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Color Doppler versus compression ultrasound as diagnostic modality for acute venous thromboembolism in patient with proximal femur fracture.

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Our work is in compliance with ethical practice, as per standard guideline.

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ABSTRACT

Objectives: This study is a comparative study between Color Doppler and Compression Ultrasound, used as diagnostic modalities for diagnosing deep vein thrombosis(DVT) in patients with proximal femur fracture .

Methods: It was a prospective study conducted over a period of one and a half years. Cases under study were patients with isolated proximal femur fracture. All the patients were evaluated by Color Doppler and Compression Ultrasound. CT Angiography was used whenever required and not as routine modality. Post-operative monitoring of the patients was done for 8 weeks.

Results: A total of 70 patients were assessed. The mean age group was 50 years, with 60% being males and 40% females. There were 10 cases of DVT diagnosed radiologically . Out of these 10 cases diagnosed, 9 cases were diagnosed positive by the Color Doppler method and 8 by the Compression Ultrasound.1case was diagnosed by CT Venography. There was complete resolution of DVT in all the patients who were diagnosed positive for DVT. It was confirmed by Color Doppler at 8 weeks post diagnosis.

Conclusion: DVT is a serious complication if untreated. Previous studies showing lesser efficacy of Color Doppler as compared to Compression Ultrasound doesn't hold true. Cases diagnosed by Color Doppler are at par with Compression Ultrasound. So we can use Color Doppler as screening modality with the added benefit of visualization of thrombus resolution

Key word: proximal femur fracture, deep vein thrombosis

Abbreviation : DVT – Deep vein thrombosis VTE – Venous Thromboembolism

PE- Pulmonary Thrombo-embolism

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Introduction- Venous Thromboembolism (VTE) is a common preventable cause of morbidity and mortality in trauma patients who survive the first 24 hours. It includes deep venous thrombosis (DVT) in extremities, pelvic veins and their embolisation to the pulmonary circulation (PE). Occurrence of DVT in trauma patients varies, ranging from 5% to 70% depending on the magnitude of injury and modalities of diagnosis[1-5] . DVT manifests clinically with pain and swelling of the lower limb . Pulmonary embolism manifests with respiratory distress and death. Many times clinical signs may be minimal or absent and pulmonary embolism may be the very first manifestation[1,3]. But in cases of trauma, many symptoms are confusing like swelling/pain in lower limb, respiratory distress, etc, which can be due to trauma itself[4] . Proximal femur fractures result from high velocity trauma in younger age groups and due to osteoporosis in older age groups. Trauma is not only associated with fractures but also with damage to vascular structure around the hip[1,6] .

Studies on Indian patients reported variable incidence of DVT (0-46%)[7-11] . One of the reasons for this variation in results may be the different diagnostic modalities used in these cases. With CT Venography, high incidence was reported[7]. One of the reasons being that CT Venography diagnoses minute thrombi ,which are clinically non significant. But CT Venography cannot be used as routine modality because of high radiation exposure, high cost and the infrastructure required.

In routine we use Color Doppler or Compression Ultrasound for diagnosing DVT. Color Doppler is the newer modality with benefits to identify non-occlusive thrombi / resolving thrombi and to visualize the calf veins that are difficult to assess with conventional ultrasound scanners.[12-16]Information on the accuracy of Color Doppler imaging in symptomless postoperative patients is sparse and limited to 5 studies that provide conflicting results,[17-21] (with reported sensitivities of 38% to 100%) But there are very few comparative studies between Color Doppler and Compression Ultrasound for diagnosing DVT. These studies were conducted on western patients either undergoing arthroplasty surgery or on non-trauma patients[22]. These studies concluded that Compression Ultrasound was better in diagnosing DVT as compared to Color Doppler . So we conducted a comparative study between Color Doppler and Compression Ultrasound in diagnosing DVT in trauma patients having proximal femur fracture only.

2. Materials and methods - It was a prospective study conducted for 18 months at our centre. The study was conducted on 70 patients, admitted with isolated proximal femur fracture (neck of femur ,inter trochantric and sub trochantric fractures)(Table-1). Patients included in this study were between18 to 65 years of age . Patients excluded from this study were those on whom CT Venography was contraindicated due to renal problem or reaction to the dye used for angiography. Patients having other medical diseases like history of cardiac or respiratory failure, undergoing treatment for malignancy,etc were excluded from the study as they were on medication which would alter their coagulation profile. Patients on hormonal contraceptives were also excluded from the study. We tried to focus on pure orthopedic patients.

