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Safety of the Prevertebral Approach for Cross C7 Transfer in Traumatic Brachial Plexus Palsy

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ABSTRACT

Introduction: High disability present in traumatic brachial plexus palsy with total nerve root avulsion, as nothing left for intra plexus repair. Nerve transfer from nearby donors has a disadvantage of having a low number of myelinated fibers to innervate totally avulsed plexus. Using cross C7 (CC7) could add more donor myelinated fibers to solve this problem.

The Aim of Study: Is to assess the safety of pre-vertebral approach (retro-esophageal) in comparison with a subcutaneous tunnel by using vascularized ulnar nerve graft (VUNG).

Patients and Methods: Nineteen patients with total nerve root avulsion were divided according to the operative procedure into two groups: Prevertebral approach for turned on cross C7 (group I), and subcutaneous tunnel with VUNG (group II).

Results: No significance difference could be detected between group I and group II regarding the mean value of shoulder motor recovery, elbow motor recovery, hand motor recovery, hand sensation, or follow-up period. However, the duration of surgery in group I was significantly lower and the hospital stay was significantly shorter than that of group II. Moreover, the incidence postoperative complications were higher in group II.

In Conclusion: Cross C7 can be done through subcutaneous approach with VUNG or through pre-vertebral retro-esophageal approach. Pre-spinal retro-esophageal approach is safer, easy, and protected tunnel for CC7 transfer to lower plexus avulsion neuritization.

Key Words: *Cross C7 – Brachial plexus – Prevertebral – retro-esophageal – Vascularized ulnar.*

INTRODUCTION

Traumatic brachial plexus palsy is highly disabling, particularly with total nerve root avulsion, which means, nothing left for spontaneous recovery, or direct intraplexal repair **[1,2]**. Motorcycle accidents and road traffic injuries are usually the etiology **[2-4]**.

Five root avulsion injuries require a lot of effort either (primary or secondary). Primary plexus surgery includes using of any donor nerves available, like spinal accessory nerve, intercostal nerves, branches from cervical plexus, phrenic, or contralateral cervical seventh nerve root, or secondary tendon or muscle transfers osteotomies and bone fusions, and free functioning muscle transfer **[1,2,5-9]**.

Gu et al. **[1]** started to present a success with the use of CC7 transfer. Other authors documented a wide range of variability in the results of their cases **[3,10-12]**.

The merits of intraplexal donor in the primary repair of brachial plexus are quit acceptable. With 5 root avulsion, there is no ipsilateral plexoplexal repair, and using the contralateral normal C7 has no permanent effect on normal contralateral limb **[13]**.

This idea is well accepted in many schools **[14,15,16]**. The usual approach entail passing a vascularized graft to connect affected avulsed plexus with donor cross C7, through a subcutaneous pathway in the front part of neck and pectoral region **[16]**. This approach is long, with blind dissection, may associated with hematomas, and exposure of the graft in a subcutaneous tunnel to a lot of problems is evident **[17-21]**.

So pre-vertebral approach (retro-esophageal) can be a solution. The purpose of this study to assess the safety of this approach in comparison with a subcutaneous tunnel by using vascularized ulnar nerve graft (VUNG), degree of difficulties in both tunnels, and merits of these approaches in cross C7 transfer.

PATIENTS AND METHODS

From December 2012 to January 2016, 19 patients with possibility of total 5 roots avulsion traumatic brachial plexus palsy presented to plastic

surgery unit, Zagazig University. No previous primary brachial plexus surgery was done for the patients. This retrospective study was done to these patients; design was approved by ethical committee of institutional review board (IRB) of Faculty of Medicine Zagazig University. Written consents containing the details of operative and postoperative interventions with permission for pre and post-operative photography were taken from all patients included in this study. These patients' were 17 males and 2 females, their age ranged from 15 to 30 years. 12 of the patients were affected in right side and 7 in the left side, caused by Motor cycle accident in 14 cases (73.68%) and road traffic accident in 5 cases (26.32%). Thorough clinical examination after detailed history taking was performed and documented in a sheet. Electromyography and CT myelography were added to aid in the diagnosis **[6,11]**.

