



## Electroneurography prognostic value in infants with Erb's palsy

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**Abstract :** This study aimed to determine prognostic value of electroneurography in infants with Erb's palsy. Thirty infants with Erb's palsy from both genders participated in this study. They were classified into two groups of equal number according to age, **group I** includes first 3 months of life and **group II** includes second 3 months of life. In this study, evaluation of biceps brachii was done through observation of its contraction during the child activity; this had been performed by using Toronto Active Movement Scale and Percentage of Nerve Degeneration by using Electroneurography. The scores for biceps contraction and percentage of degeneration were recorded for the two groups. The results revealed that there was strong inverse relation between Percentage of Nerve Degeneration and Active Movement Scale and between Percentage of Nerve Degeneration and the age for both groups. The higher Percentage of Nerve Degeneration, the less Active Movement Scale is. The higher the age, the less the Percentage of Nerve Degeneration and the better prognosis are.

**Key words:** Brachial plexus injury, Erb's palsy, Active movement Scale, Electroneurography, Percentage of degeneration, Surgical interference.

### Introduction

Obstetric brachial plexus palsy (OBPP) is an injury caused by the straining of the brachial plexus during birth, and it may range from neuropraxia to the complete avulsion of the nerve roots. Surgery may be prescribed in cases where clinical treatment does not result in an adequate recovery (Pondaag and Malessy, 2014)<sup>1</sup>.

Most birth injuries of the brachial plexus involve stretching of the nerve roots C5 and C6, affecting the movements of shoulder abduction and external rotation, elbow flexion, and forearm supination. This type of injury is known as Erb's palsy. The elbow flexion is critical to the functionality of the upper extremity and its re-establishment is one of the main goals of the surgical approach to the Erb's Palsy (Ladak et al., 2013)<sup>2</sup>.

Electroneurography has the advantage of being non-invasive method and is a fast and almost painless technique for mapping both sensory and motor function in several peripheral nerves. The contra lateral arm can be used as the control and, in contrast to Electromyography (EMG); the method is not dependant on any contribution from the child. Motor function is measured with amplitude of (CMAP) compound muscle action potential (Christina, 2006)<sup>3</sup>.

Clinical evaluation alone is not sufficient to determine the level and severity of injury. Electrodiagnostic studies, sensory and motor nerve conduction studies including F wave studies, as well as

electromyography (EMG) are helpful in determining the diagnosis, prognosis and in guiding further rehabilitative measures (Barman et al., 2012)<sup>4</sup>.

The purpose of the study was to determine prognostic value of electroneurography in infants with Erb’s palsy. It was hypothesized that there is no prognostic value for electroneurography in infants with Erb’s palsy.

**Subjects, Instrumentation and Procedures**

**1- Subjects:**

1. Subject’s age was ranged from three weeks to six months.
2. Thirty infants from both sexes participated in this study.
3. Subjects were selected according to following criteria :

**1.1 Inclusive criteria:-**

1. Thirty infants were selected from both sexes.
2. They were classified according to their age into 2 groups of an equal number ( 15 patients for each) :
  - A. **Group I:** First 3 months of infants’ life (**3 weeks to 3 months**)
  - B. **Group II:** Second 3 months of infants’ life (**above 3 months to 6 months**).
3. They were diagnosed as unilateral brachial plexus injury involving C5, C6 lesion.
4. Infants had not suffered from any injury or any other musculoskeletal problem affecting their upper limbs as fractures or dislocations.

**1.2 Exclusive criteria:-**

1. Infants who made any surgical interference as a main line of treatment.
2. Peripheral nerve injuries caused by damage to arm or forearm as fractures or metastasis,.....
3. Infants who had brachial plexus lesion caused by traumatic lesions.

**2- Methods and Instrumentations:**

**2.1 Toronto Active Movement Scale:**

The Toronto scale is used to measure return of elbow flexors and extensors, wrist extensors, finger extensors, and thumb extensors. We choose only the biceps muscle as it is the main indicator for severity and prognosis for infants with Erb’s palsy. The logic behind this indication is that the biceps is the only C5–C6 innervated muscle whose function cannot be duplicated by other muscles indication (Mukund and Rujuta, 2011)<sup>5</sup>.