In all the patients, trauma protocol of airway and breathing and circulation monitoring was done . Patients were stabilized. After getting informed consents, patients were enrolled for the study. Routine investigations were done like complete blood count, kidney function test, liver function test, cougulogram,etc. Records were maintained regarding duration of hospital stay, fracture classification, type of anesthesia (general or regional) and surgical approach used. All patients were encouraged for bed side physiotherapy as early as possible,post surgery. No chemoprophylaxis was used for DVT. On diagnosis of DVT, patients were immediately put on treatment with oral Rivaroxaban.

Bilateral ultrasound examinations were performed by experienced physicians and technicians using a 5- or 7.5- MHz ultrasound transducer. All the patients were first evaluated by Compression Ultrasound followed by Color Doppler assessment performed by different persons. The examination was started by evaluating the external iliac vein and femoral vein followed by popliteal veins. The upper halves of the peroneal veins and the posterior tibial veins were then examined[23,24](the examination of the calf veins was limited to the upper half because the distal segments of the calf veins are technically difficult to assess). Veins were always identified by their accompanying arteries. For

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Compression Ultrasound examination, the only criterion for the diagnosis of DVT was the inability to compress the veins with the ultrasound probe[23-25]. Patients were considered not to have DVT if all of the veins were fully compressible and no residual lumen was seen. Vein compressibility was always assessed in the transverse view because when compression is performed in the longitudinal plane, the transducer may occasionally slide off the vein and so falsely simulate compressibility. Ultrasonographic findings were recorded as negative, positive, or inadequate for interpretation. Images in the longitudinal axis were used for the evaluation of the Color Doppler images. At selected sites, transverse views also were obtained. Augmentation of flow was achieved by manual compression of the calf to improve visualization of the calf veins. The criteria for an abnormal color Doppler test was the absence of color in a vein after augmentation or a focal intraluminal filling defect. The Compression Ultrasound and Color Doppler findings were considered inadequate for interpretation if a complete vein or a segment of a vein could not be identified .

Compression Ultrasound and Color Doppler study was done on the 1st day of admission ,on the day of discharge or day 5 of admission. Then in the 2nd,4th,6th and 8th weeks post-operatively ,during out door follow ups . In cases with doubtful lesions or inadequate interpretation of Color Doppler or Compression Ultrasound ,CT Venography was done.

3. Results - A total of 70 patients with fracture proximal femur were assessed and evaluated for 18months.Out of 70 patients ,in 3 patients , Color Doppler and Compression Ultrasound reading was inadequate, so we carried out CT Venography. Out of 3 patients, 1 case was DVT positive ,but thrombus was minute, in distal segment and not clinically significant. A total number of cases that were radio logically proved positive for DVT were 10 (14%)(Table-2).Positive cases diagnosed by Compression Ultrasound was eight. Nine cases were diagnosed by Color Doppler. 8 cases were same for both Compression Ultrasound and Color Doppler(Table-1). A new case of DVT, diagnosed by Color Doppler had thrombus just proximal to trifurcation of popliteal vein.We were not able to comment on the sensitivity and specificity as CT Venography was not done on all patients. 1 case was diagnosed DVT positive in the 5Th week of follow up(Table-3).

Out of the total cases the number of proximal DVT was 4, the number of distal DVT was 3 and 3 cases had both proximal and distal DVT(Table-2). Cases of proximal DVT, diagnosed by Compression Ultrasound was 3 and by Color Doppler, 4. The number of cases having distal DVT was 3, of which 2 was diagnosed by sonological method and 1 case by CT Venography. 3 cases had both proximal and distal DVT and were diagnosed by both Compression Ultrasound and Color Doppler(Table-2). Better diagnosis of distal DVT by CT Venography was anticipated as Color Doppler and Compression Ultrasound are not modalities for distal thrombus. But distal thrombus has lesser probability of pulmonary embolism.

No case of DVT was reported patients in the age group of 18-30 years (Table-4). In the age group of 31-50 years, 4 patients were diagnosed positive. In the age group of 51-65, 6 patients were diagnosed positive. However the difference in age groups was not statistically significant . All patients were operated under regional anesthesia. In most of the patients, we went for osteosynthesis except for the 10 geriatric patients of fracture neck femur, where we went for hemi-arthroplasty.

In the post operative period there was no case of surgical site infection. Suture removal was done on the 14th day , post-operative. Physiotherapy protocol included non weight bearing to partial and full weight bearing, crutch walking, active and passive hip and knee range of movement, side sitting ,etc.

