A DISSERTATION ON

"CT GUIDED CELIAC PLEXUS NEUROLYSIS"

THROUGH ANTERIOR APPROACH IN PATIENTS WITH INTRACTABLE UPPER ABDOMEN PAIN

Submitted to

THE TAMIL NADU Dr.M.G.R. MEDICAL UNIVERSITY

CHENNAI

In Partial Fulfillment of the Regulations

For the Award of the degree

M. D. DEGREE EXAMINATION IN RADIO - DIAGNOSIS

BRANCH VIII

MADRAS MEDICAL COLLEGE

CHENNAI

APRIL-2015

BONAFIDE CERTIFICATE

Certified that this dissertation is thebonafide work of

Dr. H. IYENGARAN on**"CT GUIDED CELIAC PLEXUS NEUROLYSIS"** ***THROUGH ANTERIOR APPROACH IN PATIENTS WITH INTRACTABLE UPPER ABDOMEN PAIN,***during his M. D. RADIODIAGNOSIS course from May 2012 to March 2014 at the Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai – 600003.

Prof. Dr. S. KALPANA,M.D, D.M.R.D,
ASSOCIATE PROFESSOR AND GUIDE,
BARNARD INSTITUTE OF RADIOLOGY
MADRAS MEDICAL COLLEGE &
RAJIV GANDHI GOVERNMENT GENERAL HOSPITAL
CHENNAI – 600 003.

Prof. Dr. N.KAILASANATHAN, M.D.R.D,
PROFESSOR AND HEAD OF DEPARTMENT-RADIODIAGNOSIS
BARNARD INSTITUTE OF RADIOLOGY
MADRAS MEDICAL COLLEGE &
RAJIV GANDHI GOVERNMENT GENERAL HOSPITAL
CHENNAI – 600 003.

Prof. Dr. K. VANITHA M.D,D.M.R.D, D.R.M
DIRECTOR OF BARNARD INSTITUTE OF RADIOLOGY
MADRAS MEDICAL COLLEGE &
RAJIV GANDHI GOVERNMENT GENERAL HOSPITAL
CHENNAI – 600 003.

Dr. R. VIMALA M.D,
DEAN
MADRAS MEDICAL COLLEGE &
RAJIV GANDHI GOVERNMENT GENERAL HOSPITAL
CHENNAI – 600 003.

DECLARATION

I, certainly declare that this dissertation titled, "**CT GUIDED CELIAC PLEXUS NEUROLYSIS"** ***THROUGH ANTERIOR APPROACH IN PATIENTS WITH INTRACTABLE UPPER ABDOMEN PAIN***, represents a genuine work of mine. The contribution of any of the supervisors to the research are consistent with normal supervisory practice, and are acknowledged.

I, also affirm that this bonafide work or part of this work was not submitted by me or any others for any award, degree or diploma to any other university board, neither in India nor abroad. This is submitted to **THE TAMILNADU Dr.M.G.R.MEDICAL UNIVERISTY, CHENNAI** in partial fulfillment of the rules and regulation for the award of M. D Degree in RADIO-DIAGNOSIS - Branch VIII.

Date :

Place: Chennai **Dr. H. IYENGARAN**

ACKNOWLEDGEMENT

I would like to express my deep sense of gratitude to **Dr.R.VIMALA M.D,TheDean, Madras Medical College** and **Prof.Dr. K. VANITHA**, **Director, Barnard Institute of Radiology, MMC & RGGGH**, for allowing me to undertake this study on "**CT GUIDED CELIAC PLEXUS NEUROLYSIS"** ***THROUGH ANTERIOR APPROACH IN PATIENTS WITH INTRACTABLE UPPER ABDOMEN PAIN.***

I was able to carry out my study to my fullest satisfaction, thanks to the guidance, encouragement, motivation and constant supervision extended to me, by my beloved Head of the Department **ProfessorDr.N.KAILASANATHAN**. Hence my profuse thanks are due for him.

I would like to express my deep gratitude and respect to my guide **Professor Dr. S. KALPANA,** whose advice and insight was invaluable to me. This work would not have been possible without her guidance, support and encouragement.

I am also extremely indebted to **Professor Dr. S. BABU PETER,** for his valuable suggestions, personal attention, constructive criticism during my study.

My sincere thanks to **Professor Dr. K. MALATHY,** for her practical comments and guidance especially at the inception of the study and I also wish to thank **Professor Dr. D.RAMESH,** for his valuable support throughout the study.

I am bound by ties of gratitude to my respected **Assistant Professors**, **Dr. E. MANIMEGALA, Dr. K. GEETHA, Dr.CHEZHIAN. J, Dr. S. ANBUMALAR, Dr. M. S. SHYAMALA, Dr. S. SARANYA, Dr. M. P. BALAN,**in general, for placing and guiding me on the right track from the very beginning of my career in Radiodiagnosis till this day.

I would be failing in my duty if I don't place on record my sincere thanks to those patients who inspite of their sufferings extended their fullest co-operation.

Dr. H. IYENGARAN

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I **Dr. H. IYENGARAN,** solemnly declare that this dissertation titled**"CT GUIDED CELIAC PLEXUS NEUROLYSIS"** ***THROUGH ANTERIOR APPROACH IN PATIENTS WITH INTRACTABLE UPPER ABDOMEN PAIN,***is a bonafide work done by me at the **Barnard Institute of Radiology, Madras Medical College and Rajiv Gandhi Government General Hospital**, under the supervision of **Professor K. VANITHA, M.D, D.M.R.D, D.R.M, Director, Barnard Institute of Radiology**, and under guidance of **Professor Dr. S. KALPANA**. This dissertation is submitted to **The Tamil Nadu Dr. M. G .R Medical University**, **Chennai**, towards partial fulfillment of requirement for the award of M.D. Degree in Radio diagnosis.

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CONTENTS

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- To assess minor/major complications associated with the procedure.

The procedure was done through anterior approach with Absolute alcohol as the neurolytic agent. Pain assessment was done using Visual Analog scale.

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CONTRAINDICATIONS:

- Coagulopathies
- Hypovolemic status
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- Immediate post procedure pain evaluation with VAS is obtained on the table.

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1) *Sample size is only 30.*
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- To assess treatment success by evaluating pain relief using Visual Analog Scale (VAS) before and after the procedure.
- To assess minor/major complications associated with the procedure.

The procedure was done through anterior approach with Absolute alcohol as the neurolytic agent. Pain assessment was done using Visual Analog scale.

INDICATIONS:

- Patients with persistent and intractable upper abdominal pain due to malignancies / Chronic Pancreatitis of inoperable status
- Patients with severe nausea and hyperemesis due to Pancreatic cancer
- In visceral neuropathy in patients with diabetes, Inflammatory bowel disease (Crohn's disease) and sclerosing cholangitis of AIDS.

CONTRAINDICATIONS:

- Coagulopathies
- Hypovolemic status
- Ascites
- Abdominal aorta aneurysm
- Intraabdominal sepsis
- Bowel obstruction / Tumors

With proper preparation of the patient, with everything in place, procedure done under local anesthesia which involves the following steps:

PROCEDURE:

- Pre procedure VAS is obtained.
- Premedication with Inj.Pentazocine and Inj.Atropine
- Patient is positioned supine.
- A surface marker is placed over the patient abdomen at T12 to L2 level.
- A NECT abdomen is performed.
- Celiac artery and celiac plexus are localized and the best axial slice selected.
- The puncture sites are then selected. The surface marker gives the long axis and the CT machine lazer beam of the axial slice gives the horizontal axis.
- From the point of entry, the trajectory is planned (which is the third axis) on the console and depth measured.
- Patient abdomen is painted with povidone iodine and draped.
- Skin and the anterior abdominal wall infiltrated with 2% lignocaine on both sides.
- Puncture site incision is made with 11 surgical blade.
- 20G Chiba or Spinal needle is passed from the puncture site along the trajectory up to the target site, the antecrural space, bilaterally.

- The needle tip is first located with the tip artefact. A negative suction helps to rule out intra arterial placement of needle tip.
- Then a mixture of 3 ml of 2% lignocaine with 1ml of contrast is injected on each side. In this mixture, lignocaine serves two purposes. First, it assesses the needle tip by evaluating the spread. Second, the injected lignocaine, if produces mild reduction in pain, warrants a successful outcome.
- Contrast is added to the mixture, to facilitate the spread of the injected liquid in the target space. As the HU of ethyl alcohol is -210 units, like that of surrounding Fat, its spread cannot be assessed, if it is injected separately.
- Once this is confirmed, a mixture of 15 ml of neurolytic agent (Absolute alcohol) and 5 ml of 2% lignocaine is injected on each side. It is important to rule out intra arterial injection by applying negative suction. As the HU of alcohol is - 210 units, its spread can be appreciated only by means of hydrodissection. Lignocaine is added to alleviate any transient pain, associated with alcohol injection and for immediate neurolytic effect.
- The needles are then removed (Before withdrawing, the needles are flushed with saline to prevent spillage of alcohol in the trajectory which is painful) and hemostasis secured with manual pressure if needed and adhesives applied.
- Immediate post procedure pain evaluation with VAS is obtained on the table.

