of neck pain and upper limb pain severity was conducted according to the Visual Analogue Scale (VAS). While the neurological status was documented at the time of admission, according to Japanese Orthopedic Association score (JOA score) to be compared with postoperative data.

Radiological Evaluation: All included patients should be submitted for plain radiographs and Computed Tomography (CT) scan of the cervical spine to assess cervical alignment and the presence of posterior osteophytes or Ossified Posterior Longitudinal Ligament (OPLL). Magnetic Resonance Image (MRI) of the cervical spine was performed for all cases to assess the affected intervertebral discs, degree of neural tissue compromise.

Types of Surgical interventions:

1- Group A (Conventional ACDF surgery): Anterior approach for Microscopic cervical discectomy and posterior osteophytes removal using curettes and Kerrison Rongeurs for decompression of spinal cord and roots. Right Transverse incision was used in all cases, even those with three levels. Dissection of the platysma is done followed by identification and division of deep cervical fascia along the anteromedial border of the sternocleidomastoid muscle. The carotid pulse is palpated, and the dissection is directed medial to the carotid sheath down to the prevertebral fascia which is opened for exposure of the vertebral bodies and Longus colli muscle. Verification of targeted levels is done using C-arm, followed by elevation of Longus colli muscle on both sides and application of Cloward self-retaining retractor. Microscopic discectomy and removal of posterior osteophytes is done

using curettes and Kerrison Rongeurs, with the aid of Casper Cervical Retractor System. Followed by application of interbody cages for fusion.

2- Group B (ACDF Using high speed drill): Same ACDF approach with all previous steps, but with no need for curettes and Kerrison Rongeurs. After discectomy and exposure of posterior longitudinal ligament; high speed drill with 30 mm Diamond burr is used for posterior decompression of about 3-4 mm from posterior borders of the vertebral bodies above and below this disc level, followed by removal of posterior osteophytes and exposure of both uncovertebral joints. Opening of the ligament to be done with sharp hook, with exposure of the dura and assessment for adequate decompression and exclusion of subligamentous fragments. (Figure 1,2 & 3)

Outcome Measures: Data was collected from patients' medical records including the immediate post-operative period for at least 12 months postoperative. Outcomes were discussed regarding clinical outcomes: in the form of preoperative and postoperative VAS score for neck and upper limb pain, JOA score for neurological status, and post-operative Odom's score. Radiological outcomes to assess postoperative extent of decompression were considered by post-operative plain radiographs and CTs, in addition to comparing operation time, Blood loss, hospital stay and occurrence of complications in both groups.

RESULTS

Statistical methods:

IBM SPSS statistics (V. 26.0, IBM Corp., USA, 2019) was used for data analysis. Data were expressed as Mean \pm SD for quantitative parametric measures in addition to both number and percentage for categorized data. The following tests were done, Comparison between two independent

mean groups for parametric data using Student t test, Comparison between 2 dependent groups for parametric data using Paired t test and Chi-square test to study the association between each 2 variables or comparison between 2 independent groups as regards the categorized data. The probability of error at 0.05 was considered significant, while at 0.01 and 0.001 are highly significant.

This study is a retrospective study including 60 patients diagnosed with cervical disc prolapse. Patients were divided into two groups based on treating surgeon preference; Group A with total number of thirty patients (50%) and Group B; thirty patients (50%).

Characteristics of demographics:

There were 32 males (53%) and 28 females (47%) in our study, the mean age at time presentation in Group A was 49.6 ± 11.181 SD, while it was 52.4 ± 10.75 SD in Group B, with no statistical difference between both study groups. Regarding the number of operated levels, Group A showed an average of 1.57 ± 0.626 SD levels, while Group B showed average number of levels equals 1.63 ± 0.556 SD levels, which also had no significant statistical difference between both groups. (Table 1)

Pain Scores: The mean preoperative visual analogue score (VAS) of neck pain for group A (Conventional ACDF surgery) was 6.23 ± 0.858 SD, in this group the mean VAS of neck pain improved to 2.17 ± 0.699 SD at one-year follow up. In group B (ACDF using high speed drill): the mean preoperative VAS of neck pain was 6.23 ± 0.858 SD and improved to 1.97 ± 0.66 SD at the end of the first postoperative year. As regards VAS of upper limb pain, post operative values in Group A 2.5 ± 0.82 SD, showed significant improvement in comparison to preoperative values, While Group B showed similar results with postoperative values of 2.23 ± 0.568 SD.

