Measurements ct · evaluation of clinical signs and

Measurements were taken for each optic nerve with standardized instrument setting. For each eye measurement was taken 3 times andaverage of it was taken as the ONSD.

The optic nerve sheath appears as hypoechoic band dorsal to the globe. Optic nerve sheath diameter was measured by USG just before the induction of anesthesia at operative table. The diameter of the optic nerve sheath 3 mm behind the posterior sclera was measured using linear USG probe of 5-16 MHz.

linear probe was applied with gel to the closed eyelid at superior lateral aspect of eye. A cursor was placed from outer edge to outer edge of this hypo echoic band to measure the diameter as mentioned by Ohle R. et. al.

(12). In same manner post-operative ONSD was measured between 16 to 24 hours after the surgery. Care was taken as much as possible not to compress eye and cause any laceration or trauma to eyelids. Pre-Operative CT scan images was analyzed; at a depth of 3mm from the eyeball, an electronic caliper was used between outer edges of hypo echoic band of optic nerve sheath to measure the exact ONSD as described by Kalantri H. et al (19). A post-operative CT of at least 16-24 hours after the surgery was analyzed again in the same manner. Figure 1: Study Procedure Total number of patients undergoing VP shunt surgery approached for participation in study (n = 86)   Assessed for eligibility (n = 76)   Total recruited (n = 69) Pre- operative ·   Measurement of ONSD – by USG and CT · Evaluation of clinical signs and symptoms (n = 69)   Post- operative (after 16-24 hours) ·   Measurement of ONSD – by USG and CT ·   Evaluation

of clinical signs and symptoms (n = 69)   Patients not meeting eligibility criteria   (n = 7)   Not willing to participate in study (n = 10)   Questionnaire which included features of raised ICP were asked to adults. Symptoms like irritability, week cry, sunset sign and bulging fontanalle were noted in children under the 12 years of age.

Symptoms and sing noted were as follow: Raised ICP Symptoms in patients Pre-op period Y/N Post-op period (12 to 16 hours post-surgery) Y/N Headache transient visual obscurations   diplopia, photophobia, retro bulbar pain Dizziness, tinnitus   nausea, vomiting,   irritability   week cry   sunset sign   bulging fontanelle   Intra operative events were noted down and any specific action affecting the study parameters were analyzed. Statistical method Sample size was estimated using the standard formulas for estimating the agreement in continuous outcomes and was measured by using intra class correlation coefficient (ICC). The minimum expected intra class correlation coefficient between the ONSD measured by USG and CT scan was 0. 8 as sample reliability value with 80 % power and 5% level of significance. By this method sample size was calculated to be 60. Convenience sampling was done in the study. Statistical testing was conducted with statistical software (SPSS version 16. 0, Chicago, IL, USA).

Results on continuous measurements are presented as Mean ± SD (Min-Max) and results on categorical measurements are presented as Number (%). Significance is assessed at 5 %. Student t test has been assessed to find the significance of study parameters before and after the surgery. Pearson Correlation test, Interclass correlation test and Bland Altman graph plot have

been used to find level of agreement between measurement by USG and CT scan. Mcnemars test was used to analyze categorical measurements of the data.   RESULTS   Table 1 Descriptive statistics   Mean ± SD Adults (11-60 yrs)   Mean ± SD (n = 57) Pediatric (2 to 10 yrs)   Mean ± SD (n= 12) Age   34. 43 ± 18.

22 40. 68 ± 13. 36 5.

00 ± 2. 98 Sex (M: F)   38: 31 33: 24 5: 7 Weight (in kgs)   52. 61 ± 20. 06 60. 19 ± 12. 19 16. 58 ± 4.

25 USG Right Eye Pre op   5. 63 ± 0. 93 5. 81 ± 0.

79 4. 77 ± 1. 13 USG Left Eye Pre op   5. 61 ± 0. 92 5. 80 ± 0. 76 4. 75 ± 1.

16 Mean USG Pre op   5. 62 ± 0. 92 5. 80 ± 0. 77 4. 76 ± 1. 14 CT Right Eye Pre op   5.

60 ± 0. 97 5. 77 ± 0. 85 4. 78 ± 1. 11 CT Left Eye Pre op   5. 59 ± 0.

97 5. 78 ± 0. 83 4.

71 ± 1. 11 Mean CT Pre op   5. 6 ± 0. 96 5.

77 ± 0. 83 4. 75 ± 1. 11

All the ONSD values are measured in mm   Prospective observational study was conducted among 69 patients undergoing VP shunt surgery. Among them 38 were male, 31 were female and 12 were under the age of 10 years. ONSD was measured by both modalities USG and CT scan before and after the surgery. For each eye, ONSD was measured 3 times and average of it

was taken as ONSD value. To avoid bias USG and CT scan was conducted by two different individuals.