POST PROCEDURE CARE:

- Patient is shifted to the ward and advised strict bed rest for 12 hours
- Regular monitoring of vitals is done.
- Proper hydration with intravenous fluids.
- Patient can resume normal diet immediately after the procedure.
- A complete neurological examination done at 24 hours post procedure.
- A post procedure pain score – VAS score is obtained at 24 hours.
- Follow up VAS score obtained at 1 week, 1 month and 2 months.

CONCLUSION:

1) *Mean percentage reduction of pain intensity between preprocedure VAS score and Immediate post procedure VAS score, immediate post procedure and 24 hours score, 24 hours and 1 week score and preprocedure and 2 months score are 55%, 32%, 31% and 80% respectively, all of which were statistically significant.*
2) *The pain intensity score remained static from 1 week to 2 months post procedure.*

3) *Gender does not have any statistical significance in the VAS scores or in the response to procedure.*
4) *For preprocedure VAS score, the mean difference in within subject analysis is statistically significant for preprocedure VAS and immediate post procedure score.*
5) *There is difference in the Variances of differences between all possible pairs of groups with statistical significance indicating, there is a true reduction in pain intensity post procedure.*
6) *Procedure was more effective for malignancies than inflammatory condition.*
7) *Maximum percentage reduction in pain, of 88% was seen with pancreatic carcinoma.*
8) *Least percentage reduction in pain, of 74% was seen with Chronic pancreatitis.*
9) *Hypotension was the commonest complication seen in 18 patients (9 males and 9 females). All these patients settled with intravenous fluids.*
10) *Back pain was the second most common complication, seen in 14 patients (6 males and 8 females).*
11) *Shoulder pain was seen in 12 patients (6 males and 6 females).*
12) *Absence of pain relief was not reported in this study.*

13) *Complications were independent of Gender and Difference VAS score.*

14) *Complications were dependent on Age with statistical significance.*

LIMITATIONS:

1) *Sample size is only 30.*
2) *Number of patients in each disease type are not equal and also too small in the third and fourth type and hence the results cannot be generalised.*
3) *Follow up is done only up to 2 months. Hence the long term benefits or worsening of pain beyond 2 months is not known.*

KEY WORDS :

CELIAC PLEXUS, INTRACTABLE PAIN, ANTERIOR APPROACH, NEUROLYTIC AGENT, ABSOLUTE ALCOHOL, VISUAL ANALOG SCALE.

AIMS AND OBJECTIVES

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REVIEW OF LITERATURE

REVIEW OF LITERATURE

The celiac plexus is a large visceral plexus in the retro peritoneum, over the anterior and lateral surface of aorta and around the branching of celiac trunk. It serves as a relay centre for pain impulses that arise from the upper abdominal viscera

Treatment for such pain is initially achieved by low dose opiates, a narcotic drug. However, with time or with the progression of the disease, complications or tolerance set in. It is this group of patients, who can benefit from this procedure.

The first ever blockade of splanchnic nerves in the management of upper abdominal pain was done by **Kappis in** 1919. He used palpable bony landmarks as the guide for his procedure.

Wendling et al described anterior percutaneous approach for anesthetizing the celiac plexus and splanchnic nerves.

Jones provided the first description of ethanol-induced neurolysis of the celiac plexus and splanchnic nerves for long-term pain relief.

CT-guided celiac plexus block, was described by **Haaga and colleag ues** in 1977. It was in the 1950's that neurolysis under scopic guidance was done. This was followed by neurolysis under echographic guidance in 1970's.

Merrick. R. L (1941) investigated the histologic and cytologic changes in the autonomic nerves and ganglia following alcohol injection in cats. The lumbar sympathetic ganglia and rami were used for the study of degeneration and regeneration of ganglion cells and postganglionic fibres following nerve block. He concluded that the changes which occur after infiltration of a ganglion differ from those which occur after infiltration of the rami. When a ganglion is infiltrated, a permanent block to all effectors innervated by the post ganglionic fibres taking origin from it, is produced, since the alcohol kills the ganglion cells. When the rami alone are infiltrated, a temporary block is produced. In order to produce permanent sympathetic nerve block by means of paravertebral alcohol injection, the ganglia must be infiltrated. Destruction of the ganglia was was seen only when the alcohol was injected in the immediate vicinity. In some cases, only the rami were infiltrated, even though alcohol was injected close to the ganglia. In other cases, the infiltration was not sufficiently extensive to destroy all the ganglion cells. These results indicate that the point of the needle must be practically adjacent to the ganglia in order to ensure

complete infiltration. On the other hand, block of the rami is accomplished very easily. The variability of the results obtained by paravertebral injection in clinical cases may be explained at least in part on this basis.

Gregg R. V. et al (1985) studied the optimal concentration or range of concentrations of ethyl alcohol which produces neurolysis experimentally on the peripheral nerves of a cat. They conducted studies with normal saline (control), 50 %, 75% or 100% ethyl alcohol with normal saline as the diluents and concluded that any of these concentrations of alcohol can be neurolytic. However larger area of destruction was observed with higher ethyl alcohol concentration along with the variable spread of the neurolytic. At eight weeks interval, they found evidence of neurolysis. This is important for prolonged pain relief after neurolytic procedures.

Wang et al reported that the diagnostic feature of a celiac ganglion is the presence of persistent contrast enhancement on delayed images (10 minutes), which is recognized by increased attenuation compared with that of the adrenals.

Zhang et al reported that the right ganglion is mostly located at the superior angle formed by the entrance of the left renal vein into the IVC and is partly or completely covered by the IVC

Zhang XM, Zhao QH, Zeng NL, et al demonstrated The celiac ganglia: anatomy using MRI in cadavers

Kambadakone et al reported that the two most important factors that affect destruction of the celiac plexus are the amount of neurolytic agent injected and the degree of diffusion of the neurolytic agent in the antecrural space

Montero Matamala A, achieved pain relief of 80% of the cases after 2 weeks and in 60% after 6 months with no serious complications in percutaneous anterior approach using CT guidance.

Jill. C. Moore – Journal of supportive oncology reported that Regardless of the technique used, CPN has a long lasting benefit in up to 70 % t0 90% of patients with pancreatic cancer.

Wang et al described a technique in which the neurolytic agent is directly injected into a tumor mass in the retropancreatic space, in patients whose retropancreatic space is completely occupied by a primary tumor or metastatic lymphadenopathy, called **Direct Tumor infiltration**

Lieberman RP, Waldman SD. Celiac plexus neurolysis with the modified **transaortic approach**

Puli SR, Reddy JB, Bechtold ML, Antillon MR, Brugge WR. EUS-guided celiac plexus neurolysis for pain due to chronic pancreatitis or pancreatic cancer pain

Burton AW. And Yan BM, Myers RP Neurolytic celiac plexus block offers improved pain control, reduces the amount of narcotic analgesics, and has a lower incidence of constipation than standard treatment

Ischia S, Ischia A, Polati E, Finco G. Three posterior percutaneous celiac plexus block techniques. A prospective, randomized study in 61 patients with pancreatic cancer pain reported that the major benefit of celiac plexus neurolysis is in the reduced rate of analgesic consumption and lower incidence of drug-related adverse effects

B. Kastler – Interventional Radiology in pain treatment states that In the case of pain secondary to an inflammatory pathology, in particular chronic pancreatitis, upon which the efficacy of celiac neurolysis is reduced,the sit- uation seems totally different

Noble M, Gress FG. Techniques and results of neurolysis for chronic pancreatitis and pancreatic cancer pain – reported that the procedure was less effective in chronic pancreatitis compared to pancreatic cancer.

Gress F, Schmitt C, Sherman S, Ikenberry S, Lehman G. A prospective randomized comparison of endoscopic ultrasound– and computed tomography–guided celiac plexus block for managing chronic pancreatitis pain reported that the role of celiac plexus neurolysis in patients with refractory abdominal pain resulting from chronic pancreatitis is not well established with temporary relief in some patients

C. Moore reported that Local pain, diarrhea, and transient hypotension are often seen complications

Gafanovich I, Shir Y, Tsvang E, Ben-Chetrit E. demonstrated Chronic diarrhoea as a complication induced by celiac plexus block

JOURNEY OF PAIN

- HISTORY REVISITED

JOURNEY OF PAIN

- HISTORY REVISITED

Magic and pain were considered to be similar during the primitive years. An evil spirit was apparently considered to be the cause of pain and sufferings of a man. It became habitual to make an enchanter inflict a wound to the victim to banish the troubling spirit.

Ancient Greeks (including jomer), Hebrews and Egyptians believed the agony as an indication of god. Hippocrates tried to discard the spiritual aura on pain by his popular formula “Divine is the work of relieving pain” in the 400BC.