The patients were divided according to the approach for reconstructive procedure into two groups: Prevertebral approach for turned on cross C7 (group I) in which eleven patients were included, with cable sural nerve grafts to neuritize the lower trunk from cross C7. And Subcutaneous tunnel with vascularized ulnar nerve graft (VUNG) (group II) in which the other eight patients were included.

The operative procedures were done 3 to 9 months after trauma the patients stays postoperative from two to ten days in the hospital. While, the patients of group I didn't need any blood transfusion, five patients (62.5%) of group II had received 500 CC blood intraoperatively.

Surgical technique:

General anesthesia without muscle relaxation was given to the patient, and trial to give innervation to shoulder, elbow flexion, and hand was attempted after exploration of the affected plexus. While the patient lied in a supine position with tilting of the head toward normal side, assessment of the affected plexus and assuring that there was no available roots (root avulsed), can be used for intra-plexal repair. Obtaining the donor nerve transfer from spinal accessory (SAN) to suprascapular nerve and 3 intercostal nerves (ICN) to musculocutaenous nerve (MCN) was done for all the patients. Then after, exploration of the contralateral plexus was done through a transverse neck surgical incision, with dissection of the C7 nerve root, which was confirmed by electrical elbow and wrist extension after nerve stimulation. The patients then divided into 2 groups:

Group I: The prevertebral retro-esophageal pathway was achieved from contralateral donor side just dorsal to carotid sheath, then dissection by blunt small soft gauze on clamp, to be passed gently over the fascia enclosing the scalene anterior (after protecting phrenic nerve beneath the fascia). This blunt dissection continued to the potential space behind the beginning of esophagus, and in front of prevertebral fascia, simply under vision without bleeding. Then dissection from the affected side was done, then passing a flexible suction tube through this approach. To give the cross C7 extra length 4-5cm cable nerve grafts from sural nerve was done. The flexible tube was anchored to the tip of cable sural nerve graft which was fixed to the tip of donor cross C7, to be passed very gently to other side.

In Group II: After division of the whole cross C7, dissection of the vascularized ulnar nerve was done from as far as we can in the hand, then through the forearm and distal arm. The proximal end of VUNG was cut to be anastomosed with Median nerve with nylon 9-0 sutures and fibrin glue. The distal end of VUNG was passed through a subcutaneous tunnel in front of the pectoral region and the neck to contralateral normal supraclavicular region. The cross C7 was sutured to the distal end of the VUNG by nylon 9-0 and fibrin glue. Closure of all surgical wounds without drains was done meticulously. The patients were kept in bed rest for 3 weeks **[6]**.

Statistical analysis:

Data were represented as mean ± standard deviation (SD). Statistical analysis was performed using the 22.0 version of SPSS statistical software for windows. Independent student *t*-test was used in the comparison between two groups of patient. *p*-values less than 0.05 were considered significant.

RESULTS

Statistical comparison between group I and group II revealed that, the duration of surgery in group I (4.9±0.44 hours) was significantly lower than that of group II (6.10± 0.62) ($p<0.001$), and the hospital stay was significantly shorter (3.09± 1.14 days) than that of group II (6.13±2.17) ($p<0.01$).

The patients were age matching as there was a non-significant deference between the two groups ($p>0.05$). Moreover, no significance difference could be detected between group I regarding the mean value of shoulder motor recovery (2.27±0.65), elbow motor recovery, (3.54±0.69), hand motor

recovery (1.09±0.83), hand sensation (2.00±0.77) or follow-up period (25.45±5.80) when compared to that of group II (1.87±1.12, 3.13±1.12, 0.75± 0.70, 1.37±0.91 and 25.37±6.18 respectively) (p>0.05).

Regarding the postoperative complication, four cases of group I (36.36%), showed complications, two of them showed donor side numbness and another two complained of transient Motor weakness of extensors of fingers. Four cases of group II (50%), presented with complications, two of them complained Donor numbness and two patients complained of transient weakness of extensor motor activity. Furthermore, while, no case in group I needed blood transfusion (0.0%), five cases of group II (62.5%) needed blood transfusion.

Table (1): Statistical comparison between crossed C7 (group I) and vascularized ulnar nerve graft (VUNG) (group II) regarding age (years), time from injury to surgery (months), duration of surgery (hours), hospital stay (days), shoulder motor recovery score, elbow motor recovery score, hand sensation and follow up period (months).