There was no statistically significant

difference between both groups regarding pain scales by the end of the first postoperative year with p-value >0.05 .

JOA Score: In Group A: The mean Pre-operative JOA score was 10.766 ± 2.284 SD, which was improved in the one year follow up period to reach the mean values of 14.83 ± 1.57 SD, while Group B showed better results with mean preoperative JOA score of 11.02 ± 2.034 SD, and postoperative improvement with mean value of 15.7 ± 1.022 SD, which showed statistically significant difference between both groups with p-value 0.015. (Figure 4 & 5)

Odom's Criteria: Regarding postoperative Odom's criteria, In Group A: The mean value was 1.47 ± 0.629 SD, while Group B values showed nearly similar results with mean value of 1.4 ± 0.498 SD. There was no statistically significant difference between both groups, using independent sample t-test with p-value >0.05 . (Table 2, Figure 6)

As regards Intraoperative data, Group B (ACDF using Drill) showed slight better results as regards Operative time with mean 112.17 ± 13.37 SD, in comparison to Group A (Conventional ACDF) 116.67 ± 16.1 SD. Also, less blood loss was detected in Group B with mean 105.67 ± 9.26 SD, in comparison to Group A 107.67 ± 10.965 SD. However, there was no significant difference between both Groups. Hospital stays showed similar results in both groups, Group A with mean 2.17 ± 0.379 SD, While Group B mean values was 2.1 ± 0.305 SD. (Table 3)

No Intra-operative complications were reported in all our study cases of both groups, except for 2 cases in Group A, one of them related to inadequate neural decompression, while the other case was due to postoperative cage migration. Group B showed only one intraoperative complication with durotomy that managed conservatively.

Table 1. Preoperative data of the patients

Parameters		Group A	Group B	P-value
No. of cases		30 (50%)	30 (50%)	
Age/ years		49.6 ±11.18	52.4 ±10.75	0.327
No of levels		1.57 ±0.626	1.63 ±0.556	0.664
Sex	Male	17 (56.7%)	15 (50%)	0.65
	Female	13 (43.3%)	15 (50%)	
Levels operated upon	3-4	2 (6.7%)	2 (6.7%)	0.927
	3-4,4-5	2 (6.7%)	2 (6.7%)	
	4-5	6 (20.0%)	6 (20.0%)	
	4-5,5-6	6 (20.0%)	7 (23.3%)	
	4-5,5-6,6-7	2 (6.7%)	1 (3.3%)	
	5-6	7 (23.3%)	4 (13.3%)	
	5-6,6-7	5 (16.7%)	8 (26.7%)	

Table2.

	Group A	Group B	P-value
Preoperative JOA score	10.766±2.28	11.01± 2.03	0.678
Postoperative JOA score	14.83± 1.57	15.7±1.02	0.015 (Significant)
Odom’s Criteria	1.47±0.629	1.4±0.49	0.651

Table3. Perioperative data of the patients

Parameters	Group A	Group B	P-value
Operative time/ minutes	116.67±16.1	112.17±13.37	0.224
Operative blood loss/ ml	107.67±10.965	105.67±9.26	0.448
Hospital stay/days	2.17±0.379	2.1±0.305	0.456
Follow up period/months	13.27±0.761	13.25±0.799	0.91

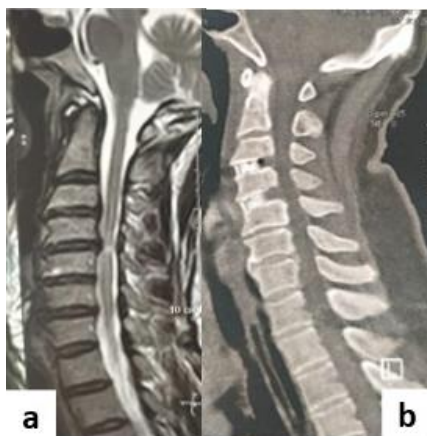


Figure (1): a) Preoperative MRI showing cervical disc prolapse at two levels with cord signal, b) Postoperative CT cervical spine showing wide decompression of posterior endplates using high speed drill with interbody cage application (Group B).