Since then the concept and the understanding of pain kept changing from time to time. Pain was considered as an emotion instead of a sensation by Aristotle and Plato. In the new awakening, Lorenzo de Medici and his Academy influenced the appearance of modern anatomic and physiological perception of pain. It was now a sensation overseen by the nervous system rather than an emotion.

Vesalius, Pare, and Paracelsus are the great names of medicine to be recalled forever. Pare: was the first to ligature blood vessels and Descartes investigated the mystic trouble of pain in the “ghost limb”.

The battle against pain and advancement in pharmacology made the 18th and 19th centuries important. Laudanum was formulated by Sydenham in 1750.Sertuener began using morphine in Hanover.

Discoveries were numerous: nitrogen dioxide was identified by Priestley in the 1770s and made use of by Davy in the 1840s; ether was described by Faraday in 1818 and used by Hickman in the 1830s; chloroform was simultaneously found by Von Liebig in Germany, Soubeiran in France, and Guthrie in the USA.

The first general anesthesia was performed by Morton on October 16, 1846, in Boston, MA, USA, (the word anesthesia having been suggested by Oliver Wendell Holmes). While surgeons did not corroborate the idea of general anesthesia at the start, they had to give up their ideas with the tremendous advancement fetched by anesthesia.

John Bonica, defined the concept of “pain clinics” and in 1973 he founded the International Association for the Study of Pain (IASP).

The problem specifies by IASP falls out as: “Pain is an unpleasant sensory and emotional experience, connected with an existing or potential tissue lesion, or described in terms of such a lesion.” Two advantages are drawn out from the definition:

1) Pain is believed as a central neuro-physio-psychological outcome with a dual proportion, a immanent one, sensory and an emotional one, which can be measured only by the sick individual by its displeasing character.

2) It vindicates the terrible moan of a mental disorder, as it emphasizes the fact that pain yielding mechanisms may have a psychological basis in addition to the physical one.

CLASSIFICATION OF PAIN –

Pain can be classified based on its duration or physiopathology.

I) Based on its duration pain can be either acute or chronic

II) Based on physiopathology pain is of 3 types –

A) Pain on account of Excess Nociperception

B) Neurogenic Pain

C) Hysterical Pain

Chronic pain syndrome-

It is quite common, to see People suffering from pain, over a long duration of time presenting with a vast number of symptoms and signs which is referred to as chronic pain syndrome.

F.Bourreau defines CPS as a band of psychological, physiological behavioural and social signs which persuade us to see pain ,irrespective of its original etiology, more as an 'illness in itself' instead of the bare symptom of an inherent physiopathological disorder.

Patients suffering from CPS can be grouped into two –

I) CPS with a dominant organic component

II) CPS with a dominant psychological component

It is important to determine what component dominates the individual before offering any treatment. However, as both organic and psychological components are present in all individuals, it is important to address each of these components for a better outcome.

TREATMENT OF PAIN –

With the advent of medicines, the treatment of pain has gone a long way. Treatment can be by medicinal or non-medicinal therapies. Each therapy has its own indications, effects and side effects.

A) MEDICINAL TREATMENT-

I) Non-narcotic Analgesics

II) Narcotic Analgesics

Undesirable Effects of Narcotics

- Constipation,
- Nausea, vomiting
- Sedation and somnolence
- Urinary retention
- Respiratory depression

B) NON-MEDICINAL THERAPIES

- Peripheral Analgesic Stimulations
- Transcutaneous Neurostimulation
- Acupuncture
- Physical Technics- vibrotherapy, massage, electrotherapy, thermotherapy, immobilization and tractions Cryotherapy,

C) PAIN SURGERY

I) Techniques that Break into the Paths of Pain

A direct surgical approach has progressively been replaced by less invasive as well as more selective techniques:

- Percutaneous neurolyses and sympatholyses (destruction of skeletal and sympathetic nerve fibres)

- Thermocoagulation admitting neurolysis with the heat inducted by an electrode adjoined with the aimed nerve
- Posterior rhizotomy, the most previous(1889) and a technique used to the lowest degree.
- Anterolateral cordotomy

II) Techniques of Retro-pain Control

III) Intracerebral and Intrarachnoid Narcotic Therapy

IV) INTERVENTIONAL RADIOLOGY

A magnificent advancement has been seen in the arena of Intervention

Radiology in the management of pain. The prime indications include Infiltration and neurolysis of the sphenopalatine and stellate ganglion, Neurolysis of the mandibular nerve, Thoracic sympatholysis, Neurolysis of the celiac plexus, Neurolysis of the sympathetic internal iliac plexus and of the unpaired plexus, Infiltration of the pudendal nerve, Infiltration,block,or ablation of a nerve root, Treatment under TDM control of osteoid osteoma and Radiofrequency ablation or tumoral alcoholization,

To conclude, we have come a long way as far as the concepts and understanding of pain are concerned. Treatment of pain is a multidisciplinary approach which has to be catered to each individual considering every possible component of pain.

CELIAC PLEXUS NEUROLYSIS

- RATIONALE

CELIAC PLEXUS NEUROLYSIS

- RATIONALE

CELIAC PLEXUS NEUROLYSIS – what is the need for this procedure?

The celiac plexus is a large visceral plexus which is situated in the retro peritoneum at a deeper level, over the anterior and lateral surface of aorta and around the branching of celiac trunk from the aorta. It serves as a relay centre for pain impulses that arise from the upper abdominal viscera which includes from the stomach cranially to the proximal transverse colon caudally.

Treatment for such pain is initially achieved by low dose opiates, a narcotic drug. However, with time or with the progression of the disease, there is a need for escalation of the dose of the drugs. With increased dose of opiates, patients experience adverse effects like constipation, nausea, vomiting, somnolence and urinary retention limiting its use, thereby poor control of pain.

Celiac plexus neurolysis, with lytic agents like ethanol or phenol, is an effective means of reducing pain that arises from the structures involved. Percutaneous image guided celiac plexus neurolysis is an

important treatment option for the management of patients with intractable abdominal pain due to upper abdominal malignancy.

Celiac plexus neurolysis helps only to diminish the intensity of pain and does not completely abolish pain. However the reduction in pain is helpful in reducing opioid requirements thereby reducing the incidence of related side effects and improving survival in patients with intractable pain due to upper abdominal malignancy.

The effect on the celiac plexus can be a simple block or complete lysis. Celiac plexus block is temporary blockage of transmission of pain through the celiac plexus. It is achieved by infiltrating steroids or prolonged local anesthetics. Celiac plexus neurolysis, or neurolytic celiac plexus block, is permanent lysis of the celiac plexus by injecting ethanol or phenol

ANATOMICAL BASIS OF PAIN

ANATOMICAL BASIS OF PAIN

Definition

The international association for the study of pain (IASP) defined Pain as an unpleasant sensory and emotional experience, connected with an existing or potential tissue lesion, or described in terms of such a lesion.

RECEPTORS AND PATHWAYS OF PAIN

Somatic pain

The sense organs for pain are the naked nerve endings found in almost every tissue of the body. Pain impulses are transmitted to the central nervous system by two fibre systems. One nociceptor system is made up of small myelinated Aδ fibres and the other consists of unmyelinated C fibres.

The conduction velocity of Aδ fibres is 12 – 30 m/s and that of C fibres is 0.5 – 2 m/s. Both fibre groups end in the dorsal horn. Aδ fibres terminate primarily in neurons in lamina 1 and 5 whereas dorsal root C

fibre on neurons in lamina 1 and 2. The synaptic transmitter secreted by primary afferent fibres subserving pain is Substance P.

Some of the axons of the dorsal horn neurons end in the spinal cord and brain stem. Others enter the anterolateral system, including the lateral spinothalamic tract.

A few ascend in the posterolateral portion of the cord. Some of the ascending fibres project to the specific sensory nuclei of the thalamus and from there to the cerebral cortex. PET and MRI studies in normal humans indicate that pain activates three cortical areas namely SI, SII and the Cingulate gyrus. The cingulated gyrus is involved in emotion and cingulated gyrectomy has been reported to lessen the distress of pain.

Many fibres activated by pain are in the reticular system, which projects to the midline and intralaminar nonspecific projection of nuclei of the thalamus and from there to many different parts of the cortex. Others project to the hypothalamus and some end in the periaqueductal gray matter, an area concerned with pain.

Visceral pain

Pain from visceral structures is poorly localized, unpleasant and associated with nausea and autonomic symptoms. It often radiates or is referred to other areas.

The autonomic nervous system, like the somatic, has afferent components, central integrating stations and effector pathways. The visceral afferent mechanisms play a major role in homeostatic adjustments.

In the viscera, there are a number of special receptors like osmoreceptors, baroreceptors, chemoreceptors etc. that respond to changes in the internal environment. The afferent nerves from these receptors make reflex connections that are intimately concerned with regulating the function of various systems with which they are associated.

