

# An Assessment of the Applicability of Shriners Hospital Upper Extremity Evaluation as a Decision-making Tool and Outcome Measure in Upper Limb Cerebral Palsy in Indian Children

## Abstract

**Background:** The aim of this study was to assess the applicability and performance of the Shriners Hospital Upper Extremity Evaluation (SHUEE) and to determine its usefulness in clinical decision-making and as an outcome measure with reference to Indian children suffering from cerebral palsy. **Materials and Methods:** The SHUEE videos of 40 children with cerebral palsy with spastic hemiplegia or asymmetrical diplegia were analyzed and scored. Seven children had undergone upper extremity surgery based on a preoperative evaluation. All seven had a postoperative evaluation. Pre- and postoperative scores were compared. Intra- and interobserver reliability was assessed. The level of familiarity and comfort of the children with the assigned tasks was gauged. **Results:** Analysis of the scores revealed that patients could be categorized into three discrete groups based on the modified House scores and Spontaneous Functional Analysis (SFA) scores, which helps in identifying the patients who would benefit from surgical intervention. In the seven children who were operated, there was a mean increase in the postoperative SFA (2.97,  $P = 0.259$ ), Dynamic Positional Analysis (3.15,  $P = 0.229$ ) and Grasp/Release Analysis (4.96,  $P = 0.334$ ) scores, though the differences were not statistically significant. There was excellent intraobserver ( $r = 0.98$ ) and interobserver reliability ( $r = 0.97, 0.96$ ) based on the intraclass correlation coefficient. The children were familiar with the assigned tasks and were not duly uncomfortable while attempting to perform them. **Conclusions:** SHUEE is a useful modality to assess upper limb function in Indian children with cerebral palsy, and can be used as a decision-making tool and mode of documentation.

**Keywords:** Cerebral palsy, Indian children, Shriners Hospital Upper Extremity Evaluation, upper limb

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## Introduction

Upper limb involvement in cerebral palsy is characterized by weakness, spasticity with or without contractures, loss of selective motor control, lack of coordination, dyskinesia and varying degrees of sensory loss.<sup>1,2</sup> The degree of upper limb involvement varies with the type of cerebral palsy, with more severe affectation in hemiplegics and quadriplegics, and milder affectation in diplegics. The classical deformities seen are shoulder adduction and internal rotation, elbow flexion, forearm pronation, wrist flexion, finger flexion/swan necking, and thumb adduction. All of these cause difficulty in spatial control of the upper limb, and interfere with effective grip and release, resulting in patients being unable to perform activities of daily living.<sup>3</sup> Identification and correction of these deformities can provide functional and cosmetic benefits.<sup>4-6</sup>

An objective functional assessment of the upper limb in cerebral palsy should aid the identification of involvement of the different segments of the upper limb so as to guide in decision making regarding intervention. It should also help classify the severity of involvement and assess the efficacy of the intervention. However, unlike gait analysis for the lower limbs, there is no universally accepted tool for objective assessment and decision making in upper limb cerebral palsy. A number of assessment tools are available, ranging from caregiver based questionnaires to sophisticated motion analysis systems.<sup>7,8</sup> The Shriners Hospital Upper Extremity Evaluation (SHUEE) is a video-based assessment which was designed to assess the upper limb function in hemiplegic cerebral palsy in children between 3 and 18 years of age. Validation and reliability has been established by its

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originating authors.<sup>9-11</sup> However, there is only one other report of its validation and use by other investigators.<sup>12</sup> There are no studies reporting its use in Indian children. The aim of this study was to assess the applicability and performance of the SHUEE in Indian children and to determine its usefulness in clinical decision-making and as an outcome measure in upper limb cerebral palsy with reference to Indian children.

## Materials and Methods

Since June 2012, all hemiplegic and triplegic cerebral palsy patients who attended the pediatric orthopedic outpatient department have been assessed using the SHUEE. We now undertook a review of all the patients who had undergone SHUEE analysis between June 2012 and December 2015. Institutional Review Board Committee approval was obtained. A total of 40 children with cerebral palsy were included in the study. Inclusion criteria were children between 2 and 18 years who had not undergone any prior surgical intervention or botulinum toxin injections for the upper limb abnormalities. Hospital records were reviewed to obtain demographic data. The SHUEE analysis was reviewed for each of these children.