Parameters	Group I (n=11)	Group II (n=8)	p-value of t-test
Age (year)	21.45±5.11	25.37±2.99	0.069
Injury to surgery (months)	4.90±1.22	6.00±1.85	0.139
Duration of Operation (hours)	4.64±0.44	6.10±0.62	< 0.001
Period of Hospital stay (days)	3.09±1.14	6.13±2.17	0.002
Shoulder Motor recovery score	2.27±0.65	1.87±1.12	0.342
Elbow motor recovery Score	3.54±0.69	3.13±1.12	0.326
Hand motor recovery Score	1.09±0 .83	0.75±0.70	0.349
Hand sensation Score	2.00±0.77	1.37±0.91	0.126
Follow-up period (Months)	25.45±5.80	25.37±6.18	0.977

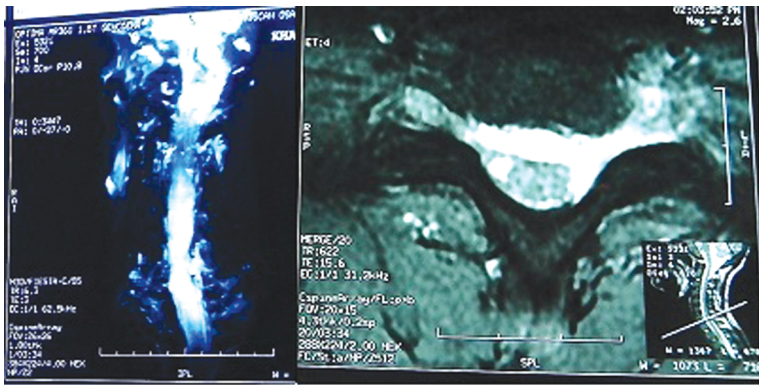

Fig. (1): Preoperative MRI delineating avulsion roots.

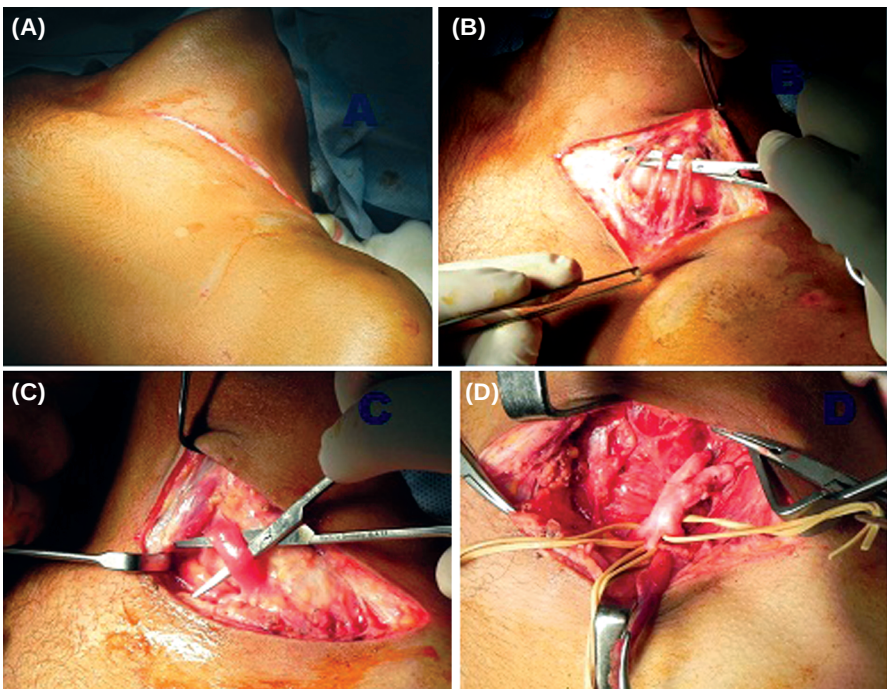

Fig. (2): Intraoperative exploration of affected brachial plexus. (A) Is supraclavicular transverse incision. (B) Is dissection and protection of supraclavicular sensory nerves. (C) Is identification of omohyoid and its dissection. (D) Is identification and dissection of upper plexus.