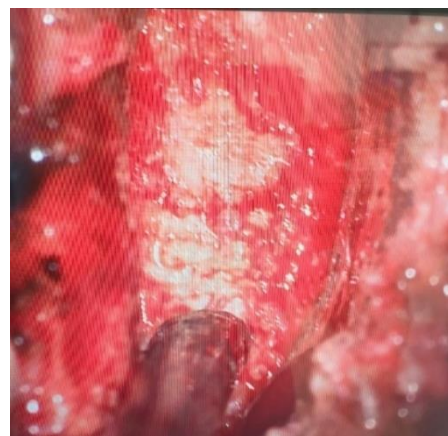


Figure (2): Intraoperative Microscopic image showing wide decompression of upper and lower cervical endplates using high speed drill.



Figure (3): a) Postoperative Plain X- ray for a case of Group A, b) Postoperative Plain X-ray for a case of Group B showing wider posterior decompression.

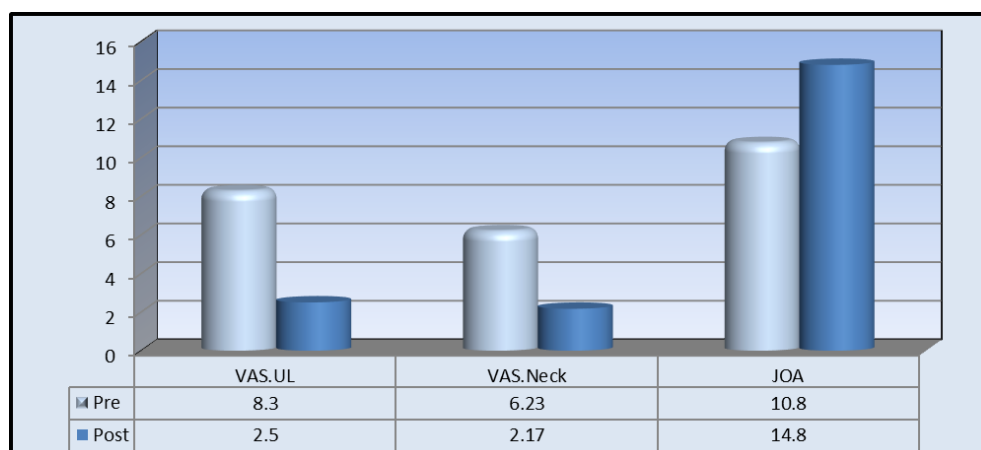


Figure (4): Comparison between preoperative & postoperative values as regards VAS UL, VAS Neck and JOA score among Conventional group (Group A)

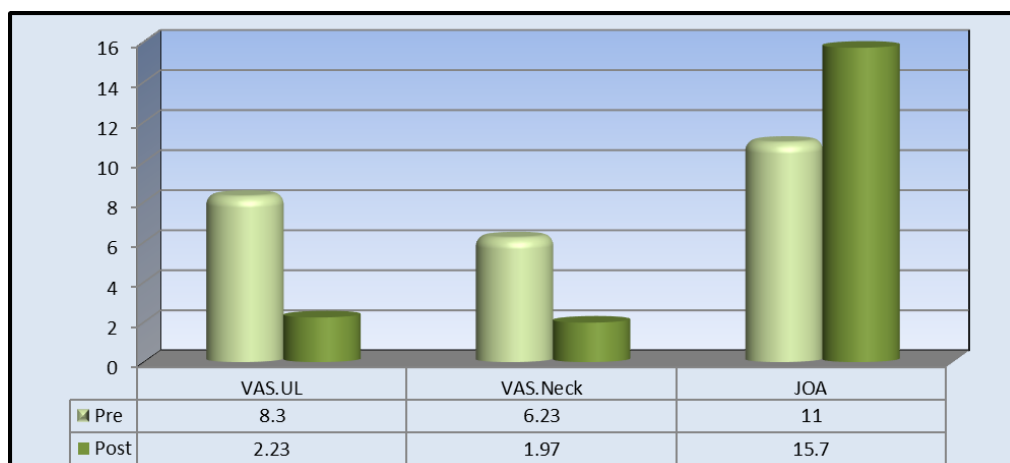


Figure (5): Comparison between preoperative & postoperative values as regards VAS UL, VAS Neck and JOA score among High Speed Drill group (Group B)