The SHUEE analysis is a video-based test which analyses the spontaneous function as well as the dynamic alignment of the different segments of the upper limb, i.e., the elbow, forearm, wrist and thumb and fingers while performing 16 tasks. It consists of two sections: the first section assesses the tone (Modified Ashworth Scale), and active and passive range of motion of the upper limb joints. It also records the ability to perform activities of daily living, and the goals of the patient and family based on history. The second section is the videotaped part which assesses the spontaneous use of the affected upper limb (Spontaneous Functional Analysis [SFA]), dynamic segmental alignment of the extremity while performing tasks (Dynamic Positional Analysis [DPA]) and Grasp/Release Ability (GRA). Sixteen tasks are grouped together to evaluate specific segments namely thumb and fingers, wrist, forearm, and elbow. The SFA was recorded for 9 out of the 16 tasks and was scored using a modified House scale [Table 1].<sup>13</sup> Similarly, the DPA was scored for all the tasks based on the alignment of the segment analyzed. Finally, GRA recorded the ability of the patient to grasp and release an object with the wrist in flexion, neutral, and extension. The total score in each category was expressed as a percentage.

Seven children underwent surgery. Operative decision was made based on the SFA scores and the segmental alignment deficiencies seen in the DPA analysis. Children with thumb involvement underwent adductor release with or without augmentation procedures such as extensor pollicis longus transposition, or brachioradialis to abductor pollicis longus transfer. One child underwent flexor digitorum superficialis release for finger flexion contracture. The wrist malalignment was addressed by flexor carpi ulnaris (FCU)

**Table 1: The modified House Scale (a dynamic approach to thumb-in-palm deformity in cerebral palsy, House *et al.* 1981)**

Class	Designation	Activity level
0	Does not use	Does not use the involved upper limb
1	Poor passive assist	Uses as stabilizing weight only
2	Good passive assist	Can hold onto object placed in the hand and may stabilize it for use by the other hand
3	Poor active assist	Can actively grasp object and hold it weakly
4	Good active assist	Can actively grasp object, stabilize it well and may manipulate it against other hand
5	Spontaneous use	Performs bimanual activities easily; may use hand spontaneously or without reference to the other hand

to extensor carpi radialis brevis transfer or FCU release. Pronation contractures were treated with pronator teres release and in one case, pronator quadratus release [Table 2]. Each of these children underwent SHUEE analysis postoperatively. Pre- and postoperative scores were analyzed.

The intra and interobserver reliability of SHUEE was assessed. Intraobserver reliability was assessed by the videos being reviewed by the same observer after a gap of 2 weeks. Interobserver reliability was assessed by scoring of videos of 10 patients by a pediatric orthopedic consultant, a pediatric orthopedic fellow and an orthopedic resident.

## Statistical analysis

Pre- and postoperative scores were compared using the Wilcoxon signed rank test in the seven patients who underwent surgery of the involved upper limb. Intraclass Correlation Coefficient with a confidence interval of 95% was used to determine intra and interobserver reliability of the SFA and DPA scores. Weighted kappa was used to assess the agreement of the GRA scores with the level of statistical significance set at  $P < 0.05$ .

## Results

A total of 40 children participated in this study. There were 24 boys and 16 girls. The mean age was 8.62 years (range 2–15 years). Thirty patients were spastic hemiplegics while the others were asymmetric diplegics (diplegics with significant upper limb involvement on one side). None were cognitively impaired.

Analysis of the scores revealed that patients could be categorized into three groups. The first group had modified house scores of 0, 1 or 2 in all the activities. This corresponded to an SFA percentage of 0%–40%. These were children with chronic neglect who either ignored the involved extremity or at the most, used it as a dead weight to stabilize objects. They were considered unsuitable for