All cases of radiologically proven DVT were treated with Tab Rivaroxaban (15mg, BD for 3 weeks then 20mg OD for further 3 weeks). Thrombus resolution was assessed by normal venous flow on Doppler study. In all patients of DVT, complete resolution of thrombi was noted at 8 weeks.

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4. Discussion – DVT is a common but preventable complication in trauma patients[1,3]. Indians are supposed to have low incidence of DVT. However, the studies on orthopedic patients in India gave variable incidence.[7-11]

Till date all studies on Indian patients have used a single diagnostic modality. High incidence was noted when CT Venography was used[7].Normally we use Color Doppler and Compression Ultrasound as routine diagnostic modalities. On searching pubmed and google , we found only one comparative study between Color Doppler and Compression Ultrasound[22].This study was on western patients, undergoing arthroplasty surgery. This study showed better efficacy of Compression Ultrasound. On going through few other related articles[26], general inference was that Color Doppler is less efficient for diagnosing DVT. But our study contradicts this notion. In our study we found Color Doppler at par with Compression Ultrasound .

By studying on Indian patients , we were able to clear several myths. With regard to present aim of study being related to diagnostic modality, Color Doppler is at par with Compression Ultrasound. Though cases diagnosed by Color Doppler were more, but considering the sample size we were not able to give generalized statement of better efficacy of Color Doppler. Since the population in our country is large, so we generally choose single diagnostic modality. Previously it was Compression Ultrasound, but now we can shift to Color Doppler for better results . Color Doppler can even better visualize resolution of thrombus.

Another fact which we found in our study was that DVT can occur up to 4 weeks post op[5,27,28]. This is an important concern. In all the previous studies ,results were based on indoor patients. But the risk of DVT is there even in the follow up period. All previous studies undertook baseline CT Venography scanning of all patients. Since DVT can occur in follow up period so it is not possible ethically as well as practically to expose patients for CT in each follow up.

Another significance of our study was that we conducted our study on trauma patients. Trauma patients require more thoughtful evaluation because pathogenesis of DVT starts immediately after injury. Many other factors are responsible for hypercoagulability[29]in post trauma patients like lack of adequate hydration, prolonged immobilisation[1,5], decreased serum levels of Antithrombin III[29,30] and damage to soft tissue. Surgical procedure adds to further insult. Trauma is itself associated with lower limb swelling giving false positive clinical impression.

Our study had a few weaknesses that must be considered. First of all sample size was small. Secondly, we were not able to document on sensitivity and specificity as we did not carry out baseline CT Venography of all patients. It would have given more authenticity to our study, but we were more focused on screening modality.

Since there are only two studies comparing Color Doppler and Compression Ultrasound (including ours), so more study in this regard is required This will help us in formulating screening protocol for DVT. Screening protocol consists of schedule of screening, modality to be used and requirement of CT Venography. DVT screening should also be done in follow up period, not only in indoor period, as DVT can occur in post operative period. DVT monitoring is much debated in the Indian subcontinent as DVT incidence is considered low here and same result is superimposed on trauma patients.

5. Conclusion –In our study we found that result of color Doppler is better or at par with compression ultrasound in diagnosing DVT. Color Doppler has added benefit of visualization of thrombus resolution. Like compression ultrasonography, color Doppler ultrasound has limitations for screening DVT in calf muscle and beyond. Further refinements in ultrasound technology can improve the functional outcome. In particular, increased technical sensitivity to faint flow signals such as power Doppler[31] and the application of ultrasound contrast agents show promise[32]

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Table-1

TYPE OF FRACTURE	NUMBER OF CASES
INTER- TROCHANTRIC(I/T)	28
NECK OF FEMUR	14
SUB TROCHANTRIC(S/T)	12
I/T WITH S/T	16
TOTAL	70

Table-2

DIAGNOSTIC MODALITY	LOCATION OF THROMBUS		
	PROXIMAL (TOTAL CASE=4)	PROXIMAL AND DISTAL (TOTAL CASE=3)	DISTAL (TOTAL CASE=3)
COMPRESSION ULTRASOUND	3	3	2
COLOR DOPPLER	4	3	2
CT VENOGRAPHY	_	_	1

Table- 3

TIME POST INJURY	NUMBER OF DVT CASES
Within 1 week	3
1-2 week	2
2-4 week	4
4-6 week	1
Total	10

Table -4

Age group	Number of patient	DVT cases
18-30	8	0
30-50	28	4
50-65	34	6
Total	70	10