The receptors for pain and the other sensory modalities present in the viscera are similar to those in the skin, but there are marked differences in their distribution. There are no proprioreceptors in the, and few temperature and touch sense organ pain receptors are present, although they are more sparsely distributed than in somatic structures.

Afferent fibres from the visceral structures reach the CNS via sympathetic and parasympathetic pathways. Their cell bodies are located in the dorsal roots and the homologous cranial nerve ganglia. Specifically, there are visceral afferents in the facial, glossopharyngeal and vagus nerves; in the lower thoracic and upper lumbar dorsal root; and in the sacral roots.

There may also be visceral afferent fibres from the eye in the trigeminal nerve. Visceral sensation travels along the same pathways as somatic sensation in the spinothalamic tracts and thalamic radiations, and the cortical receiving areas for visceral sensation are intermixed with the somatic receiving areas in the postcentral gyri.

ROLE OF AUTONOMIC NERVOUS SYSTEM IN PAIN

The autonomic nervous system is a complexly connected system which automatically regulates organ function to an organisms needs. Through numerous connections with sensory, motor and limbic apparatus, the ANS influences the voluntary nervous system.

Functionally and anatomically there are three organizational levels that can be differentiated in autonomic nervous system.

The highest level is the diencephalon and reticular formation, which control and regulate the function of target systems. The second level is divided into sympathetic and parasympathetic system. These systems are closely linked and antagonistic in their effect on the target systems. The peripheral intramural system is under the control of central autonomic feedback but can act autonomously within limits.

The significance of the autonomic functional disorders, the involvement of the sympathetic and parasympathetic systems in pathologic changes are often ignored even though the autonomic nervous system is extensively involved in all body reactions and disease. This is especially true for acute and chronic pain.

Organization of the Sympathetic Nervous System –

The cell bodies of the preganglionic sympathetic fibres are located in the thoracic and lumbar segments of the spinal cord. In this area, the sympathetic trunk has a rigorous segmental structure, that is one segment consists of one dermatome, myotome, enterotome, angitome, sclerotome, etc...

The preganglionic sympathetic fibres exit from the spinal cord via the anterior root, along with the efferent fibres of the peripheral nerve. After leaving the anterior root, they are called white communicating branches (medullated nerve fibres) and extend to the paired sympathetic trunk (trunkus sympathicus) on both sides of the vertebral bodies.

The sympathetic trunk extends from the base of the skull to the coccyx. On each side of the trunk, there are approximately 22 sympathetic

trunk ganglia which are interconnected by interganglionic branches. In the neck there are large ganglia namely superior, middle and inferior cervical ganglion. In the thoraco-lumbar region, the sympathetic trunk is in a rigorous metameric structure. Caudally there exist four sacral pairs of ganglia and a single rudimentary coccygeal ganglion.

A part of the preganglionic fibres traverse, either ascending or descending through the interganglionic branches without forming synapses through several sympathetic trunk ganglia. They then synapse with the postganglionic neurons. This means that the experimental or therapeutic stimulation of a single preganglionic neuron can affect up to eight dermatomes, angiotomes etc., whereas the stimulation of a postganglionic neuron will affect only one segment.

Another group of the prepreganglionic sympathetic fibres passes through the sympathetic trunk ganglion without synapsing and leaves the ganglion as the splanchnic nerves. The splanchnic nerves extend to the unpaired prevertebral ganglion and intramural plexus. There they synapse and form the post ganglionic neurons.

Located in the region of the ganglia there are always autonomic plexi. These plexi are predominantly in the region of the lung hilus, heart and large vessels (cardiac, pulmonary, celiac etc). All preganglionic neurons for the thoracic region originate between C8 and T5. Furthermore

all fibres for the abdominal and pelvic organs originate between T5 and L2.

The post ganglionic fibres of the abdominal and pelvic organs begin from plexi and do not travel with the segmental nerves, but with the vessels to the intramural plexi as periadventitial reticulum.

Wall and Melzack in their classic treatise on pain have enumerated on the basic scientific evidence for the role of the sympathetic nervous system in pain.

- After nerve injury, interactions have been shown to occur between the sensory system and the sympathetic system at the level of the dorsal root ganglion. It has been shown experimentally also that there is cross excitation between nerves of all sizes after injury via synapses.
- After nerve injury adjacent functioning nerves also become weakly sensitive to circulating catecholamines.
- Inflammation related pain may also receive contributions from the sympathetic system. Surgical or chemical sympathectomy has been found to reduce plasma extravasation induced by bradykinin or serotonin

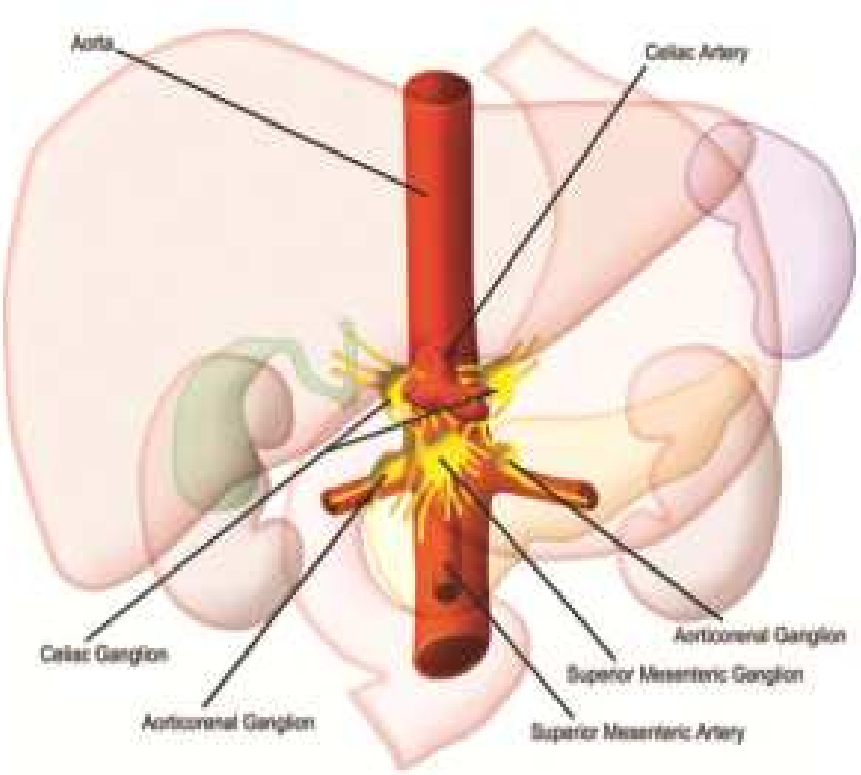
ANATOMY AND PHYSIOLOGY

OF

CELIAC PLEXUS

ANATOMY AND PHYSIOLOGY OF CELIAC PLEXUS

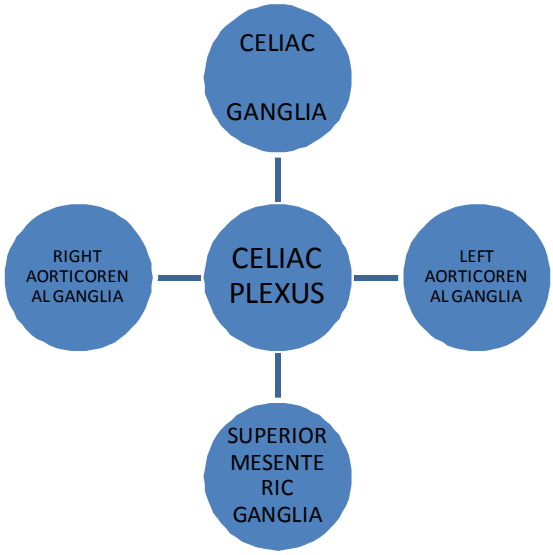
The celiac plexus is a large visceral plexus which is situated in the retro peritoneum at a deeper level, over the anterior and lateral surface of aorta and around the branching of celiac trunk and superior mesenteric artery from the aorta.



Celiac plexus is not a single ganglion. It is formed by a dense network of interconnecting nerve fibres between three independent ganglia namely celiac, superior mesenteric, and bilateral aorticorenal ganglia. Predominant fibres are the preganglionic sympathetic efferent nerve fibres.