**Table 2: Details of surgical procedures performed**

Patient number	Age/sex	Diagnosis	Procedure
1	9/female	Spastic hemiplegia left side	Pronator release
2	7/male	Asymmetric diplegia with left upper limb involvement	Adductor pollicis and FCU release
3	10/female	Spastic hemiplegia left side	Adductor pollicis release, flexor digitorum superficialis release and rerouting of the extensor pollicis longus
4	9/male	Asymmetric diplegia with right upper limb involvement	Adductor pollicis release, FCU to extensor carpi radialis brevis transfer, extensor pollicis longus release and brachioradialis to abductor pollicis longus transfer
5	13/male	Spastic hemiplegia right side	Adductor release, extensor pollicis longus transposition, and FCU to extensor carpi radialis brevis transfer
6	11/male	Spastic hemiplegia left side	Pronator teres rerouting, pronator quadratus release, FCU to extensor carpi radialis brevis transfer and adductor pollicis release
7	12/male	Spastic hemiplegia left side	Adductor pollicis release, rerouting of extensor pollicis longus, pronator teres release, and release of lacertus fibrosus

FCU=Flexor carpi ulnaris

surgery and were offered constraint therapy. If cosmesis was a concern, the option of wrist arthrodesis was offered.

The second group had modified House scores of 3's and 4's which indicated extremities which could actively assist during tasks but were limited by spasticity or contractures of the individual segments of the limb, and deficient distal selective motor control. SFA percentages were between 41% and 80%. There were 15 children in this group. These limbs were considered to have potential for improvement with surgical interventions.

The children in third group had a score of 5 in all or most of the activities with an SFA percentage of more than 80%. These children had spontaneous use of their upper extremity with minimal segmental involvement. 11 children were in this group.

We looked at the 15 children belonging to the group II, out of whom 7 underwent surgery. The mean age at the time of surgery was 10.14 years. There were 5 boys and 2 girls. All these children had both pre- and postoperative video analysis.

The mean followup was 8.7 months and the repeat analysis was done at a mean of 7.4 months after surgery.

Preoperatively, the mean SFA was 60.93, mean DPA was 69.32, and GRA was 66.46. Postoperatively, the values were 63.90, 72.47, and 71.42 respectively. However, there was no statistically significant improvement in SFA, DPA, or GRA [Table 3].

There was excellent intraobserver ( $r = 0.98$ ) and interobserver reliability ( $r = 0.97, 0.96$ ) with regard to categorizing the patients into the different groups based on the SFA scores [Table 4 and Figure 1].

## Discussion

Upper limb involvement in cerebral palsy is characterized by weakness, spasticity with or without contractures, loss

**Table 3: Comparison of pre- and post-operative Shriners Hospital Upper Extremity Evaluation scores**

Score	Mean±SD		Mean of paired differences	P
	Preoperative	Postoperative		
SFA	60.93±6.50	63.90±7.54	2.97	0.259
DPA	69.32±8.01	72.47±7.20	3.15	0.229
GRA	66.46±27.22	71.42±23.00	4.96	0.334

SFA=Spontaneous Function Analysis, DPA=Dynamic Positional Analysis, GRA=Grasp/release ability, SD=Standard deviation

of selective motor control and lack of coordination leading to difficulty in spatial placement of the upper limb and ineffective grip and release, resulting in patients being unable to perform activities of daily living. In addition, the flexed position of the elbow and the wrist can be unsightly and school going children may bear the brunt of taunts, resulting in a defective self-image. Proper identification and correction of the upper extremity deformities can potentially provide functional, cosmetic, and psychological benefits.

The SHUEE was designed in 1996 to determine the potential for improved function by identifying the degree of spontaneous use and the dynamic segmental alignment of the affected extremity during on-demand use. Following its description, there are only a few reports of its validation and use in the clinical setting.

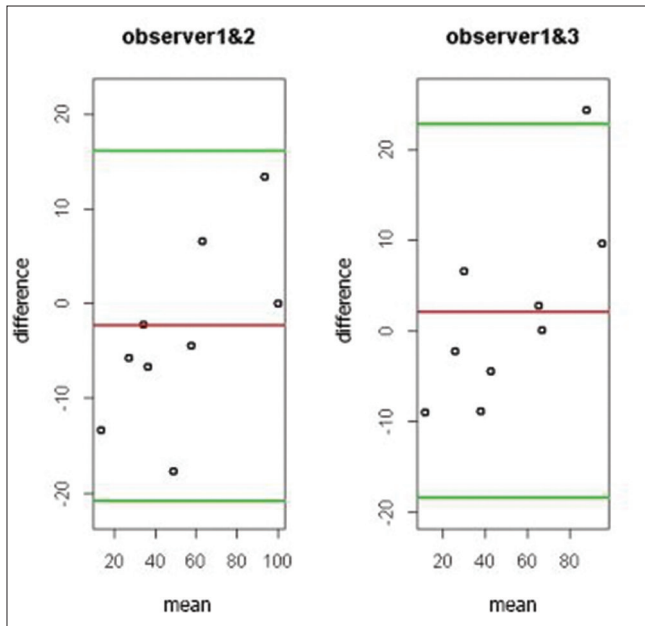
Davids *et al.* used SHUEE to retrospectively study the relationship between static and dynamic assessments of the thumb in 33 children with spastic hemiplegia before and after surgery.<sup>10</sup> The mean time to followup was 2 years and 2 months. They found that dynamic thumb alignment was worse than static thumb alignment preoperatively. Postoperatively, there was an improvement in both the dynamic and static alignment but more so in the static component.