**Table 1: Active Movement Scale observational muscle grade (Clarke and Curtis, 1995)<sup>6</sup>**

|                           |          |
|---------------------------|----------|
| <b>Gravity Eliminated</b> |          |
| No contraction            |          |
| Contraction, no motion    | <b>0</b> |
| Motion ≤ 1/2 range        | <b>1</b> |
| Motion > 1/2 range        | <b>2</b> |
| Full motion               | <b>3</b> |
|                           | <b>4</b> |
| <b>Against gravity</b>    |          |
| Motion ≤ ½ range          |          |
| Motion > ½ range          | <b>5</b> |
| Full motion               | <b>6</b> |
|                           | <b>7</b> |

## 2.2 A computerized electromyographic apparatus:

The aim of a neurographic examination is the diagnosis of motor and/or sensory conduction disturbances in peripheral nerves. Often electromyographic examinations are followed by a neurographic one. Each of these various neurographic examinations works with their own stimulation programs, recording parameters, and evaluating schemes. The user may recall them from the PC, change them and/or create new ones (Hoffmann and Krechel, 2012) <sup>7</sup>.

### Composition of computerized electromyographic apparatus:

Four-channel EMG machine with integrated stimulator are used for detecting percentage of degeneration in biceps brachii muscle. It is composed of:

#### 2.2(a).Electrodes:-

There are 3 types of electrodes (stimulation, recording and ground electrodes) used mainly during electroneurographic application. Two pen electrodes with 2-3 cm distance in between are used for stimulation and two surface electrodes are used (active on motor point of the muscle and indifferent electrode on relatively silent area) for recording. It is necessary to use an additional ground electrode which is placed in between the stimulation and the recording site.

#### 2.2(b).Amplifier:

The amplifiers used in electromyography are differential amplifiers with a broad dynamic range and a broad frequency range. Per channel there are three input connectors for the inverted, the non inverted input, and the ground connector on the head box.

#### 2.2(c).Stimulators (Motor and Sensory):

Different stimulators are mounted on the EMG machine, thus used for various examinations such as neurography and the recording of evoked potentials. Special types of electrodes are used for stimulation of sensory nerve fibers.

## 3- Procedures:

### 3.1 Toronto Scale:

The child is observed from two positions (with gravity elimination and against gravity) for elbow flexion as a result of biceps brachii contraction.

### 3.2 Electroneurography:

For measuring the percentages of degeneration and detecting severity and prognosis of the lesion from the biceps brachii muscles as a main indicator for the lesion, a computerized electromyographic apparatus (Neuroscreen plus – four channel – version 1.59 produced by TOENNIES, 97204 Hochberg, Germany) is used with surface electrodes.

#### ▪ Position and preparation of the subjects :

- a. Neonates and infants were placed supine on an examination table.
- b. Tested area of the upper limb was bared skin and the stimulating and the recording sites were cleaned with medical cotton damped with alcohol to reduce skin impedance.
- c. Head was maintained in mid position to avoid elicitation of any primitive reflexes which might alter the tone distribution in his body.
- d. Room temperature and humidity should be monitored to avoid any interference with results that were gained from the apparatus.

#### ▪ Application:

- ENoG was performed first on the healthy side and then repeated on the affected side.

- A bipolar stimulator was placed over the Erb’s point and manually adjusted to determine the best position to generate the compound muscle action potential (CMAP) and sensory nerve action potential (SNAP) amplitude of C5, C6 nerve roots component.
- For biceps muscle, the **active electrode** was placed on the motor point of the biceps muscle with the **reference recording** electrode placed further distal on a relatively silent point. The **ground electrode** was placed below the lateral 1/3 of the clavicle or above scapula. A rectangular pulse with 5 ms time base and a frequency of 1 Hertz was produced.
- The stimulation current intensity was increased stepwise until there was no further increase in the amplitude of the diphasic myogenic compound muscle action potential (CMAP).
- An additional 10% of current was added to ensure supramaximal stimulation.
- The stimulation intensity ranged from 15 to 40 milliamps.
- To calculate the **percentages of degeneration** the following equation is used (Snow and Wackym, 2009) <sup>8</sup>
- Percentage of degenerated fibers =

$$100 - \left( \frac{\text{Amplitude of evoked response in affected side}}{\text{Amplitude of evoked response in normal side}} \times 100 \right)$$