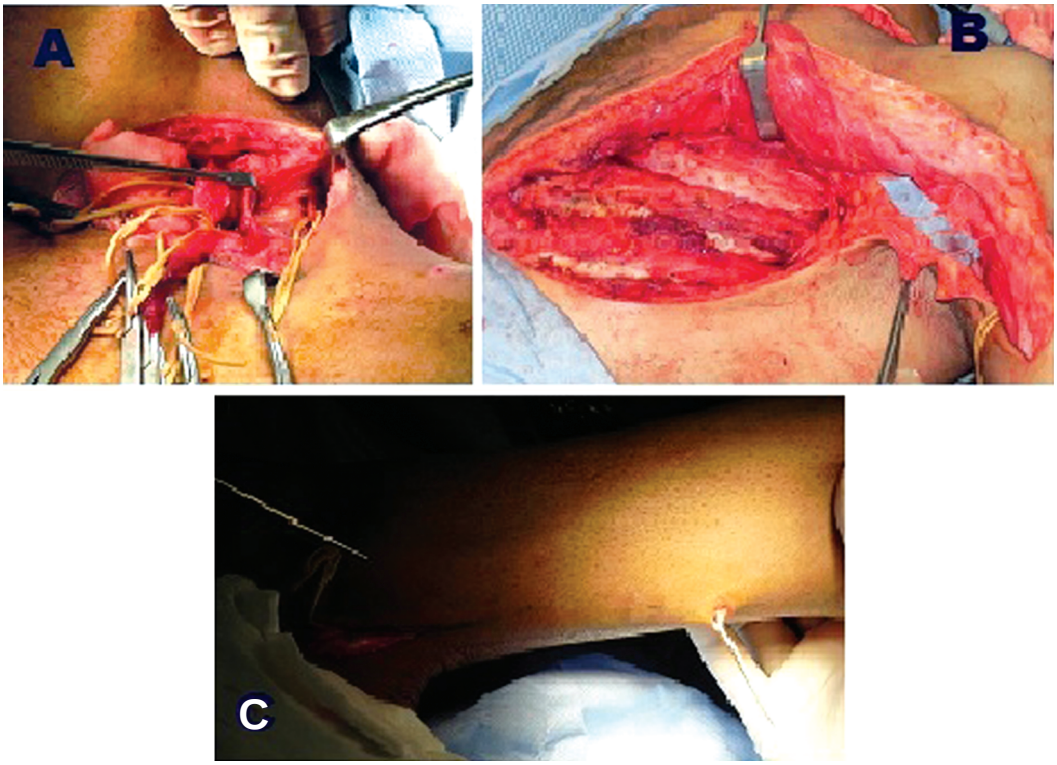

Fig. (3): SAN and ICN & sural nerve. (A) Is SAN identification and dissection. (B) Is ICN s dissection. (C) Is sural nerve harvesting.

