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The study to compare the skin to epidural space distance obtained by formulated predictive equation of BMI with LOR technique and USG in patients scheduled for elective surgery and pain relief".

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Abstract
BACKGROUND: *Epidural space identification most commonly performed by LOR (Loss Of Resistance) technique, is a blind procedure and success depends on many anatomical variations, correct identification. There is a positive correlation between BMI (Body Mass Index) and skin to epidural space depth. USG technique has been attributed to more accurate estimation of epidural space depth. We conducted the study to compare the skin to epidural space distance obtained by formulated predictive equation of BMI and LOR technique, USG technique in the patients scheduled for elective surgery and pain relief.*
METHODS*: A prospective, randomized study was conducted in 60 patients belonging to ASA physical status I, II in age group 18 -60 years scheduled for elective lower abdominal, lower limb surgeries & pain relief will be randomly selected and compared. In every patients the distance from skin to epidural space is measured by 3 techniques namely the formulated predictive equation of BMI, LOR technique, USG technique.*
RESULTS: *continuous variables were analysed with the unpaired t test Anova, post HOC test and correlation test. Categorical variables are analysed with Chi-Square test, fisher exact test. Statistical significance was taken as p< 0.05. The data was analysed using EpiInfo software (7.1.0.6 version; center for disease control, USA) & Microsoft Excel 2010*
CONCLUSION: *If the Depth of Epidural Space assessed by USG method is considered as the actual insertion length, then we can conclude that USG method is better than the estimated insertion length assessed BMI and LOR methods. But the Depth of Epidural Space assessed by BMI is better than the LOR method in prediction of distance.*
Keywords: *Epidural space depth, BMI, LOR technique, USG technique.*

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I. Introduction

Epidural anaesthesia is being increasingly used to provide anaesthesia for surgery on the lower abdomen, perineum and lower extremities. Epidural space identification most commonly performed by LOR (Loss Of Resistance) technique, is a blind procedure and success depends on many anatomical variations, correct identification.

There is a positive correlation between BMI (Body Mass Index) and skin to epidural space depth. USG technique has been attributed to more accurate estimation of epidural space depth. We conducted the study to compare the skin to epidural space distance obtained by formulated predictive equation of BMI and LOR technique, USG technique in the patients scheduled for elective surgery and pain relief.

II. Aims And Objectives

The aim of the study:

- To find a correlation between BMI & distance from the skin to epidural space.

Body Mass Index (quetelet's Index)	=	Weight (kg) /Height2 (m)

Formulated Predictive equation of depth of epidural space from skin in relation to BMI based on linear regression analysis as

DEPTH (mm)	=	a + b (BMI)
a	=	17.7966
b	=	0.9777

THE PARAMETERS CORELATED ARE:
1.Age and distance from the skin to epidural space
2.Sex and distance from the skin to epidural space
3.Height and distance from the skin to epidural space
4.weight and distance from the skin to epidural space
5.BMI and distance from the skin to epidural space

The parameters compared are;
- Skin to epidural space distance in mm by USG.
- Skin to epidural space distance in mm by LOR technique.
- Skin to epidural space distance in mm by Formulated Predictive equation of depth of the epidural space from the skin in relation to BMI

MATERIALS AND METHODS
After obtaining Ethical Committee approval 60 Patients presenting for elective lower abdominal, lower limb surgeries and pain relief will be randomly selected & compared .In every patients the distance from skin to epidural space is measured by 3 techniques namely the formulated predictive equation of BMI, LOR technique & USG.
STUDY DESIGN:
Prospective, randomized, Cohort study

INCLUSION CRITERIA:
- Age : 18-70 years
- ASA : I & II
- Surgery : Elective
- Mallampattiscores : I & II
- Who have given valid informed consent.

EXCLUSION CRITERIA:
- Increased Intracranial pressure.
- Uncorrected Coagulopathy.
- Patients receiving anticoagulants.
- Obvious spinal deformity.
- Previous spinal surgery, spinal trauma, local infection / mass / oedema.
- Neurological disease.
- Pregnancy.
- Generalisedoedema of the body.
- Inadequate Epidural block

III. Methodology

All 60 patients were subjected to USG guided estimation of skin to epidural space distance by transverse plane with patient in sitting position at the level of L2 L3 on the previous day of the planned procedure. Simultaneously the BMI for these patients were calculated, and with the use of Formulated Predictive equation of depth of the epidural space from the skin in relation to BMI, We calculated the Skin to Epidural space distance in all patients.

All patients were kept in nil per oral for 10 hrs. T.Diazepam 10mg orally given to the patient the previous day night.Patient shifted to operating room and then monitor like NIBP, ECG, SPO2 were connected and base line parameters were recorded. IV line started in a larger peripheral vein preferably with 18G venflon. Then the patient was preloaded with ringer lactate 20ml/ kg over 20 min. inside the operation theatre the patient was now positioned in sitting position.

With strict Aseptic precautions after infiltrating local anaesthetic at L2 L3 space, Epidural block was performed by anaesthesiologist(unaware of the distance from the skin to epidural space by USG and BMI) with

18G Tuohy Epidural needle and the epidural catheter was introduced into the epidural space at 4-5 cm distance. Then the epidural test dose of 1.5% lignocaine 3ml with 1 in 200000 dilution of adrenaline was given and the placements of the catheter into the epidural space is confirmed and the surgery is proceeded.

Continuous intraoperative monitoring is done throughout the procedure. After the procedure is over, the patients were shifted to the post anaesthesia care unit and monitored.