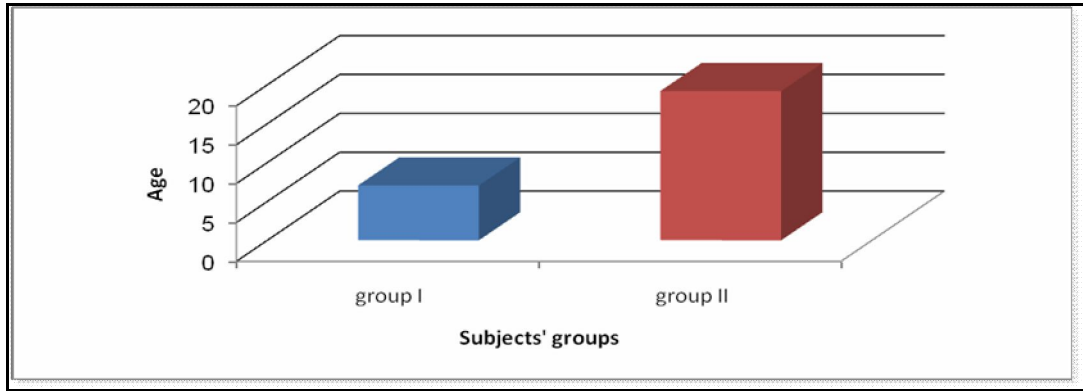
**Results:**

The purpose of this study was to determine the electroneurography prognostic value for infants with Erb’s palsy and to compare the percentage of degeneration in the first 3 months of life against the second 3 months of life in infants with Erb’s palsy. This helps in decision making for early or late primary reconstructive surgery for infants with Erb’s palsy. **Group I** was first 3 months infants’ life (12 females and 3 males), while **Group II** was the second 3 months infants’ life (7 female and 8 male). Data obtained from both groups was statistically analyzed and compared. The measured variables were Toronto Active movement scale (AMS) and Percentage of nerve degeneration in both groups. As shown in table (2), and illustrated in figure (1,2,3), the age, Active movement scale and Percentage of nerve degeneration (mean ± standard deviation) of **group I** were 7.06 ± 3.1 weeks, 1.6 ± 1.4 and 89.8 ± 3.7 % respectively, and that of **group II** were 19.2 ± 3.44 weeks, 2.20 ± 1.14 and 86.1 ± 3.83% respectively.

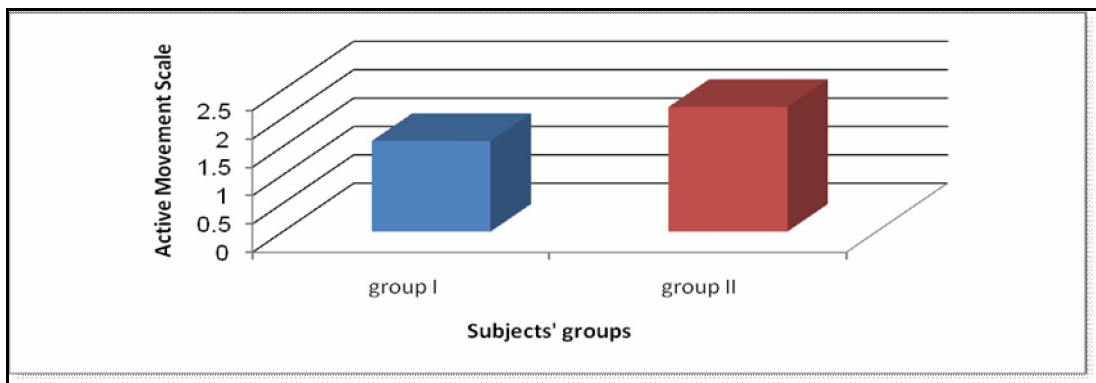
**Table (2): Mean values of age, Active movement scale and Percentage of nerve degeneration for group I and group II:-**