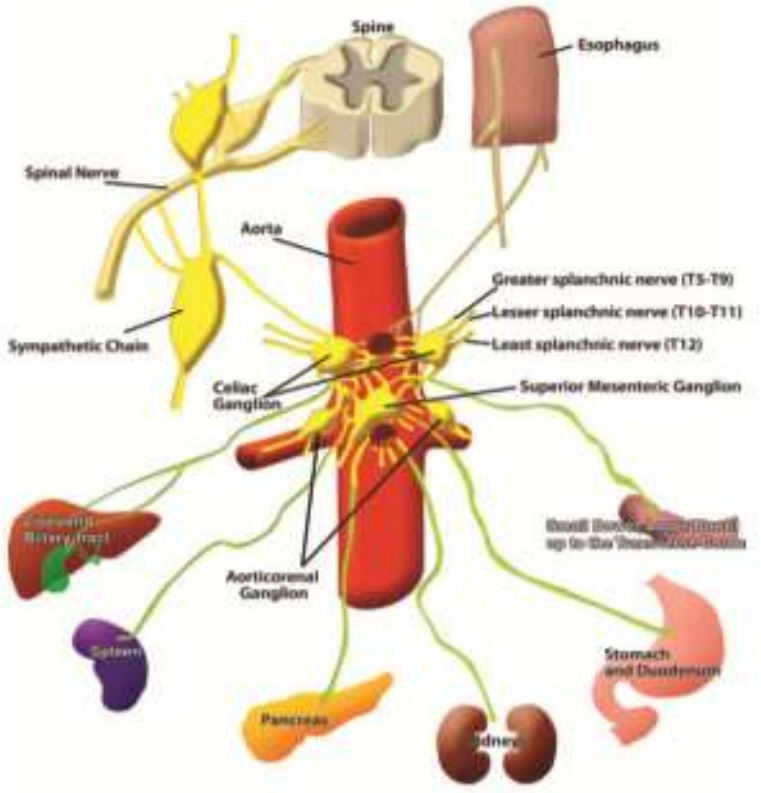
These are derived from three splanchnic nerves namely the greater splanchnic (T5 through T9), the lesser splanchnic (T10 through T11), and the least splanchnic (T12) nerves. The vagus nerve through its posterior trunk contributes to preganglionic parasympathetic efferent fibres.

COMPONENTS OF CELIAC PLEXUS



Along with these splanchnic nerves, the visceral afferent fibres from pancreas, liver, biliary tract, gallbladder, spleen, adrenal glands, kidneys, mesentery, stomach, and the small and large bowels proximal to the transverse colon, also course through the celiac plexus and finally terminate in the spinal cord. These visceral afferent fibres carry nociceptive stimuli from the distal esophagus, up to the proximal transverse colon i.e upper abdomen.

The celiac plexus thus represents the main centre for transmission of pain to the upper abdominal organs. Hence neurolysis of this relay centre is an effective method for manipulating pain that originates in these organs.



The hypogastric plexus innervates the remainder of the large bowel i.e from the left colonic flexure to anus and the pelvic organs. Hence total visceral denervation is not a complication of celiac plexus neurolysis.

The celiac plexus rests in the deep part of the retroperitoneal space and lies in the bed of fat anterior to the aorta, just below to the level of branching of the celiac artery from the aorta.

Anteriorly it is related to the stomach and pancreas. Posteriorly, the diaphragmatic crus, separates the ganglia from the vertebral column. The

NERVE FIBRES IN THE CELIAC PLEXUS

Preganglionic sympathetic efferents	• Greater splanchnic (T5 through T9) • Lesser splanchnic (T10 through T11) • Least splanchnic (T12) nerves
Preganglionic parasympathetic efferents	• Posterior trunk of vagus nerve
Visceral afferents	• From pancreas, liver, biliary tract, gallbladder, spleen, adrenal glands, kidneys, mesentery, stomach, and the small and large bowels proximal to the transverse colon

splanchnic nerves are situated posterior to the crus, in the retrocrural space. On the right posterolateral aspect, the ganglion is related to inferior vena cava. Further laterally are the bilateral kidneys.

It is important to know the anatomical relations of the plexus as these are the structures that would be damaged during the procedure. The group of ganglia extend for several centimetres on the anterior and lateral aspect of aorta.

RELATIONS OF CELIAC PLEXUS

Anteriorly	• Stomach • Pancreas
Posteriorly	• Diaphragmatic crus • Splanchnic nerves • Vertebral column

Zhang et al reported that the location of the celiac ganglia was found to be at the level of T12 or L1 in 94 % of cases. The right ganglion is slightly more cranial than the left. The left and the right celiac ganglia are positioned approximately 0.9 cm and 0.6 cm below the celiac artery. Size of the celiac ganglion ranges from 0.5 to 4.5 cm with a mean size of 2.7 cm. The landmark for localisation of celiac ganglia is the celiac artery as its relationship with the ganglia is more consistent than the relationship of the vertebral column.

MORPHOLOGICAL CHARACTERISTICS OF CELIAC PLEXUS

Level	• T 12 – L 1
Size	• Mean size 2.7 cm (0.5 – 4.5 cm)
Right ganglia	• 0.6 cm below celiac artery
Left ganglia	• 0.9 cm below celiac artery

CT CROSS SECTIONAL ANATOMY

On CT cross sectional imaging, the bilateral ganglia have a characteristic discoid or multilobulated configuration resembling the limbs of nearby adrenal gland. On axial CT images, the left ganglion is consistently located anteromedial to the left adrenal, between the adrenal gland and the diaphragmatic crus. The right ganglion is located consistently between the IVC and the right diaphragmatic crus, anteromedial to the right adrenal gland and posteromedial to the IVC.

CT CHARACTERISTICS OF CELIAC PLEXUS

Shape	• Discoid or multilobulated configuration
Level	• At the level of pancreas
Visualisation	• Right less often seen than left
Left ganglia location	• Anteromedial to left adrenal, between adrenal gland and the diaphragmatic crus
Right ganglia location	• Superior angle formed by the left renal vein entering into the IVC and is covered by the IVC
NECT/	• Adrenals and celiac ganglia look

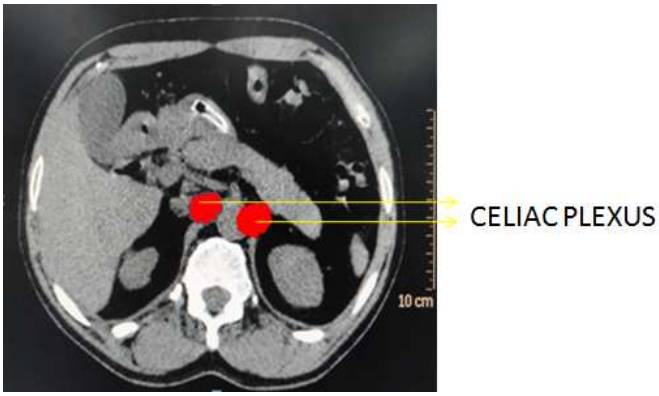
Portovenous phase	similar
Delayed images(10 min)	• Persistent contrast enhancement of ganglia

Zhang et al identified that the right celiac ganglion is commonly found at the superior angle formed by the left renal vein entering into the IVC and is covered by the IVC. The celiac ganglia are most commonly located at the level of the pancreas.

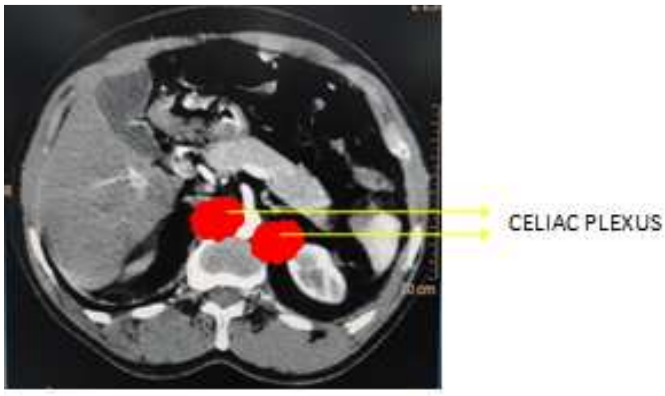
Both the adrenal glands and the celiac plexus have similar attenuation values on unenhanced and portovenous phase CT image. The differentiating feature according to Wang et al lies in the persistent contrast enhancement of the ganglia on delayed images (10 minutes).

The right ganglion is less often seen than the left because of the minimal space on the right side between the IVC and the right crus.

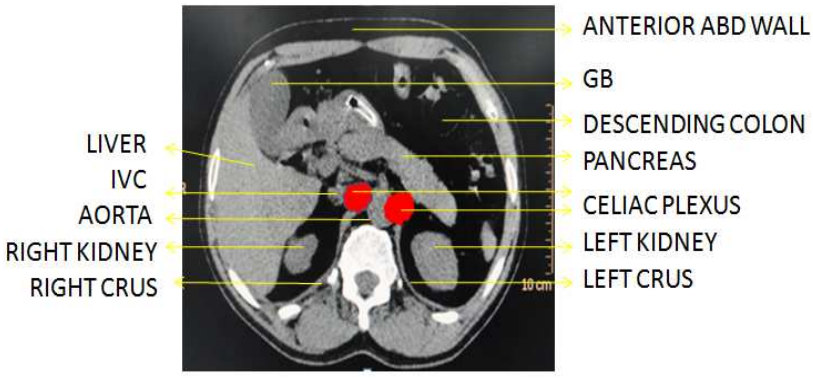
LOCATION OF CELIAC PLEXUS – NECT AXIAL SECTION



LOCATION OF CELIAC PLEXUS – CECT AXIAL SECTION



RELATIONS OF CELIAC PLEXUS – NECT AXIAL SECTION



MODALITIES OF NEUROLYSIS

MODALITIES OF NEUROLYSIS

NEUROLYSIS UNDER CT GUIDANCE

Why CT guidance? Why not other imaging modalities

The first ever blockade of splanchnic nerves in the management of upper abdominal pain was done by Kappis in 1919. He used palpable bony landmarks as the guide for his procedure. It was in the 1950's that neurolysis under scopic guidance was done. This was followed by neurolysis under echographic guidance in 1970's. Since then, the procedure and the technique of celiac plexus neurolysis has gone a long way.