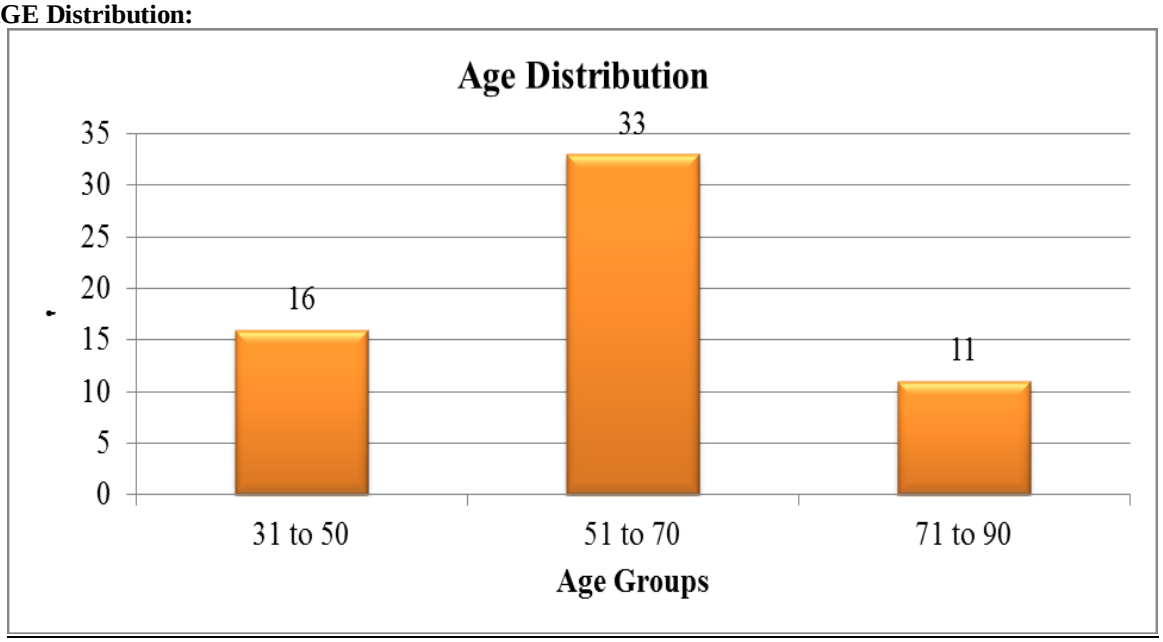
IV. Observation And Results

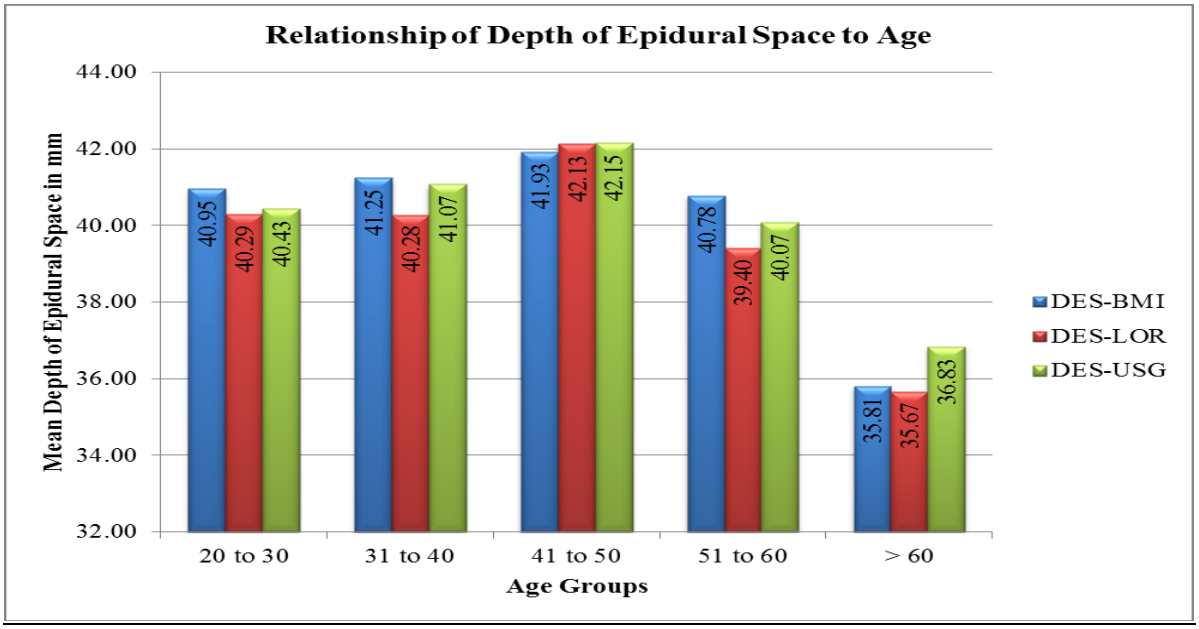
Study Groups	Name of Group	Procedure	Number of Subjects
Group A	DES – BMI	Estimation of Depth of Epidural Space using Body Mass Index(BMI) method	60
Group B	DES – LOR	Estimation of Depth of Epidural Space using Loss of Resistance(LOR) method	
Group C	DES - USG	Estimation of Depth of Epidural Space using (Ultrasound Sonography Test(USG)	

Statistics:

Descriptive statistics was done for all data and suitable statistical tests of comparison were done. Continuous variables were analysed with the unpaired t-test, ANOVA, Post Hoc tests and Correlation tests. Categorical variables were analysed with the Chi-Square Test and Fisher Exact Test .