| Item                                 | Group I          |       |      | Group II         |       |      |
|--------------------------------------|------------------|-------|------|------------------|-------|------|
|                                      | $\bar{X} \pm SD$ | Range |      | $\bar{X} \pm SD$ | Range |      |
|                                      |                  | Min   | Max  |                  | Min   | Max  |
| Age (weeks)                          | 7.06 ± 3.1       | 3     | 12   | 19.2 ± 3.44      | 16    | 24   |
| Active movement scale (score)        | 1.6 ± 1.4        | 0     | 4    | 2.20 ± 1.14      | 0     | 4    |
| Percentage of nerve degeneration (%) | 89.8 ± 3.7       | 81.9  | 94.3 | 86.1 ± 3.83      | 80.2  | 93.3 |

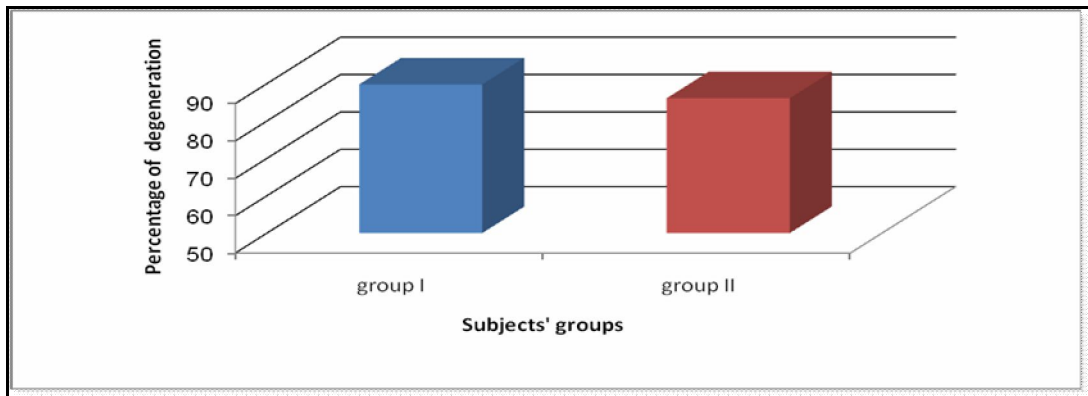
$\bar{X}$  : mean    **Min:** Minimum  
 SD: Standard Deviation                      **Max:** Maximum



**Fig (1): Mean Age (weeks) for the two age groups (I and II)**



**Fig (2): Mean Active Movement Scale (scores) for the two age groups (I and II)**



**Fig (3): Mean percentage of degeneration (%) for the two age groups (I and II)**

**Correlation between Age and Percentage of Degeneration**

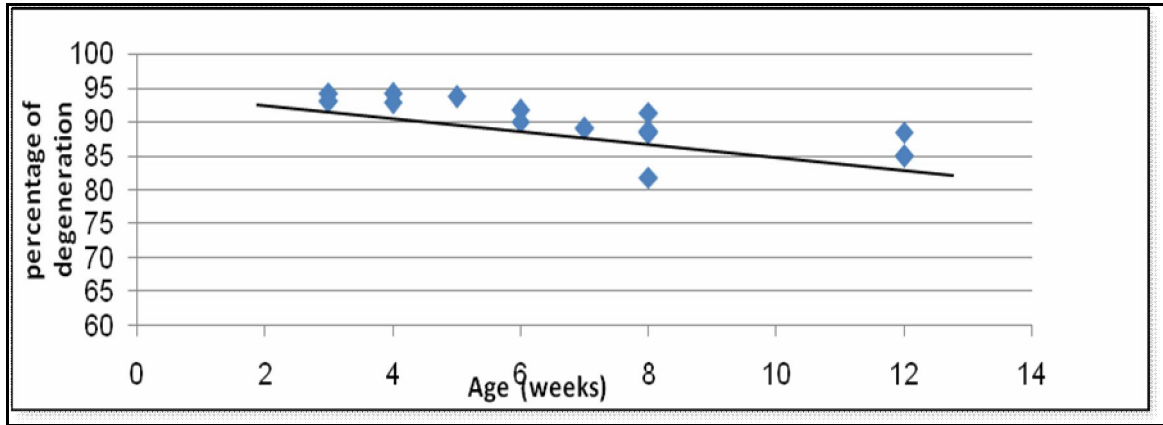
**I. Correlation between Age and Percentage of Degeneration for group I:**