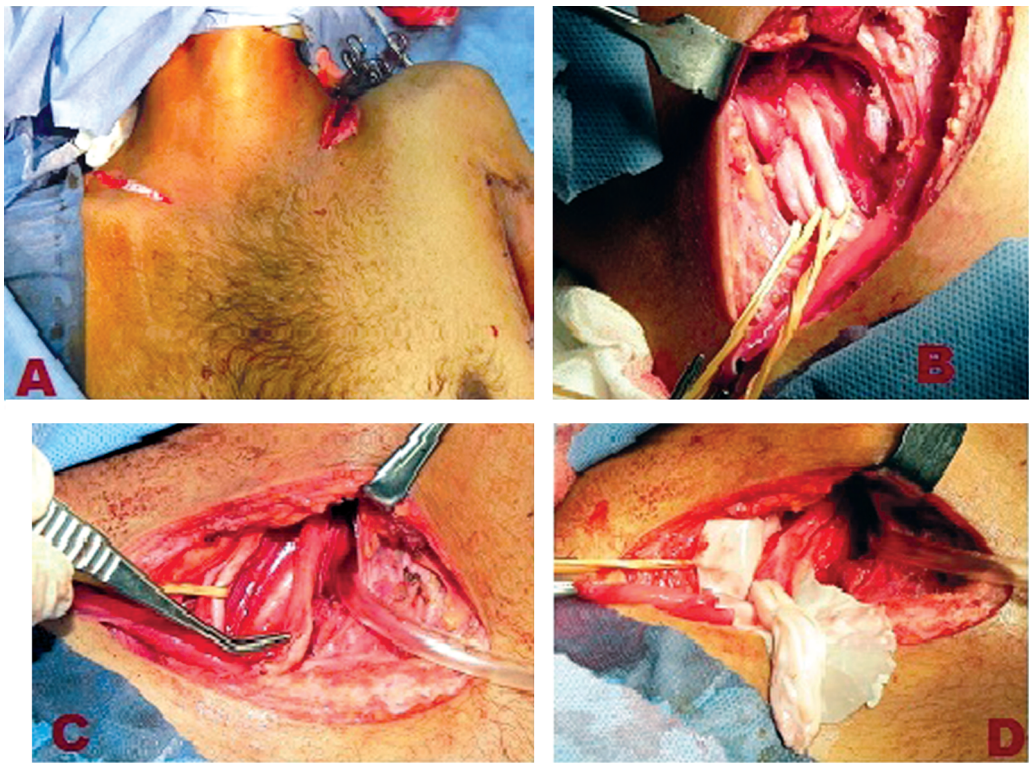

Fig. (4): Dissection of contralateral plexus. (A) Is a skin incision and supraclavicular nerves dissection. (B) Is identification of CC7. (C) Is harvesting of the total CC7. (D) Is increasing length of CC7 by cable nerve graft.

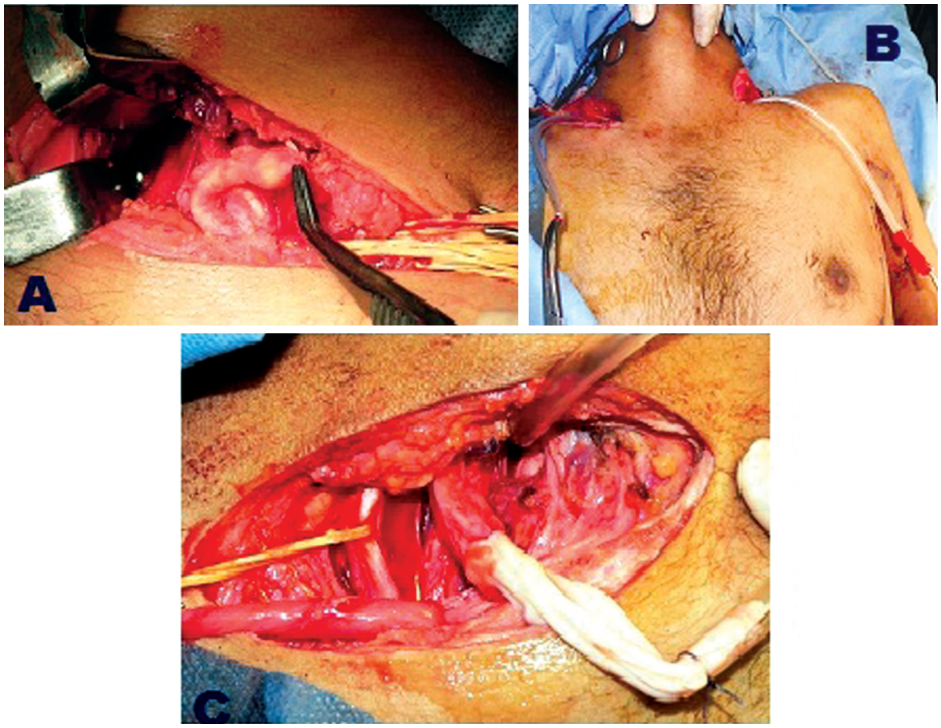

Fig. (5): Pre-vertebral retro-esophageal tunnel. (A) Is blunt dissection from normal side to affected side. (B) Is passing of a catheter in the pre-vertebral tunnel. (C) Is tying tip of catheter to tip of cable nerve graft.

Fig. (6): Subcutaenous approach using VUNG.

Fig. (7): Preoperative case of avulsed plexus.

Fig. (8): Postoperative case of avulsed plexus operated with CC7.

DISCUSSION

The logic management for traumatic brachial plexus palsy includes both surgery and perioperative physical therapy **[2,3,5,22]**.