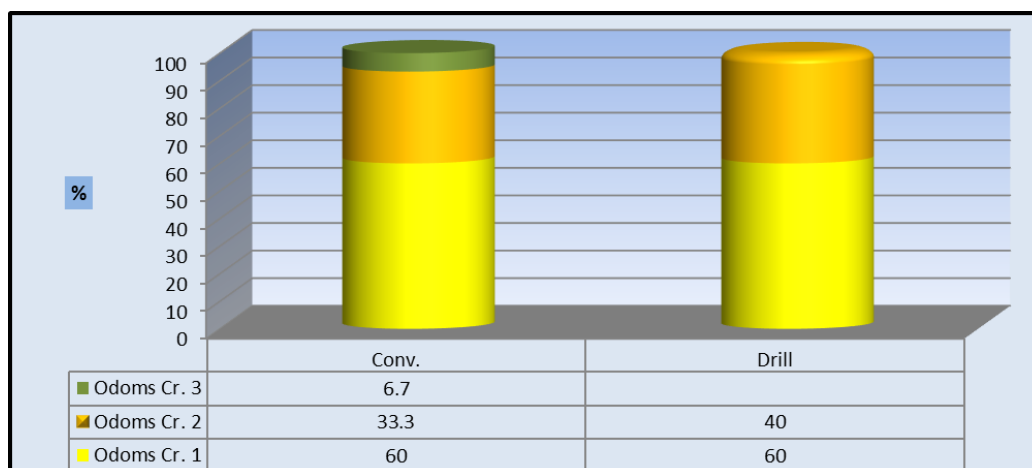


Figure (6): Percentage of postoperative Odom’s Criteria in Both Groups.

DISCUSSION:

Anterior Cervical Discectomy and Fusion (ACDF) is considered the most used approach for the surgical management of cases with cervical disc prolapse or degenerated discs as it can efficiently achieve good results in the form of immediate stability, lordotic curve restoration, and fusion enhancement. Postoperative Cage subsidence is one of the crucial problems that occurs in these surgeries due aggressive uncontrolled curettage of vertebral endplates or due to excessive distraction because of improper selection of cage size and quality^{10,12}.

In our current study, we tried to assess the efficacy of safe decompression of the neural elements by removing the compressing posterior osteophytes after controlled partial drilling of the upper and lower endplates. Two patient groups underwent surgical treatment of cervical disc prolapse and disc-osteophyte complex, group A (Conventional ACDF) and group B (ACDF using high speed drill). The demographic, clinical and radiological properties were homogenous with no statistically significant difference.

In a recent study, comparison between two similar groups was done as regards pain

scores, JOA score and Odom’s criteria. Good outcomes according to Odom’s criteria were detected in group A in which ADCF was done using High speed drill at a rate of 93.3%, while in the other group where ACDF was done by curette; the rate was 89.9%. Significant improvement was noted in pain by VAS scores in both groups, and so, no significant difference was detected in both techniques in terms of clinical recovery¹⁰.

These results were comparable to our study’s results which showed that the Postoperative VAS of neck pain and Upper limbs were significantly improved in both groups in comparison to preoperative values, yet both had nearly the same end results and there was no statistically significant difference between both groups regarding pain scales by the end of the first postoperative year. Also, the mean postoperative Odom’s criteria showed nearly the same values in both groups. While as regards JOA score used for postoperative neurological assessment, our study showed statistically significant difference between both groups, with better results in the high-speed drill group.

Although it has been reported in the literature that high-speed drill has a thermal effect that may cause necrosis in the

surrounding bone and lead to apoptosis in osteoblasts¹³⁻¹⁵. Our study showed no complications related to the thermal effect of the high-speed drill on the rate of fusion or any other parameters in comparison to the other group that depends on curette and Kerrison Rongeurs.

Many complications are known to be related to ACDF surgery. C5 palsy is one of the common complications, in addition to dysphagia, hoarseness, infection, cerebral fluid leakage, epidural hematoma, and pseudoarthrosis^{1,5,16}.

Our study which includes 60 patients showed only 3 complications after procedure. Group A (Conventional ACDF) showed 2 cases with complications, the first one was related to inadequate decompression of spinal cord with residual posterior osteophytes apparent in postoperative images, patient had postoperative residual symptoms and was managed conservatively with medical treatment. The second case showed cage migration due to inadequate decompression and placement of the cage, it needed another surgery for better decompression using high speed drill this time and re-positioning of the cage was done. Group B (ACDF Using high speed drill) showed only one case with complication, patient had intraoperative accidental durotomy while using the drill with CSF apparent postoperative in the Redivac drain. This case was managed conservatively by application of gel foam on the dura intraoperative, then late removal of the Redivac, no CSF collection or leakage from the wound was detected.