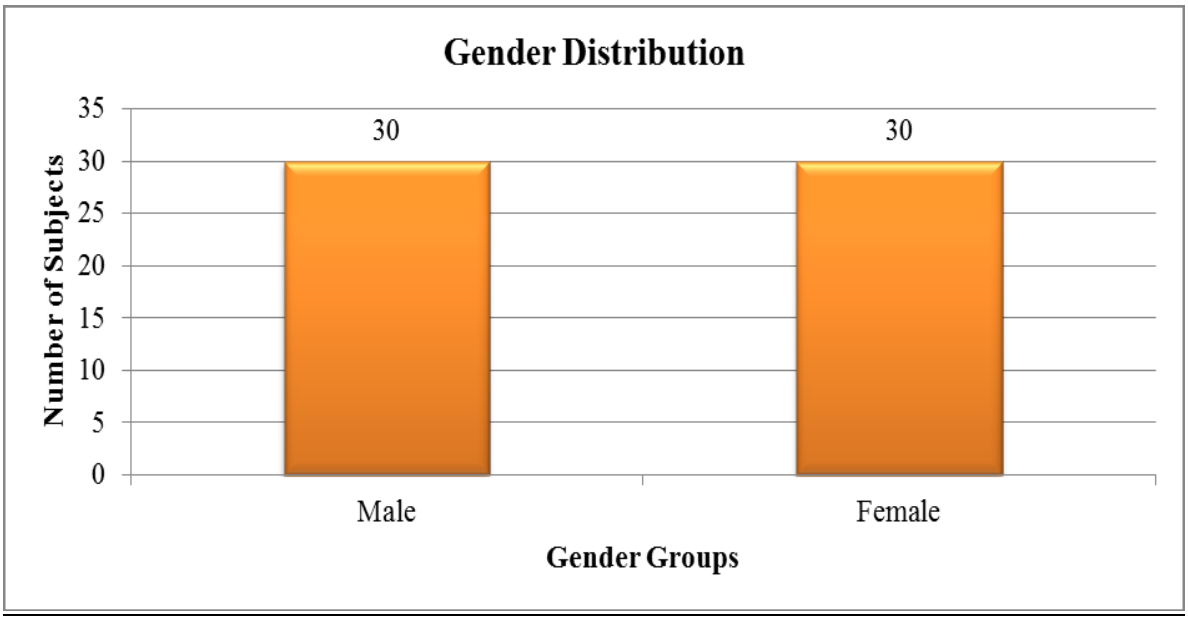
AGE Distribution:

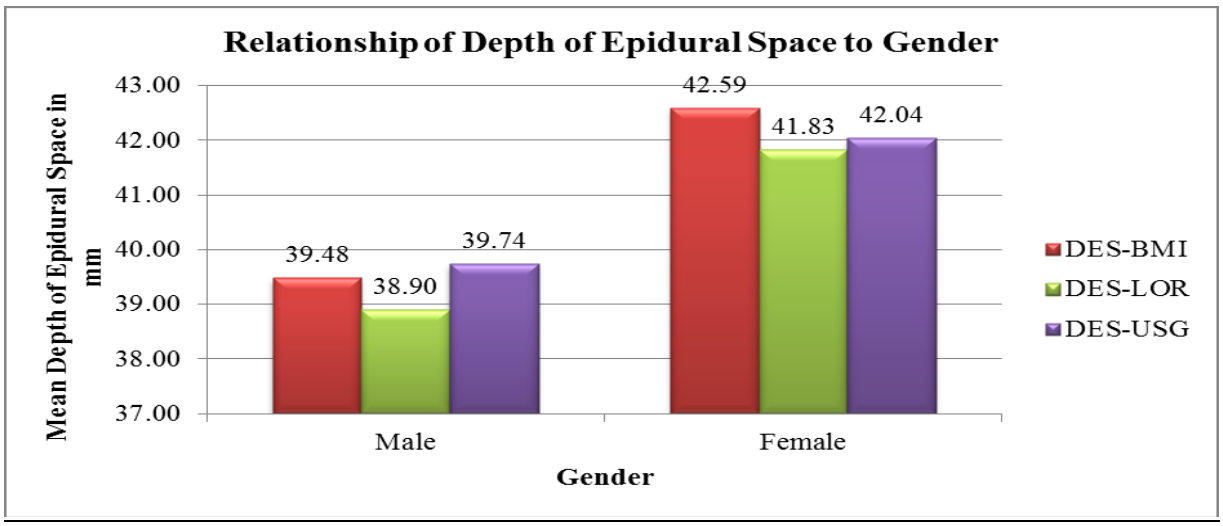




By conventional criteria the association between the Depth of Epidural Space assessed by LOR, BMI and USG methods and age is considered to be not statistically significant since $p > 0.05$.

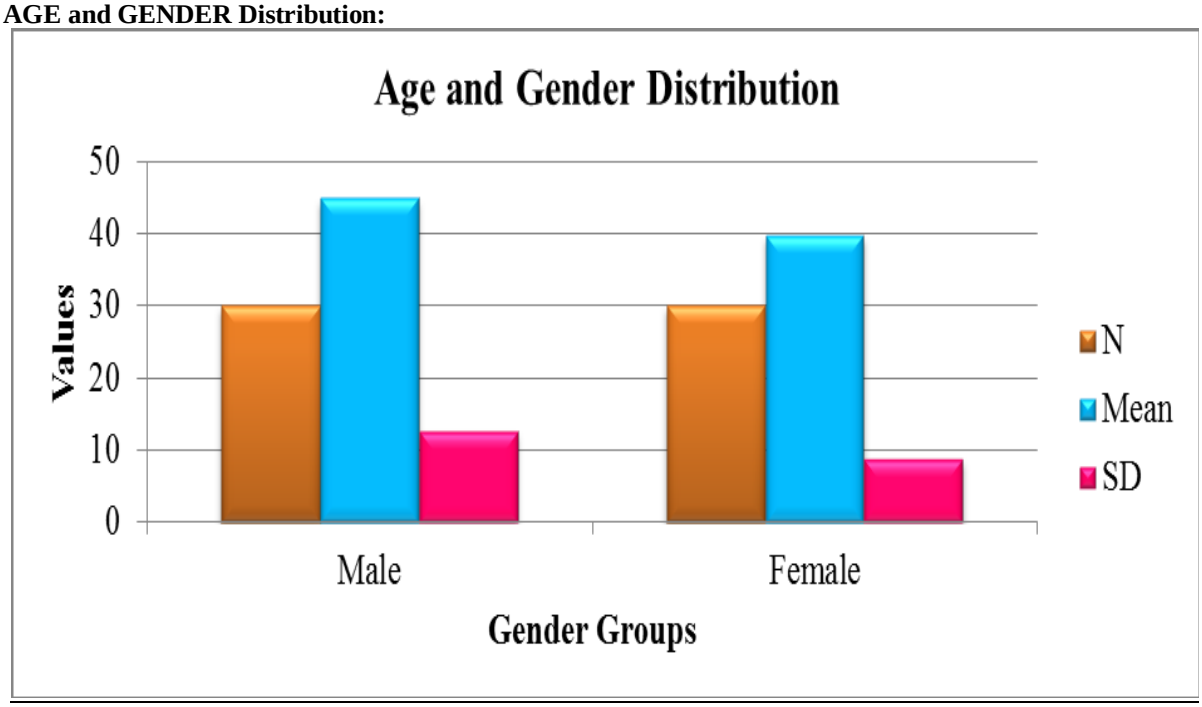
GENDER Distribution:

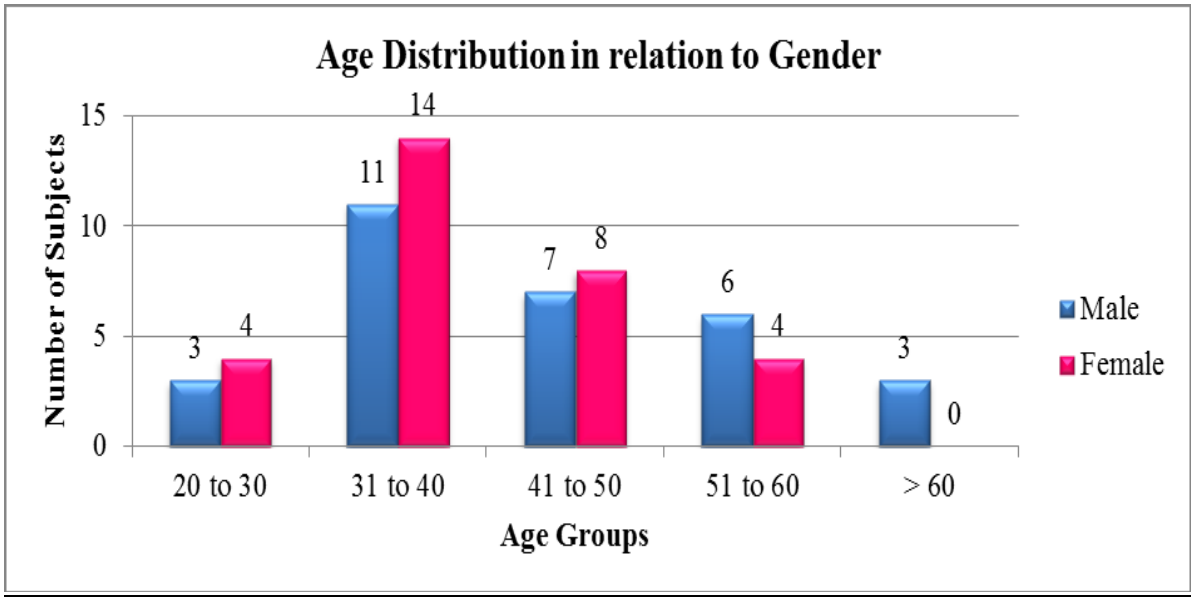




By conventional criteria the association between the Depth of Epidural Space assessed by LOR, BMI and USG methods and gender is considered to be not statistically significant since $p > 0.05$.

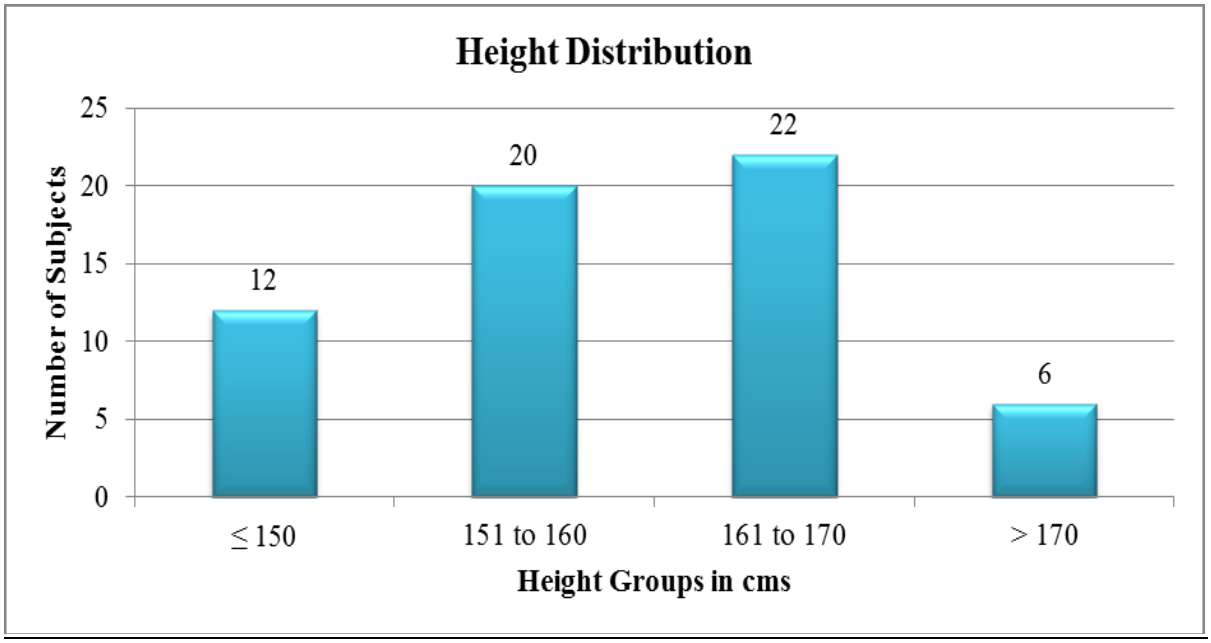
AGE and GENDER Distribution:

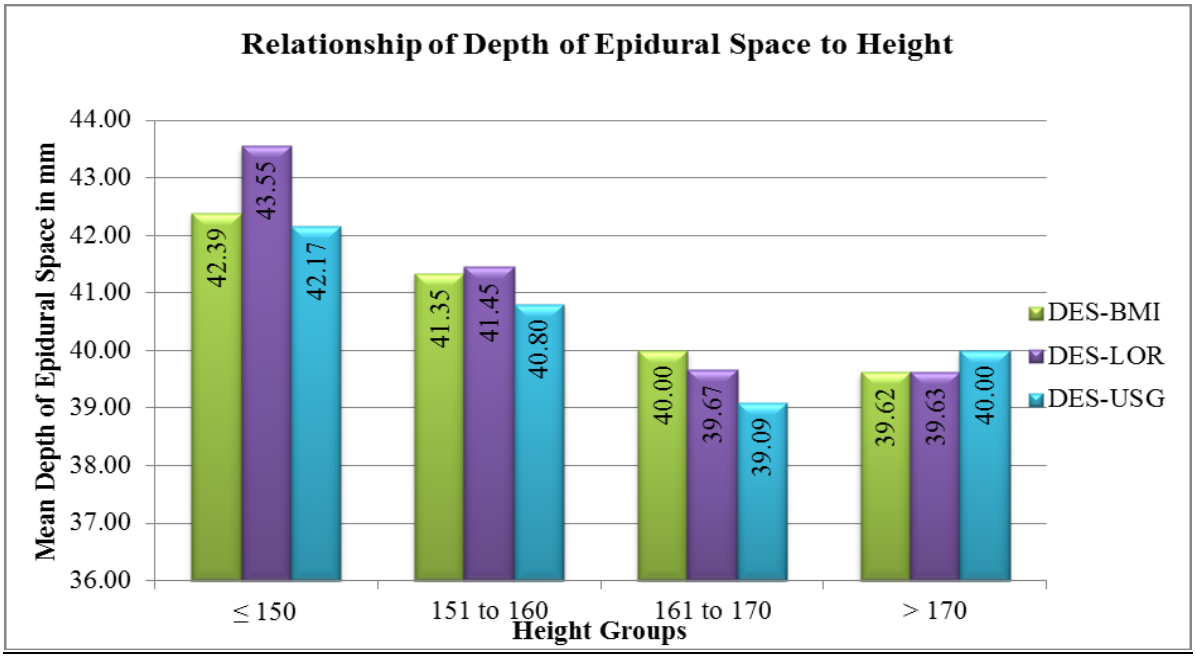




Since age in relation to Gender is not statistically significant, it means that there is no difference between the groups. In other words the groups contain subjects with the same basic demographic characteristics.

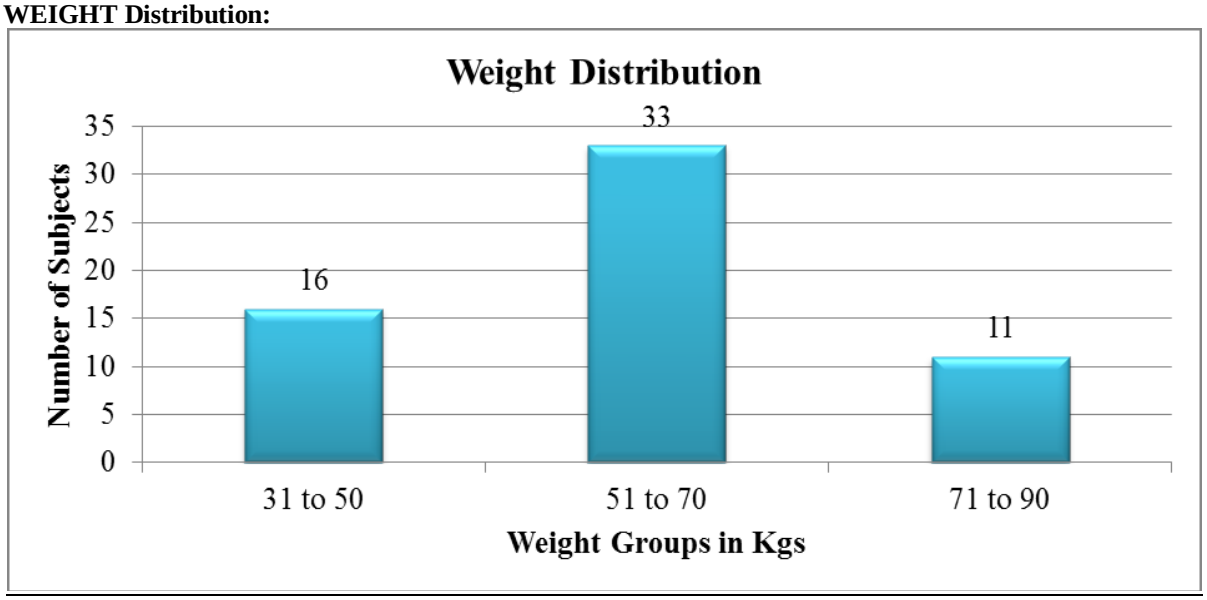
HEIGHT DISTRIBUTION:

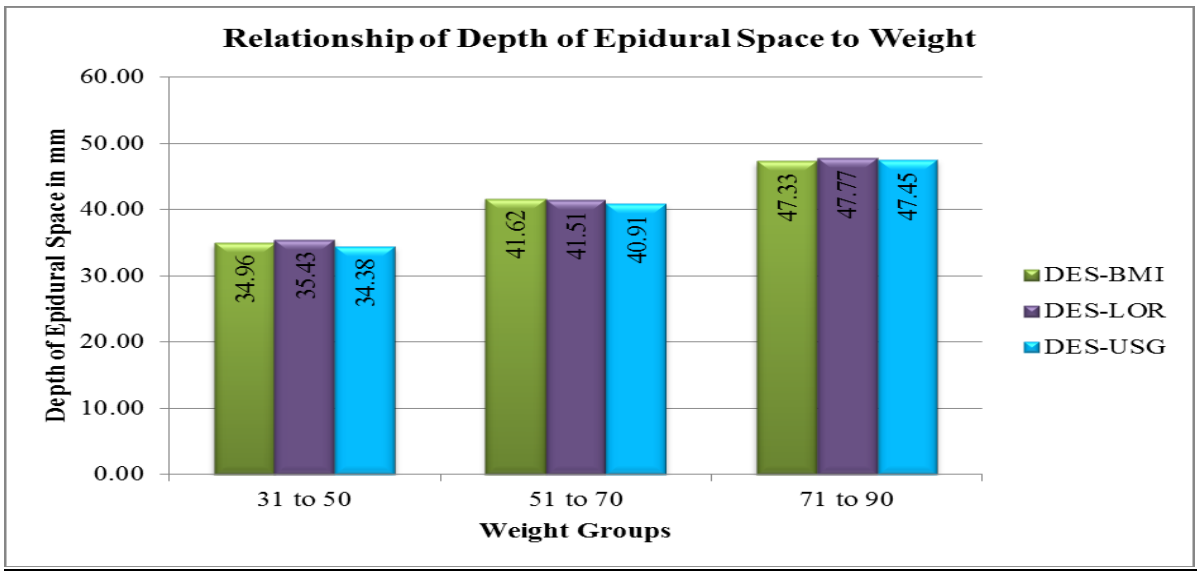




By conventional criteria the association between the Depth of Epidural Space assessed by LOR, BMI and USG methods and height is considered to be statistically significant since $p < 0.05$.

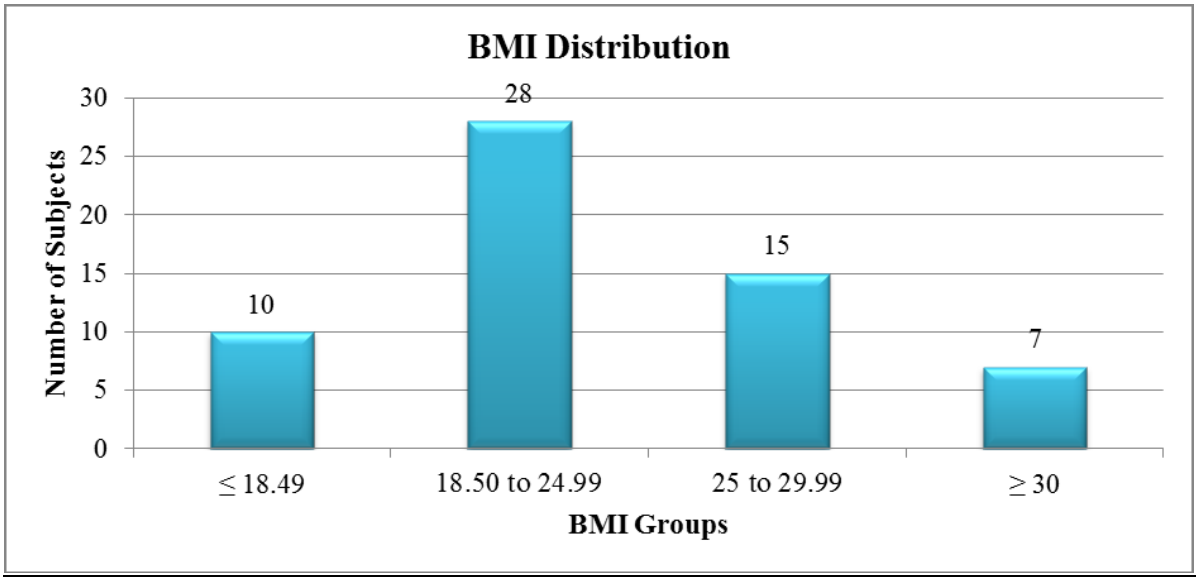
WEIGHT Distribution:



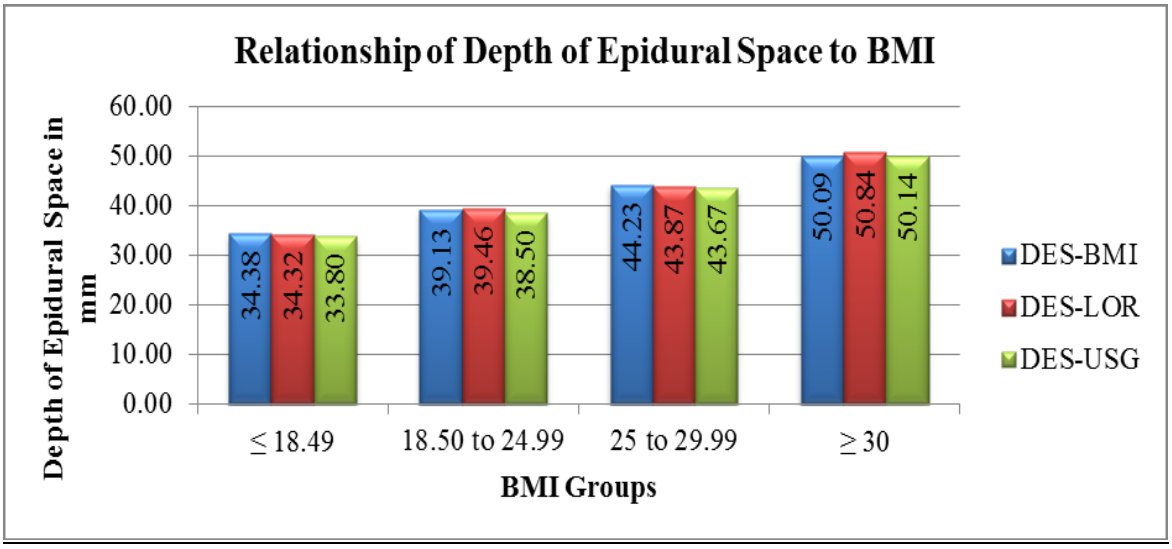


By conventional criteria the association between the Depth of Epidural Space assessed by LOR, BMI and USG methods and weight is considered to be statistically significant since $p < 0.05$

BMI Distribution:



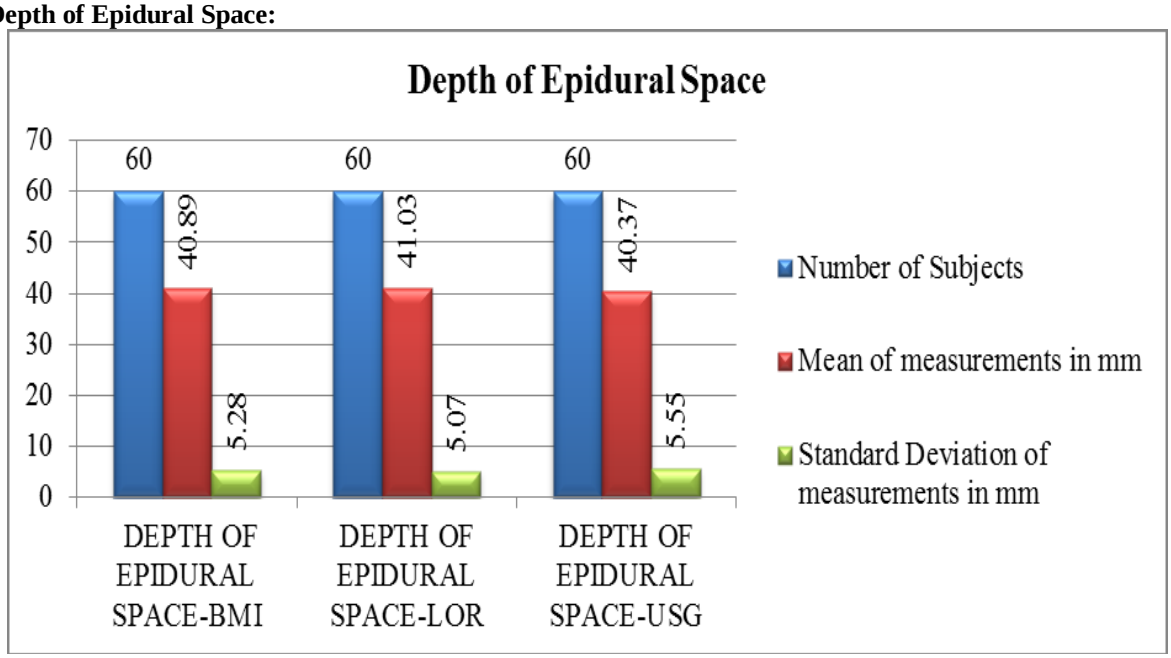
	BMI	N	BMI Mean±SD	DES-BMI Mean±SD	DES-LOR Mean±SD	DES-USG Mean±SD
Underweight	≤ 18.49	10	16.90±1.14	34.38±2.28	34.32±1.12	33.80±2.20
Normal	18.50 to 24.99	28	22.19±1.98	39.13±2.57	39.46±2.00	38.50±2.78
Overweight	25 to 29.99	15	26.66±1.10	44.23±2.04	43.87±1.12	43.67±2.13
Obese	≥ 30	7	33.80±3.44	50.09±3.93	50.84±3.37	50.14±4.85



By conventional criteria the association between the Depth of Epidural Space assessed by LOR, BMI and USG methods and BMI is considered to be statistically significant since $p < 0.05$.

STATISTICAL SIGNIFICANCE:
This indicates that there is a true difference between the measurement groups in relation to BMI and the difference is significant
BMI vs DES-BMI :There is a strongly positive correlation between BMI and estimation of depth of epidural space by BMI method. This is indicated by the Pearson's R Correlation value of 0.953742. This means as BMI increases the depth of epidural space increases.
BMI vs DES-LOR: There is a strongly positive correlation between BMI and estimation of depth of epidural space by LOR method. This is indicated by the Pearson's R Correlation value of 0.999571. This means as BMI increases the depth of epidural space increases.
BMI vs DES-USG: There is a strongly positive correlation between BMI and estimation of depth of epidural space by USG method. This is indicated by the Pearson's R Correlation value of 0.945355. This means as BMI increases the depth of epidural space increases.
Clinical Significance : The depth of epidural space increases by 15.7% (DES-BMI method), 16.5% (DES-LOR method) and 16.3% (DES-USG method), in relation to a 16.9% increase in BMI.
Conclusion :There is a strong positive association between BMI and depth of epidural space

Depth of Epidural Space:



DEPTH OF EPIDURAL SPACE	BMI Method	LOR Method	USG Method
Number of Subjects	60	60	60
Mean of measurements in mm	40.89	41.03	40.37
Standard Deviation inmm	5.28	5.07	5.55

Depth of Epidural Space – BMI method vs LOR method vs USG method
Anova: Single factor

Summary:

Groups	Count	Sum	Average	Variance
DEPTH OF EPIDURAL SPACE-BMI	60	2453.3	40.8883333	27.9003700
DEPTH OF EPIDURAL SPACE-LOR	60	2462.06	41.0343333	25.7395639
DEPTH OF EPIDURAL SPACE-USG	60	2422	40.3666666	30.812429

Post Hoc Test	DEPTH OF EPIDURAL SPACE-BMI	DEPTH OF EPIDURAL SPACE-LOR	DEPTH OF EPIDURAL SPACE-USG
DEPTH OF EPIDURAL SPACE-BMI	-	0.01376996	0.00131465
DEPTH OF EPIDURAL SPACE-LOR	-	-	0.00397478
DEPTH OF EPIDURAL SPACE-USG	-	-	-
CRITICAL VALUE		**0.016666667**	

ANOVA:

Source of Variation	*SS*	df	MS	f	P value	F crit
Between Groups	14.78461778	2	7.392308889	322.500	0.0000	3.047012
Within groups	4982.68944	177	28.1507878			
Total	4977.474058	179				

By conventional criteria the difference between the Depth of Epidural Space assessed by LOR, BMI and USG methods is considered to be statistically significant since $p < 0.05$

Statistical Significance
This indicates that there is a true difference among the Depth of Epidural Space estimation methods and the difference is significant.
In simple terms, among patients scheduled for elective surgeries and pain relief the mean depth of epidural space varies from 40.88 mm to 40.36 mm on an average with a F = 322.500 and p-value of 0.0000 according to ANOVA.
When a within the groups comparison was done using unpaired t-test and post hoc test using benferroni correction.
The p-values of all three group comparisions (DES-BMI vs DES-LOR, DES-BMI vs DES-USG, DES-LOR vs DES-USG) were found to be significant below the critical value of 0.01666

Clinical Significance

- The Depth of Epidural Space assessed by BMI method was meaningfully less (0.34%) in comparison to LOR method.
- The Depth of Epidural Space assessed by BMI method was meaningfully more (1.34%) in comparison to USG method.
- The Depth of Epidural Space assessed by LOR method was meaningfully more (1.3%) in comparison to USG method.