Person Product Moment Correlation Coefficient was used to determine the relation between Age and Percentage of Degeneration for **group I**. There was significant strong inverse correlation between Age and Percentage of Degeneration (level of significance  $\alpha = 0.01$ ). (Table 3, Figure 4).

**Table (3): Correlation between Age and Percentage of Degeneration for group I:-**

| Items | Percentage of Degeneration       | r value | p value | Significance |
|-------|----------------------------------|---------|---------|--------------|
| Age   | 1 <sup>st</sup> 3 months of life | -0.72   | 0.0017  | S            |

r value : Person Product Moment Correlation Coefficient



**Fig (4): Correlation between Age and Percentage of Degeneration for group I**

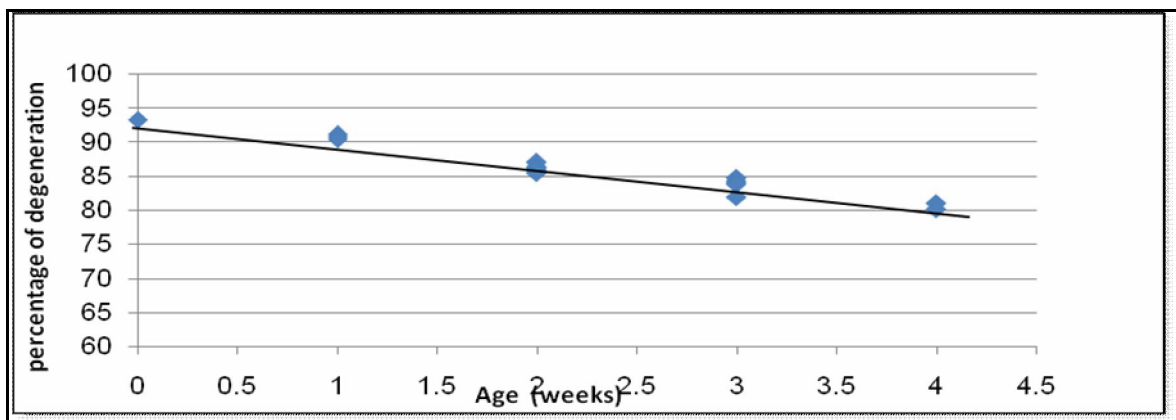
**II. Correlation between Age and Percentage of Degeneration for group II:-**

Person Product Moment Correlation Coefficient was used to determine the relation between Age and Percentage of Degeneration for **group II**. There was significant weak inverse correlation between Age and Percentage of Degeneration (level of significance  $\alpha = 0.01$ ). (Table 4, Figure 5).

**Table (4): Correlation between Age and Percentage of Degeneration for group II:-**

| Items | Percentage of Degeneration       | r value | p value | Significance |
|-------|----------------------------------|---------|---------|--------------|
| Age   | 2 <sup>nd</sup> 3 months of life | -0.6    | 0.0089  | S            |