The present study confirms that High speed drill is an efficient and safe tool in ACDF surgeries for decompression of neural tissue with comparable results to conventional surgery and even with better outcomes as regards neurological outcome by JOA Score, in Addition to less operation time and intraoperative blood loss.

There are some limitations in our study.

First, this study is a retrospective study which was done completely in a single institute. Second, patients' allocation was according to surgeon preference and not at random. Finally, the sample size is small and lacked long-term follow-up. So, multicenter comparative study with long-term follow-up is recommended to establish the obtained results.

Conclusion: High speed drill is an efficient and safe tool that can be used in ACDF surgery for adequate neural decompression and removal of posterior osteophytes, with good clinical and radiological outcomes comparable to conventional methods, even with better neurological outcome, less operative time, and blood loss. However, a multicenter study with long term follow-up is highly recommended.

List of abbreviations:

ACDF: Anterior Cervical Decompression and Fusion.
ACCF: Anterior Cervical Corpectomy and Fusion.
CSF: Cerebro-Spinal Fluid
JOA: Japanese Orthopedic Association.
SD: Standard Deviation.
VAS: Visual Analogue Score.

Conflict of Interest:

The authors declared that there is no conflict.

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كفاءة جهاز الحفار سريع الحركة في رفع الضغط الكافي والآمن عن الأعصاب في جراحات استئصال الغضروف العنقي من الأمام

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البيانات الخلفية: إن مخاطر عدم الرفع التام للضغط علي النخاع الشوكي والأعصاب أثناء الجراحات الأمامية المعتادة لاستئصال الغضروف العنقي؛ ليست بالقليلة خاصة مع حالات الزوائد العظمية الخلفية الكبيرة والغضروف المنفصل، ولذلك فإن لاستخدام الحفار الجراحي سريع الحركة بدلاً من الآلات الجراحية المعتادة دور ربما يساعد في الوصول إلي رفع ضغط عن الأنسجة العصبية بشكل كامل وآمن..

الغرض: مقارنة النتائج الإكلينيكية والتغيرات على مستوى الأشعة للتدخل الجراحي الأمامي العادي في حالات الإنزلاق الغضروف العنقي، مع التدخل الجراحي الأمامي باستخدام الحفار الجراحي السريع لرفع الضغط عن النخاع والأعصاب.

تصميم الدراسة: تحليل بأثر رجعي لسلسلة من الحالات.

المواد والأساليب: تضمنت الدراسة الحالات المصابة بإنزلاق غضروفي عنقي والتي تمت علاجها عن طريق التدخل الأمامي لاستئصال الغضروف وتثبيت الفقرات وذلك بمستشفيات جامعة عين شمس. وقد تم تقسيم تلك الحالات إلى مجموعتين؛ مجموعة (أ) (٣٠ حالة) وقد تم علاجها بالتدخل الأمامي المعتاد، ومجموعة (ب) (٣٠ حالة) تم علاجها باستخدام جهاز الحفار السريع

النتائج: إن التحسن في مؤشرات الألم شهد تحسناً ملحوظاً في المجموعتين، ولكن بدون فرق إحصائي واضح. نفس النتائج قد شهدتها تغيرات ما بعد الجراحة الخاصة بالتحسن الإكلينيكي. أما على مستوى التغيرات الوظيفية، فقد أثبتت النتائج تحقيق المجموعة (ب) التي تم استخدام الحفار الجراحي بها تحسن ملحوظ مع فارق إحصائي واضح عن المجموعة (أ). كما شهدت المجموعة (ب) أيضاً نتائج أفضل على مستوى المدة الزمنية للجراحة، ونسبة فقدان الدم داخل الجراحة عن المجموعة (أ).

الخلاصة: إن استخدام الحفار الجراحي في الجراحات الأمامية لاستئصال الغضروف العنقي هو وسيلة آمنة وكافية لرفع الضغط التام عن الأنسجة العصبية وذلك مع تحسن ملحوظة على مستوى مؤشرات الألم والتحسن الإكلينيكي والوظيفي بعد الجراحة.