At present there are multiple modalities by which celiac plexus neurolysis can be achieved each having their own merits and demerits. The various available modalities include - Fluroscopic guidance, Ultrasound guidance, MDCT guidance, MRI guidance and Endoscopic Ultrasound guidance

FLUROSCOPIC GUIDANCE

Celiac plexus neurolysis under fluoroscopic guidance is a simple technique as does not need any expertise to operate the machine. Though the technique is simple and easy, there is no clear anatomical distinction

between the plexus and other intra abdominal structures which makes it tough.

There is an overlap of abdominal structures like pancreas, great vessels, mass lesions and enlarged lymph nodes. This anatomical indistinction results in higher rate of complications like vascular or nerve injuries. The need for contrast is a disadvantage in patients with compromised renal status.

FLUROSCOPIC GUIDANCE

Advantage	• Simple and easy
Disadvantage	• Anatomical indistinction • Need for contrast • Radiation • Higher incidence of complications

ULTRASOUND GUIDANCE

Ultrasound guided neurolysis is a very simple technique with low cost. Another advantage is that the aortic trunk, celiac trunk and SMA and other surrounding vessels are easily delineated in real time imaging. There is no need for radiation exposure. During injection of the neurolytic

pharmacological agent, its diffusion can be seen easily without the need for contrast obviating contrast related complications.

The disadvantage is that the technique is operator dependent and it needs expertise for easy completion of the procedure. In addition the retroperitoneal organs are not clearly delineated which is a point of concern.

ULTRASOUND GUIDANCE

Advantage	• Simple, cheap and easy • No risk of radiation • No need for contrast
Disadvantage	• Skilled personnel • Retroperitoneal dark areas

MDCT GUIDANCE

Celiac plexus neurolysis under CT guidance is the preferred modality at present. CT gives a clear picture of the anatomical relations of the intra abdominal structures including the retroperitoneal structures.

Celiac artery, aorta, SMA, Renal vessels, adrenals, pancreas and kidneys are clearly delineated, thereby giving a clear picture of their

anatomical relations. Celiac plexus can be located on a CT which helps to plan the procedure.

MDCT GUIDANCE

Advantage	• Anatomical distinction • High spatial and contrast resolution • Real time monitoring(CT fluro) • Pre and intra procedural planning
Disadvantage	• Radiation

During procedure, with the help of CT, the point of needle entry, the trajectory and needle tip localisation can be achieved with ease obviating any unintended injury to nearby structures. Real time monitoring and visualisation of spread of neurolytic agent is achieved with CT fluoroscopy.

The main disadvantage is radiation and its associated complications.

MRI GUIDANCE

Neurolysis under MRI guidance is more useful when there is a need for high soft tissue resolution. It also has the advantage of no radiation.

MRI GUIDANCE

Advantage	• Excellent soft tissue resolution • No risk of radiation • No need for contrast
Disadvantage	• High cost • Expert personnel • Availability

exposure and its applicability in patients with compromised renal status as there is no need for contrast. However this technique is available only in specialized centres and it is expensive and requires expertise for a better outcome.

ENDOSCOPIC ULTRASOUND GUIDANCE

Celiac neurolysis under endoscopic ultrasound guidance is a better alternative to transabdominal ultrasound guided procedure.

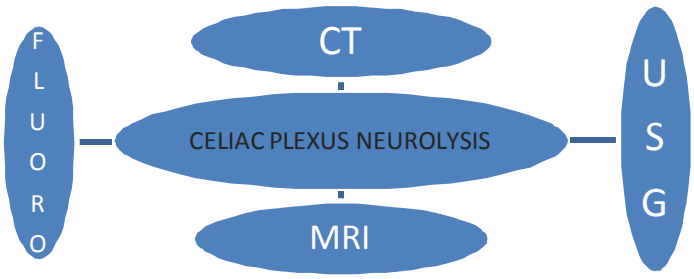
ENDOSCOPIC US GUIDANCE

Advantage	• Real time monitoring • Lesser complications

Disadvantage	• Availability • Expert personnel • Invasive • Complications • Snow storm effect

As it is anterior based, the neurological complications associated with posterior approach are obviated easily. It also helps in monitoring the spread of injected agent in real time. The disadvantage is that the technique is operator dependent and requires an expertise to locate the celiac ganglia especially after injection of lytic pharmacological agent due to ‘snowstorm effect’.

To conclude, though there are multiple modalities for performing this procedure, CELIAC PLEXUS NEUROLYSIS UNDER CT GUIDANCE is the preferred method. However, depending on the patients anatomy, indications and availability, other modalities can also be performed.



APPROACH TO THE PROCEDURE

APPROACH TO THE PROCEDURE

Why an anterior approach....?

Just as there are many modalities for neurolysis, the approach to the procedure are also many. Each of these approaches evolved over time and each of them have their own indications, technique, advantages and disadvantages.

The different approaches for celiac plexus neurolysis are:

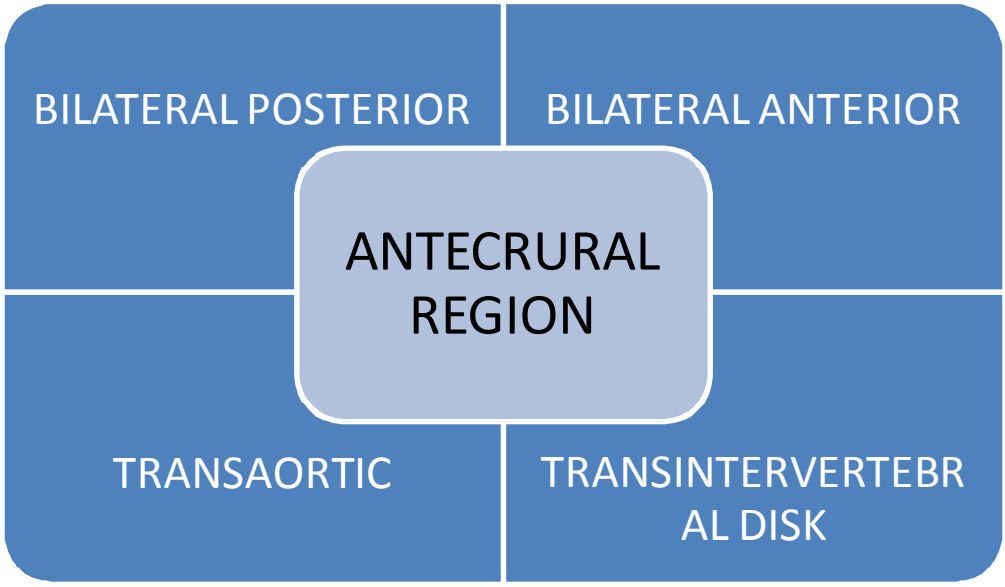
- **Uni/Bilateral Posterior Paravertebral Antecrural Approach**
- **Uni/Bilateral Anterior Paramedian Antecrural Approach**
- **Uni/Bilateral Posterior Paravertebral Retrocrural Approach**
- **Uni/Bilateral Posterior Transintervertebral Disk Approach**
- **Left Posterior paravertebral Transaortic Approach**
- **Uni/Bilateral/Multidirectional Direct Tumor Infiltration**
- **Organ Traversal technique**
- **Hydrodissection technique**

ANTECRURAL REGION

As the name indicates it lies anterior to the aorta and crura on each side. The celiac plexus is located to this region. Hence this is the most commonly used site for injecting the pharmacological agent for neurolysis.

This region can be approached through various routes like bilateral posterior, bilateral anterior, transaortic, and transintervertebral disk approach.