r value : Person Product Moment Correlation Coefficient



**Fig (5): Correlation between Age and Percentage of Degeneration for group II**

**Correlation between Scores of Active Movement scale and Percentage of Degeneration:**

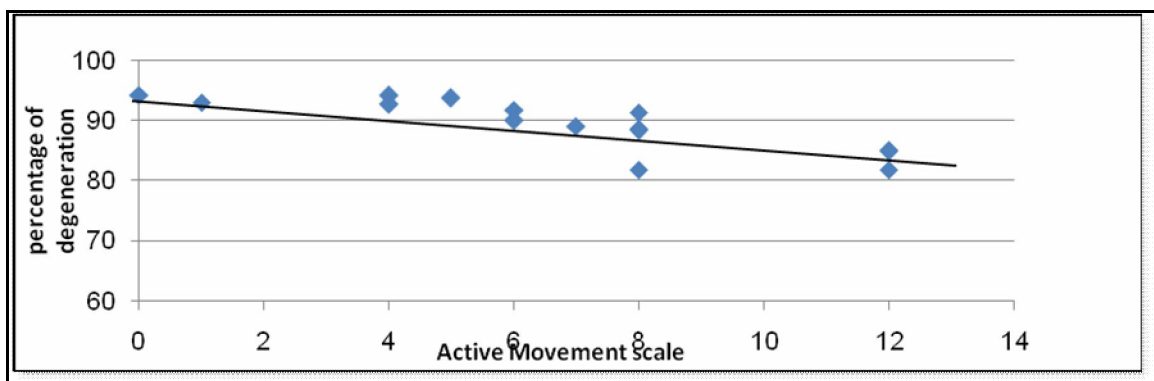
**I. Correlation between Active Movement scale and Percentage of Degeneration for group I:**

Person Product Moment Correlation Coefficient was used to determine the relation between Active Movement scale and Percentage of Degeneration for **group I**. There was significant strong inverse correlation between Active Movement scale and Percentage of Degeneration (level of significance  $\alpha = 0.01$ ). (Table 5, Figure 6).

**Table (5): Correlation between Active Movement scale and Percentage of Degeneration for group I:-**

| Items                 | Percentage of Degeneration       | r value | p value | Significance |
|-----------------------|----------------------------------|---------|---------|--------------|
| Active Movement scale | 1 <sup>st</sup> 3 months of life | -0.98   | 0.0001  | S            |

r value : Person Product Moment Correlation Coefficient



**Fig (6): Correlation between Active Movement scale and Percentage of Degeneration for group I.**

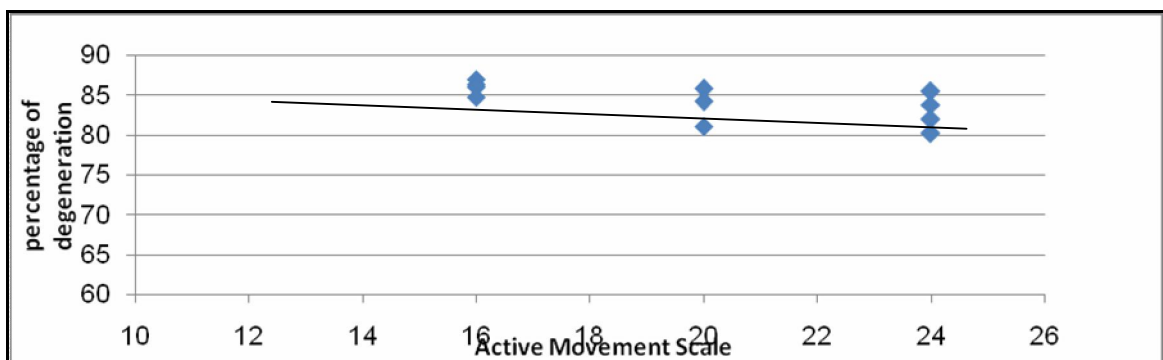
**II. Correlation between Active Movement scale and Percentage of Degeneration for group II:**

Person Product Moment Correlation Coefficient was used to determine the relation between Active Movement scale and Percentage of Degeneration for **group II**. There was significant strong inverse correlation between Active Movement scale and Percentage of Degeneration (level of significance  $\alpha = 0.01$ ). (Table 6, Figure 7).