If the upper part of the plexus is the only affected part (like C5-6 injury, or C5-6-7 injury), the prognosis will be favourable with 80% or more success in shoulder and elbow function restoration **[11,23,24]**, But in total traumatic brachial plexus injury the story is more tragic **[2,11,10,12]**.

The nerve transfer with or without free functioning muscle transfer is now the black horse in the management of these grave problems **[11,12, 22-25]**.

These nerve transfer methods used SAN to SSN and ICNs to MCN, motor branch to biceps, got a great acceptance worldwide **[2,14,22]**.

Nerve transfer from nearby donors has a disadvantage of having a low number of myelinated fibers to innervate totally avulsed plexus **[14]**.

Chen and Gu presented a good idea to solve this problem, by using cross C7 to add more and more donor myelinated fibers **[26]**.

Later on many investigator documented the merits of CC7, as it holds more than 25,000 myelinated fibers, both sensory and motor **[3,10,11, 12,14,27]**.

After the make use of the CC7 in nerve transfer for totally avulsed traumatized plexus, a lot of debate happened, regarding the efficacy, donor motor and sensory deficits, and using total CC7 or posterior part of it. Another one is to take ipsilateral VUNG through a subcutaneous tunnel or to use pre-spinal tunnel **[6,10,27,28]**.

A lot of studies demonstrated some temporary sensory loss of the palm at distribution of median nerve (MN) after posterior division cutting of cross C7 **[6,11,15]**. Others declared sensory loss in index and thumb with anterior division sectioning of CC7 **[2,3,10,11,12,28]**. Chuang presented degrees of weakness of donor side triceps and sensory changes at dorsum of the hand at the distribution of radial nerve (RN) **[14,15]**.

Sammer and Shin stated that the complications from donor side were grave after CC7 usage **[12]**. They also declared that total CC7 harvesting carry more complication incidence (45%). This may imply that harvesting total CC7 incurs the risk of a high complication rate containing MN and RN sensory loss in the hand), motor weakness (30% muscle weakness of triceps and extensors of the fingers) **[12]**.

In other words, some other researcher documented a very few complication after using CC7 as a donor **[1,3,10,11,15]**. And this was apparent with the patients included in this study, as we did not found any permanent sensory or motor loss after using CC7 as a donor.

Gu et al. **[1,27]** and Chuang & Hernon **[14]** used after section of the whole CC7 as a donor with the ipsilateral VUNG. And they presented very pleasing results with motor hand recovery of M3 higher than 50%. Other surgeons insisted to use hemiCC7 in their repair to decrease donor morbidity. Their results approached only 30% recovery of M3 motor hand function **[3,10,11,12,19,29]**. Other surgeons presented 65% recovery of hand grip with whole CC7 **[2,3,10-12,19,29,30]**. In this work we presented only total CC7, to get the maximal myelinated fibers as a donor. And again I did not found any problem with donor side morbidity.

The merits of prevertebral approach as a tunnel for CC7 to neuritize avulsed lower part of the brachial plexus includes firstly that this route contains loose tissue of less vascular structures with the viscera in front and fascia on the cervical spine behind. Through this pass an easy and bloodless dissection can be achieved **[1,31]**. Secondly, this pass is not narrow permitting the application by suction catheter under vision of the cable nerve grafts on the CC7 without any kink. Thirdly, this approach is shorter than subcutaneous tunnel and protected deeply in the neck **[16]**. This study is with this idea as after statistical comparison between group I with pre-vertebral tunnel, and group II with subcutaneous tunnel with VUNG, revealed that: The prevertebral approach was safe less time consuming, no injuries of important structures, less bloody, less hospital stay, and the patients did not need any blood transfusion.

And the last issue is the time interval between the injury and the reconstruction of the affected plexus, a lot of surgeons propose earlier surgeries not more than 6 months **[32-35]**, but many patients presented to us later after 6 months and before 1 year. For them, counseling and explanation of poorer results after surgery had been declared.

In conclusion:

Providing nerve transfer to repair totally avulsed traumatic brachial plexus with the maximum

number of meylinated fibers is highly recommended. Taking cross C7 can be done through subcutaneous approach with VUNG or through prevertebral retro-esophageal approach. Pre-spinal retro-esophageal approach is safe, easy, and protected tunnel for CC7 transfer to lower plexus avulsion neuritization.

Conflict of interests: The author declares that no Conflict of interests.

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