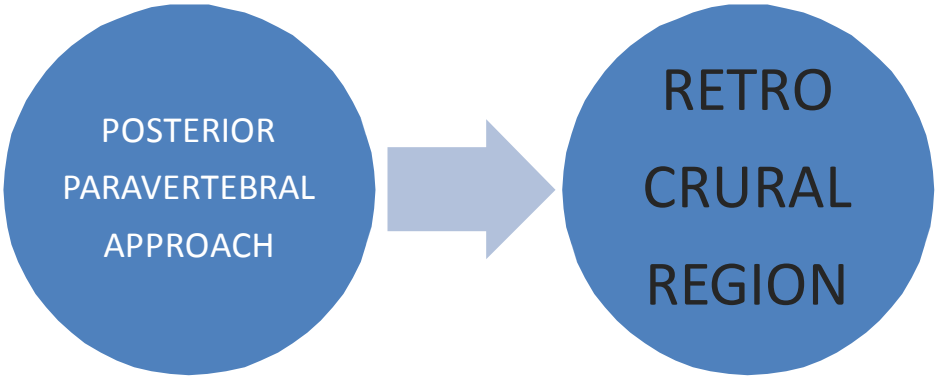
APPROACH TO ANTECRURAL REGION



RETROCRURAL REGION

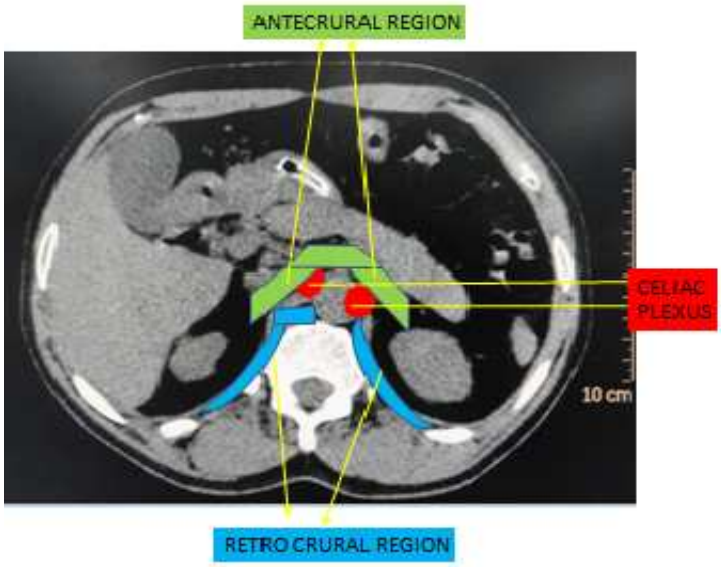
As the name indicates, this region lies behind the crura and the aorta.

APPROACH TO RETROCRURAL REGION



The splanchnic nerves are located to this region which are selectively blocked on infiltration of this region. This region is usually approached via the posterior paravertebral retrocrural approach.

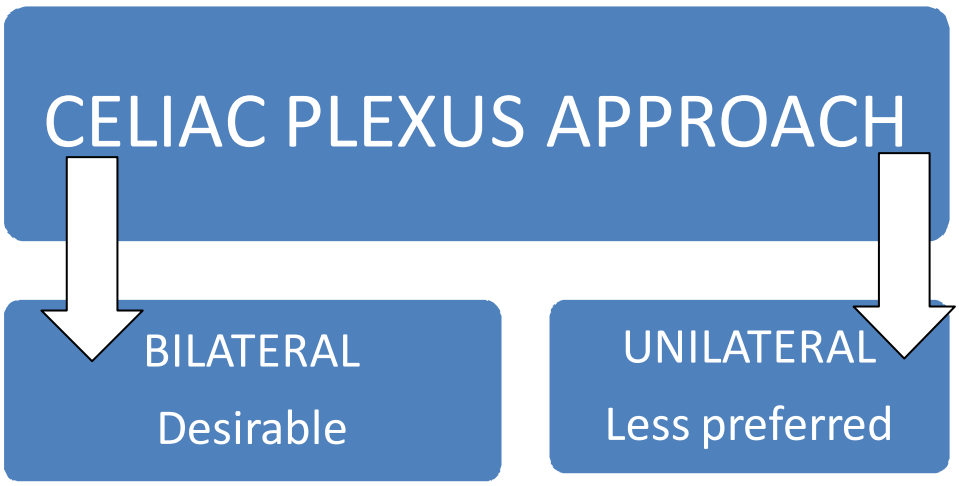
ANTE CRURAL AND RETRO CRURAL REGION ON CT



BILATERAL VS UNILATERAL APPROACH

Each of these approaches can be either unilateral or bilateral. But the spread of the pharmacological agent in the desired region i.e. antecrural or retrocrural is easily achievable through a bilateral approach. As the treatment success solely depends on the spread of the pharmacological agent, bilateral approach is preferred over the unilateral one.

BILATERAL VS UNILATERAL APPROACH



To conclude, it is the bilateral approach that is preferred whenever it is possible. Unilateral approach is done only when bilateral approach cannot be done for some other reasons.

POSTERIOR PARAVERTEBRAL ANTECRURAL APPROACH

This is the most commonly performed approach. Patients can be positioned prone or in lateral decubitus. The target region is the antecrural space which is approached by bilateral paravertebral route dorsally. From the point of entry, the needles travel in the paravertebral space negotiating the vertebral transverse process and renal parenchyma until they reach the antecrural space between aorta (1- 2 cm anterior to aorta) and diaphragm posteriorly and pancreas anteriorly.

The desired axial level is at a point between the celiac trunk and SMA branching from the aorta. Normally around 30 – 40 ml of the pharmacological agent is used.

The advantage is that the dorsal surface which is the site of entry is more or less flat and does not show respiratory movements which makes the procedure simple. Most of the patients are comfortable in prone position, though they are more comfortable in supine position. Injury to the anterior abdominal viscera is less common as the needle falls short of these structures.

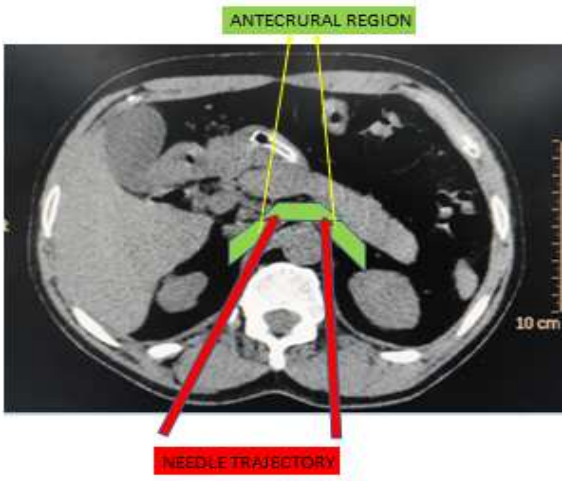
The disadvantage is that the incidence of neurological complications, spinal cord trauma and renal injuries are more. It cannot be done in patients who cannot lie prone. Post procedure diaphragmatic irritation is also common. The neurological complications are either due to inadvertent spread of neurolytic agent in the retrocrural space or due to direct injury with the needle.

POSTERIOR PARAVERTEBRAL ANTECRURAL APPROACH

Patient position	• Prone or lateral decubitus
Route	• Posterior Bilateral paravertebral
Target region	• Antecrural space
Volume of agent	• 20 – 30 ml

Advantage	• Comfortable • No visceral injury
Disadvantage	• Neurological complications • Diaphragmatic irritation • Spinal cord trauma

B/L POSTERIOR PARAVERTEBRAL ANTECRURAL APPROACH TRAJECTORY



ANTERIOR PARAMEDIAN ANTECRURAL APPROACH

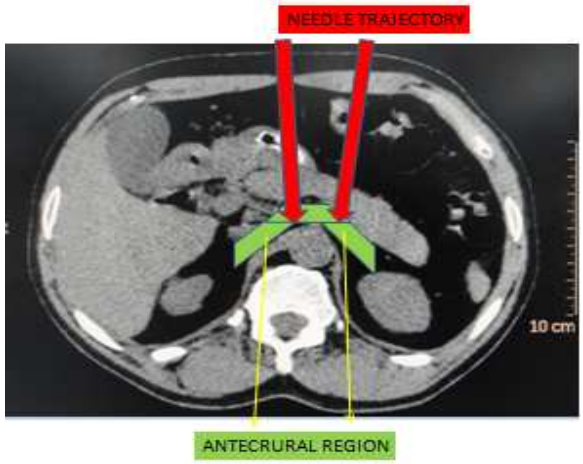
In the past, celiac plexus neurolysis was done via anterior approach. This approach was first described by Wendling et al in 1918. As there were many complications associated with it, the procedure was abandoned.

However with the introduction of image guided technique, the complications have come down.

In this procedure, patient lies supine. Patients feel more comfortable lying supine than prone. The approach is through the anterior abdominal wall on either side of the midline. From the point of entry, needle is directed towards the antecrural space (which is the target region) at a level between the celiac trunk and SMA.

As the needle traverses from anterior abdominal wall to the antecrural space, it pierces the intra abdominal organs like stomach, liver, pancreas and bowel loops. This results in complications like gastric perforation, drug induced chemical peritonitis, fistulous tracts of pancreas, and subcapsular hematoma of the liver. However the incidence of these complications is very low.