**Table (6): Correlation between Active Movement scale and Percentage of Degeneration for group II:-**

| Items                 | Percentage of Degeneration       | r value | p value | significance |
|-----------------------|----------------------------------|---------|---------|--------------|
| Active Movement scale | 2 <sup>nd</sup> 3 months of life | -0.97   | 0.0001  | S            |

r value : Person Product Moment Correlation Coefficient



**Fig (7): Correlation between Active Movement scale and Percentage of Degeneration for group II.**

## Discussion:

The purpose of the study was to determine prognostic value of electroneurography in infants with Erb's palsy. It was hypothesized that there is no prognostic value for electroneurography in infants with Erb's palsy.

The results of our current study agreed with this study as the results had been shown that the mean values  $\pm$  SD of Percentage of nerve Degeneration for first 3 months of infants' life was  $89.8 \pm 3.7$  % while for the second 3 months infants' life was  $86.1 \pm 3.83$ %. The results revealed that there was significant strong inverse relation between Percentage of Nerve Degeneration and Active Movement Scale and between Percentage of Nerve Degeneration and the age for both groups (First and second 3 months of infants' life group). As, the higher Percentage of Nerve Degeneration, the less Active Movement Scale, the less the function, the more severity and the higher the age, the less the Percentage of Nerve Degeneration and the more prognosis is.

Regarding the patients who present in infancy, the prognosis should be precisely foreseen. If complete recovery is not expected, plexus exploration should be performed as early as possible to improve the outcome. The clinical examination remains an important aspect of the evaluation in these cases because of the controversy surrounding the reliability of electrophysiological and imaging studies. However, there is also debate over the accurate interpretation of the clinical findings. Some authors suggest that the absence of biceps function at three months of age should be the threshold for early exploration, whereas others suggest that the absence of hand movements at three months and the absence of biceps functions at four months, or even later, should warrant exploration (Bahm et al., 2007 and Gilbert, 2008)<sup>9,10</sup>. These studies came in parallel with this study that aimed to help in for prediction prognosis of Brachial Plexus Palsy (BPP) especially Erb's palsy

In a previous study with Clarke et al., (2009)<sup>11</sup> in Toronto determined that neurolysis ( primary reconstruction) alone produces no beneficial effects in children with OBPP, whereas sectioning of the neuroma and reconstructing with grafts comprise the gold standard for obtaining good results. As their primary outcome, these authors used the Active Movement Scale (AMS)—designed to evaluate 15 distinct movements of the upper limb—to retrospectively assess 108 patients with a mean follow-up of 4 years. Their results disagree with our study in which we stated that late surgical interference (after 3 months) cannot lead to satisfactory recovery as in their study, they are dependant only on a functional or clinical test that might be affected by several situation and didn't give any accurate results about the severity or the prognosis of the cases and the electrodiagnostic methods could give the same results earlier than any clinical manifestations appeared.

There are several procedures which are traditionally known to predict peripheral nerve prognosis. Each of these tests has its own advantages and disadvantages in evaluation of nerve degeneration. Although none of them alone predicts prognosis definitely, electroneurography (ENoG) is one of the most objective and the most commonly used tests. In predicting prognosis by ENoG, compound muscle action potentials (CMAPs) of bilateral facial nerves are recorded. The minimum critical value suggesting unfavorable prognosis is 90 % or above which recovery is incomplete (Valls-Sole, 2007)<sup>12</sup>. This came in agreement of our results which revealed that the higher the percentage of nerve degeneration, the less the function and the worse prognosis is expected.

Neurophysiological investigations are required in peripheral nerve lesion for several reasons: determination of underlying pathological process, localization of the lesion, or prediction of prognosis. ENoG is considered as the most convenient method, mostly valuable in the 10th day of the disease on average in determining the ratio of axon loss and predicting the prognosis. It was also reported to be the most useful method in selection of cases for decompression surgery in idiopathic peripheral facial palsy (Nurten et al., 2016)<sup>13</sup>.

## Conclusion

It could be concluded from these results that the higher Percentage of Nerve Degeneration, the less Active Movement Scale. This means, the less the function, the more severity and the higher the age, the less Percentage of Nerve Degeneration. So, 2-Percentage of degeneration is an accurate, objective way and a useful method for nerve damage and should be routinely used in evaluation of Erb's Palsy.



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