The mean ONSD by USG (before surgery) was 5. 80mm ± 0. 77 mm and 4. 76 ± 1. 14 mm in adults and children respectively (table: 1).   Table 2: Difference in ONSD preoperatively and post operatively   ONSD variables Adults age group Mean ± SD (n= 57)   Pediatric age group Mean ± SD (n= 12)   P value USG Right Eye Pre op 5. 81 ± 0.

79 4. 77 ± 1. 13 < 0. 001 USG Right Eye Post op 4.

51 ± 0. 73 3. 90 ± 1.

08 USG Left Eye Pre Op 5. 80 ± 0. 76 4. 75 ± 1. 16 < 0. 001 USG Left Eye Post Op 4. 52 ± 0.

71 3. 90 ± 1. 08 Mean USG Pre OP 5. 80 ± 0. 63 4. 76 ± 1. 14 < 0.

001 Mean USG Post Op 4. 52 ± 0. 72 3. 90 ± 1. 08 CT Right Eye Pre OP 5.

77 ± 0. 85 4. 78 ± 1. 11 < 0. 001 CT Right Eye Post Op 4. 48 ± 0. 76 3. 84 ± 1.

09 CT Left Eye Pre Op 5. 78 ± 0. 83 4.

71 ± 1. 11 < 0. 001 CT Left Eye Post Op 4. 516 ± 0.

76 3. 86 ± 1. 09 Mean CT Pre Op 5. 77 ± 0. 83 3.

90 ± 1. 08 < 0. 001 Mean CT post op 4. 49 ± 0. 76 3. 85 ± 1. 09
All the ONSD values are measured in mm   (Test done: paired t test was

done comparing two age groups separately) In adult patients (group of 11 to 60 years) ONSD (average) measurement by USG preoperatively and postoperatively was found to be 5. 80 ± 0.

63 mm and 4. 52 ± 0. 72 respectively (p < 0. 001).

Similarly, in pediatric population (group of 2 to 10 years) ONSD (average) measurement by USG in preoperatively and postoperatively was found to be 4. 76 ± 1. 14 mm and 3. 90 ± 1. 08 mm (p < 0. 001).

There was significant reduction in ONSD measurement after the VP shunt surgery.   Figure 1: Pearson Correlation Test between ONSD measured by USG and CT (n= 69)   The mean ONSD by USG was plotted against x axis and average ONSD by CT scan was plotted against y axis during pre-operative and post-operative period. Correlation coefficient was found to be r = 0. 95 (p <0. 001). We observed a strong correlation between the ONSD measured by USG and CT scan. Table 3 Interclass Correlation test between USG and CT   Variables Compared (n = 69) ICC value n = 69 p value   USG right eye pre operatively CT right eye pre operatively   0.

97   <0. 001   USG Left eye pre operatively   CT left eye pre operatively   0. 97   <0. 001   Average USG pre operatively Average CT pre operatively   0. 97   <0. 001   USG right eye post operatively   CT right eye post operatively   0.

97   <0. 001   USG Left eye post operatively CT Left eye post operatively 0. 97   <0. 001   Average USG post operatively Average CT post operatively

0. 97   <0. 001   A high degree of reliability was found between ONSD measured by USG when compared to CT scan. .

Average interclass correlation between ONSD by USG and CT was 0. 97 (p < 0. 001) suggesting a strong agreement between them.   Figure 2: Bland Altman Graph plot between two modalities of measurement (n= 69) (Values in x and y axis are measured in mm) To check the agreement between two measured diameters (USG and CT scan) Bland Altman graph plot was constructed in figure 3. Difference between USG diameter and CT diameter are plotted against their means (USG scan + CT scan) /2 in both the eyes before and after the surgery. The tight cluster around center " zero" in all four groups shows a minimal variation in two different measurement modalities.   Table 3 Comparison of clinical symptoms among patients pre operatively and post operatively   Symptoms Present pre operatively (n = 57)   Present post operatively (n = 57)   P value Headache   34 (59%)   21 (36%)   <0. 001   Visual obscuration   33 (57%) 16 (28%)   <0.

001   Nausea vomiting   36 (63%)   12 (21%)   <0. 001   Dizziness, tinnitus 33 (57%)   11 (19%)   <0. 001   Diplopia, Photophobia   33 (57%)   13 (22%) <0. 001   (Test performed: Mcnemars test)   We assessed 57 patients between the age group of 11 to 60 years of age and evaluated them for clinical symptoms of increased ICP preoperatively and post operatively. Clinical symptoms in pediatric age group could not be noted down. Also 12 among these 57 patients had poor GCS in whom clinical symptoms could not be assessed.