This difference is true and significant and has not occurred by chance

V. Discussion:

IDENTIFICATION OF EPIDURAL SPACE BY BMI:

In our study no relationship was found between age and depth of epidural space in all patients .but in all age group, as the BMI increased, the depth of epidural space also increased and this difference was statistically significant ($p<0.05$)

It also found that as the weight of the patients increased ,depth of the epidural space also increased in all patients.

Palmer S et al also found direct relationship between patient weight and distance from the skin to the epidural space ($p<0.0001$).Also found that there is no relationship between height and distance from the skin to epidural space.

like our study they also found the best correlation between the distance from the skin to epidural space and body weight .the correlation between the skin to the epidural space and height was less striking .our study also demonstrated similar finding.

IDENTIFICATION OF EPIDURAL SPACE BY USG:

USG technique has been attributed to a more accurate estimation of epidural space depth, a more optimal determination of the needle insertion point, and the insertion angle in case of difficult anatomy (obesity, obstetric patients ,scoliosis),or the presence of implanted hardware and reduced failure rate

Balki M1, Lee Y,conducted study in 46 obese parturients, with prepregnancy body mass index (BMI) > 30 kg/m(2), requesting labor epidural analgesia. Ultrasound imaging was done , and the distance from the skin to the epidural space (ultrasound depth, UD) at the level of L3-4 measured. Actual distance from the skin to the epidural space (needle depth, ND) on the needle with a sterile marker also measured. They found that good correlation between the ultrasound-estimated distance to the epidural space and the actual measured needle distance in obese parturients.

IDETIFICATION OF EPIDURAL SPACE BY LOR TECHNIQUE:

Figueredo E was compared different LOR technique. LOR with air, with isotonic saline, or a combination of both were the techniques shown to be simplest and safest. With respect to safety, LOR with air led to the greatest number of complications (pneumocephalus, air embolism, insufficient analgesia, higher incidence of dural puncture, nerve root compression, subcutaneous emphysema). When a small air bubble is created inside the syringe, LOR with saline solution is reliable and teachable, as well as safe and effective.

VI. Conclusion:

If the Depth of Epidural Space assessed by USG method is considered as the actual insertion length, then we can conclude that USG method is better than the estimated insertion length assessed BMI and LOR methods. But the Depth of Epidural Space assessed by BMI is better than the LOR method in prediction of distance.

This will be useful for anesthesiologists to choose an appropriate needle size base on BMI method. Appropriate choice of the needle size can increase the comfort between both patients and anesthesiologists, improve efficiency and reduce complications

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[1]. **Komaljit Kaul Ravi, Tej K. Kaul, SuneetKathuria, Shikha Gupta,Sandeep Khurana;** Distance from skin ti Epidural Space: Correlation with Body Mass Index

[2]. **Bruggemann da Conceição, TSAII; Gustavo MeurerIII; Claudia SwarovskyIII; Getúlio Rodrigues de Oliveira Filho, Pablo EscovedoHelayel, TSAI; Diogo .Evaluating the depth of the epidural space with the use of ultrasound**

[3]. Rev. Bras. Anestesiol. vol.60 no.4 Campinas July/Aug.2010) V.L.H. Hoffmann, M.P. Vescauteren, J.P. Vrengde, G.H. Hans, H.C. Coppejans and H.A. Adriaensencompared skin to Epidural Space Distance (SED) and Tip to Tip Distance(TTD), a measure

of Posterior Epidural space Depth(PESD), in 40 patients with a 27G whitacre needle after identification of the epidural space using the Hanging Drop(HD) or Loss of Resistance(LOR) and air technique

[4]. **Maria Bauer, John E.George III, John seif, and Ehab Farag,** In 1980, cork and colleagues and cursive were able to localize and estimate the distance from the skin to epidural space by USG. The increasing popularity of this technique is due to accurate estimations, optimal determination of the needle insertion point's angle and reduce the failure rate.

[5]. **Susan K. Palmes, M.D, Stephen E. Abram, MD, Anitha M. Maitra, MD and**. **John H. Von Colditz, PhD** (Study was conducted in 125 obstetric patients having electric continuous epidural blocks for relief of pain during labour. They studied the distance from skin to lumbar epidural space hare any systematic relationship between P + height and weight

[6]. **V.Sharma, A.K. Swinson, C. Hughes, S.Mokashi and R.Russell.** The study was conducted in 1210 pasturients. The mean distance from skin to human epidural space was 5.4 cm. In a multiple regression model, both BMI and ethnicity significantly influenced the distance from skin to Lumbal epidural space (Journal of the Association of Anaesthetists of Great Britain and Ireland – 2011, 66)

[7]. **Brummett CM1, Williams BS, Hurley RW, Erdek MA**. **A Prospective, observational study of the relationship between body mass index and depth of the epidural space during lumbar transforaminal epidural steroid injection;**
Eighty-six consecutive patients undergoing lumbar transforaminal ESI at the L3-L4, L4-L5, and L5-S1 levels were studied. Using standard protocol, the foraminal epidural space was attained using fluoroscopic guidance. The measured distance from needle tip to skin was recorded (depth to foraminal epidural space). The differences in the needle depth and BMI were analyzed using regression analysis.

[8]. **Sahota JS1, Carvalho JC, Balki M, Fanning N, Arzola C**. **ULTRASOUND estimates for midline epidural punctures in the obese parturient: paramedian sagittal oblique is comparable to transverse median plane.**

Dr S. KASTHURI BAI, et. al. "The study to compare the skin to epidural space distance obtained by formulated predictive equation of BMI with LOR technique and USG in patients scheduled for elective surgery and pain relief." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 20(01), 2021, pp. 24-35.