In another study, the same group used SHUEE to assess the postoperative functional outcome following single event

**Table 4: Intraclass coefficient for intra- and interobserver reliability for Spontaneous Function Analysis and Dynamic Positional Analysis scores**

Reliability	r (CI)
Interobserver reliability	0.97 (0.8000.98)
Intraobserver reliability	0.96 (0.8700.99)

CI=Confidence interval



**Figure 1: Interobserver reliability of the Spontaneous Functional Analysis and Dynamic Positional Analysis scores**

multilevel upper limb surgery in a cohort of 40 children.<sup>11</sup> Video analysis was done at a mean of 4 months before surgery and then repeated at a mean of 14 months postsurgery. They found statistically significant, but not clinically important improvement in SFA score, statistically significant and clinically important improvement in DPA scores and unchanged grip release analysis score. They concluded that SHUEE could be used reliably in clinical decision-making and to assess functional outcomes following surgical interventions.

Tedesco *et al.* studied 19 children with spastic hemiplegia out of whom five underwent surgery.<sup>12</sup> SHUEE analysis was done at a mean of 1 year postoperatively. They found a mean improvement in SFA by 3.5% and DPA by 44.8%. GRA was 100% preoperatively and did not change after surgery.

This study, which is the first such study conducted on Indian children, corroborates the findings of the previous studies. It has shown that it was possible to classify children into subgroups based on the SFA scores. Children with active assist upper extremities could be identified and their specific segmental deficiencies could be addressed

with surgery. Postoperative video analysis was helpful in documenting the improvement in the performance of the various segments as well as the upper limb as a whole.

The SHUEE can be used to evaluate a wide age group of children. The youngest child in our study was 2 years old. Although SHUEE was described for 3–18 year olds, we found that the 2-year-old child was cooperative and able to perform all the required tasks. The children, especially the younger ones, enjoyed performing the various activities and participated whole heartedly. The performance of tasks gave a better understanding of the spontaneous function of the involved limb and helped in differentiating between dynamic and fixed deformities. One major advantage was that the video recording could be taken by trained personnel who were not necessarily a part of the decision-making team. The video could then be viewed by the team of surgeons, physiotherapists, and occupation therapists to formulate a treatment plan.

The disadvantages of SHUEE are that, first, it is difficult to assess children with mental retardation or hyperactivity disorders. Second, in the Indian context, cutting the Play Dough using knife and fork, and putting on shoes and socks were unfamiliar activities for some of the children. However, they were able to perform the tasks after being instructed and shown how to do it. Modification of these activities in the SHUEE may make it more applicable for Indian children.

The shortcomings of the study were first, the few numbers of patients who underwent surgery and none who received other interventions such as botulinum toxin injections or joint stabilizing procedures such as arthrodesis. Second, the postoperative followup of the patients was short. However, there are no guidelines as to when SHUEE should be performed after surgery. The original article mentions a range from 6 months to 4½ years.<sup>9</sup> Thirdly, we did not assess patient or caregiver satisfaction with the surgery.

### Conclusions

SHUEE video analysis is a useful tool for assessing upper limb function in Indian children with cerebral palsy. It helps to determine the subset of patients with upper extremity cerebral palsy who would benefit from surgical intervention, and also, the nature of intervention required by the patient. It is reliable and can be used as a good mode of documentation.

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## Conflicts of interest

There are no conflicts of interest.

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