Mcnemars test was used to assess the difference in symptoms before and after the surgery. A significant proportion of patients had no symptoms after the surgery compared to before the surgery with p value of less than 0. 001. DISCUSSION   Monitoring raised ICP is extremely important in neurosurgery patients as it is associated with increased morbidity and mortality. Standard method of monitoring ICP is by placement of intraparenchymal probe or intraventricular catheter which is associated with higher rate of complications such as hemorrhage, infection and incorrect catheter placement (1).

Noninvasive radiological investigations to detect raised ICP are MRI and CT scan. CT scan is used more often in daily clinical practice because it is faster and readily available. Another equally effective method of detecting raised ICP is by measurement of ONSD.

Optic nerve sheath is covered by dura which increases in size when there is a rise in intracranial pressure. ONSD has positive correlation with invasively measured ICP and is detected within seconds of raised ICP (2) (3) (4). ONSD measurement in CT scan or MRI has high sensitivity and specificity to detect raised intracranial hypertension with a cut off value of 4. 6mm in females and 4.

8 mm in males (1) (5) (6).   Bed side ultrasonographic measurement of ONSD to detect raised ICP is gaining popularity as it is easily available and faster than CT scan or MRI. Its use has been studied in multiple cases like TBI, hydrocephalus, shunt malformation etc. Systemic review by Ohle et al.

conclude measurement of ONSD by USG as a better diagnostic tool to detect raised ICP than radiological feature of CT scan (7) .

Shirodkar et al. showed strong correlation between USG and MRI in measuring ONSD among patients diagnosed with meningoenchephalitis (8). It was a prospective study in which participants did not undergo any surgical intervention. Similarly a restrospective study by Kalantari et al. among normal population found strong correlation between ONSD measurement by CT scan and MRI. We studied correlation between USG and CT scan in measuring ONSD as CT scan is performed more often for patients undergoing VP shunt surgeries.   In our study ONSD was measured both before and after the surgical procedure at 3 mm depth behind the papilla as described by Ohle R etl al (7). Our study shows a strong correlation between ONSD measurement done by USG and CT with average ICC value of 0.

97 (p < 0. 001, 95 % CI of 0. 96 -0. 98. Bland-Altman graph plot was drawn for both measurements before and after VP shunt procedure which also shows strong correlation between these two modalities. This finding is comparable to study by kalantari in which ONSD by CT and MRI showed correlation of 0. 89 (p <0.

001, CI 95% 0. 86-0. 91) of and ICC of 0.

89 (p < 0. 001, CI 95% of 0. 86-0. 91).   Previous Studies have shown ONSD increases within seconds of raised ICP and can be detected early with the help of ocular ultrasonography (8) (2) (9). A study conducted by Zaidid et al. (10) showed ONSD measurement could also detect VP shunt obstruction.

Other objective of our study was to measure ONSD both preoperatively and post operatively . Till now to the best of our knowledge there has been no study measuring ONSD value before and after VP shunt surgery. It would be helpful to know the difference in measurement after the procedure.

Among adult patients (group of 11 to 60 years) ONSD (average) measurement by USG preoperatively and postoperatively was found to be 5. 80 ± 0. 63 mm and 4. 52 ± 0. 72 respectively.

Similarly, in pediatric population (group of 2 to 10 years) ONSD (average) measurement by USG in preoperatively and postoperatively was found to be 4. 76 ± 1. 14 mm and 3. 90 ± 1. 08 mm. There was a significant reduction in ONSD after VP shunt surgeries in both the groups.

Our result is similar to the study done by Singhal et al. among paediatrics population (11) where ONSD was measured before and after EVD placement or tumor surgery.   We studied clinical parameters of raised ICP like headache, nausea, vomiting etc. before and after shunt surgery among 57 adult patients and sings like bulging fontanel, weak cry, irritability was noted among children. 12 out of 57 patients had poor GCS in whom clinical symptoms could not be noted down and pediatrics sample was small for analysis of clinical sings. Analysis of these data in adults showed improvement in clinical symptoms after the surgery in a significant proportion of patients. This finding is consistent with study done by Singhal et al.

(11) in which patients had both reduction of ONSD and improvement in clinical symptoms after surgical intervention.   In patients undergoing VP

shunt surgeries standard investigation tool for evaluation of position and

function of VP shunt is CT scan which is time consuming and

requires patient to be shifted. USG is quick and easy bedside investing which

can be repeated easily if required. So, we suggest along with clinical

parameters ONSD measurement before and after surgery could be used as a

tool to detect functional outcome of VP shunt.