B/L ANTERIOR PARAMEDIAN ANTECRURAL APPROACH TRAJECTORY



This approach is more suitable for post operative status patients who cannot lie prone. It also carries lesser risk for renal injury as it is away from the field. The neurological complications associated with posterior approach is also very less because this approach does not enter the retrocrural space.

ANTERIOR PARAMEDIAN ANTECRURAL APPROACH

Patient position	• Supine
Route	• Anterior bilateral paramedian approach
Target region	• Antecrural space
Volume of agent	• 20 – 30 ml
Advantage	• Comfortable position • Used in post operative status • Less renal injury • Less neurological complications • Less diaphragmatic irritation
Disadvantage	• Perforation of viscera • Peritonitis • Liver hematoma • Vascular injuries

Thus, it is evident that a successful celiac plexus neurolysis can be done with any of these approaches. Though both these approaches have certain complications, they are less commonly seen. Hence the choice of approach is governed by various factors and it should be tailored for each individual.

POSTERIOR PARAVERTEBRAL RETROCRURAL APPROACH

This approach is usually preferred when the anterior crural space is distorted for example pancreatic carcinoma or lymph node enlargement. As the antecrural space is obliterated the anterior approach cannot be performed. In such situations, this approach is preferred as the target for this is the retrocrural region.

Injection of neurolytic agent into this space, preferentially blocks the splanchnic nerves which are the contents of this space. As it is a confined space it cannot take up large volumes of neurolytic agents. Hence generally about 5 – 10 ml is given.

As the antecrural space is not infiltrated with the agent, the outcome of this approach is less satisfactory.

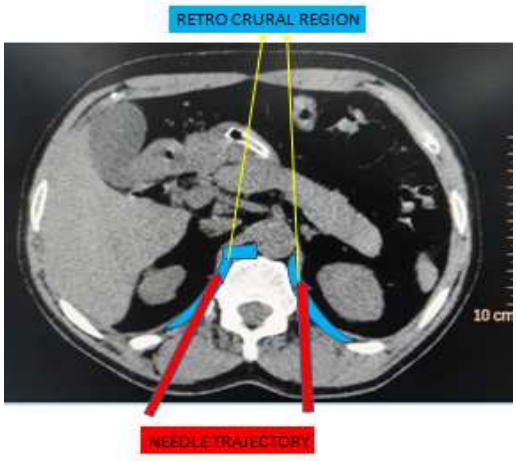
However, if this is performed in combination with infiltration of antecrural space, best possible results can be achieved. As with any other

posterior approach, this is associated with neurological complications, spinal cord injury and diaphragmatic irritation.

POSTERIOR PARAVERTEBRAL RETROCRURAL APPROACH

Patient position	• Prone
Route	• Posterior bilateral paravertebral
Target region	• Retrocrural space
Volume of agent	• 5 – 10 ml
Advantage	• Preferrential splanchnic nerves blockade • In combination with antecrural space block, maximum results achieved
Disadvantage	• Neurological complications • Diaphragmatic irritation • Spinal cord trauma

TRAJECTORY



POSTERIOR TRANSINTERVERTEBRAL DISK APPROACH

In this approach, the needles are passed through the intervertebral disc space instead of the paravertebral route. This approach is preferred only when the paravertebral approach cannot be performed for any reasons.

Patients are positioned prone. Usually the intervertebral disc spaces between T12 and L2 are used. As the needle passes through disc space, injuries to abdominal viscera is less likely.

POSTERIOR TRANSINTERVERTEBRAL DISK APPROACH

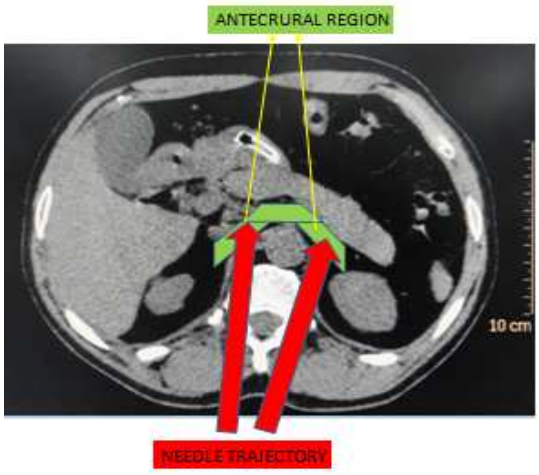
Position	• Prone
Route	• Posterior bilateral trans intervertebral disc
Target region	• Antecrural space
Volume of agent	• 20 – 30 ml
Advantage	• Helpful when paravertebral route is not accessible for other reasons • Less visceral injury
Disadvantage	• Discitis • Disc herniation • Spinal cord injury

The target area is the antecrural space. Positioning of the needle tip within this space is confirmed by, a give away feel, due to loss of resistance, on piercing the anterior longitudinal ligament.

As the needle passes through the intervertebral disc space this approach is prone for complications like Disc inflammation, disc disruption, herniation and spinal cord injury. Because of these complications, this is never a first choice approach.

POSTERIOR TRANSINTERVERTEBRAL DISK APPROACH

TRAJECTORY



Lt POSTERIOR PARAVERTEBRAL TRANSAORTIC APPROACH

In this approach, needle is passed through the walls of the aorta. Patients are positioned prone. A single needle is used which is passed in the left paravertebral region towards the direction of aorta.

On reaching the aorta, both the anterior and posterior walls are pierced to reach the antecrural space. On reaching this space, the procedure is the same as with any other approach.

There are no specific indications for this approach. The only advantage of this approach is that a single needle is sufficient in this. As the needle tip reaches the midpoint of the antecrural space, there will be free spread of drug on both sides immediately after injection.

It is important to have a complete pre procedure evaluation of the patient for any aneurysms or dissection or abnormal branching of aorta and for any other intraabdominal pathologies which may affect the outcome.

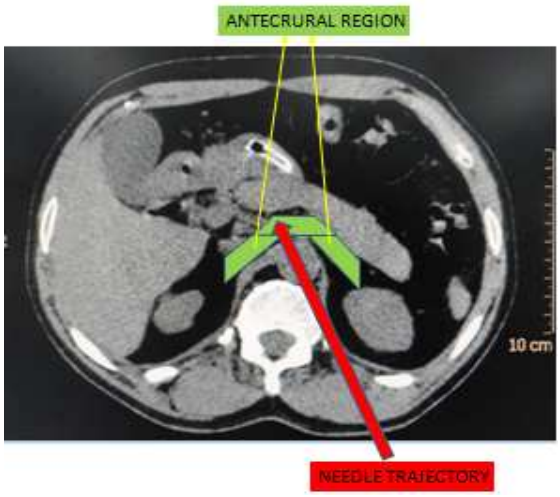
However this approach is associated with risk of massive hemorrhage which can be life threatening.

LEFT POSTERIOR PARAVERTEBRAL TRANSAORTIC APPROACH

Position	• Prone
Approach	• Left posterior paravertebral transaortic
Target	• Antecrural space
Volume of agent	• 15 – 25 ml
Advantage	• Single needle alone required

	• Less spinal cord injury
Disadvantage	• Massive bleeding

LEFT POSTERIOR PARAVERTEBRAL TRANSAORTIC APPROACH TRAJECTORY



DIRECT INFILTRATION OF THE TUMOR

This technique is done for patients whose antecrural space is completely obliterated by a tumor mass. As there is no space for infiltrating the drug, it is infiltrated into the tissue itself which occupies the space. This destroys the tumor to some extent and the infiltrated celiac ganglion as well thereby resulting in the desired effect.

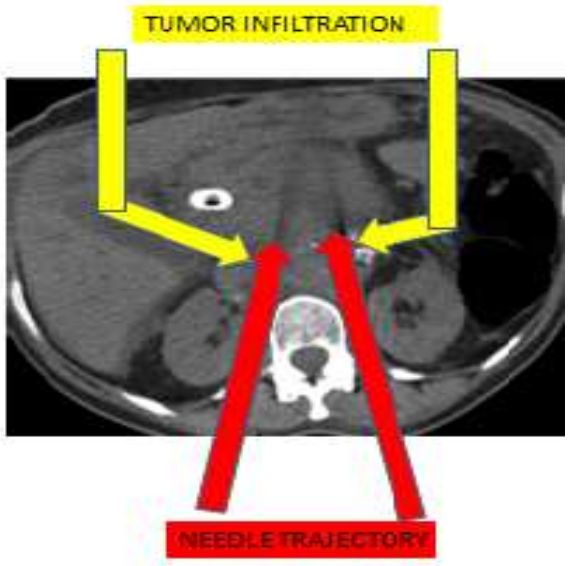
DIRECT INFILTRATION OF THE TUMOR

Position	Prone
Approach	Multidirectional anterior

	transabdominal
Target	Tumor mass in antecrural space
Volume	Larger volumes required
Indication	When entire antecrural space is infiltrated by a tumor mass
Disadvantage	Poor pain relief

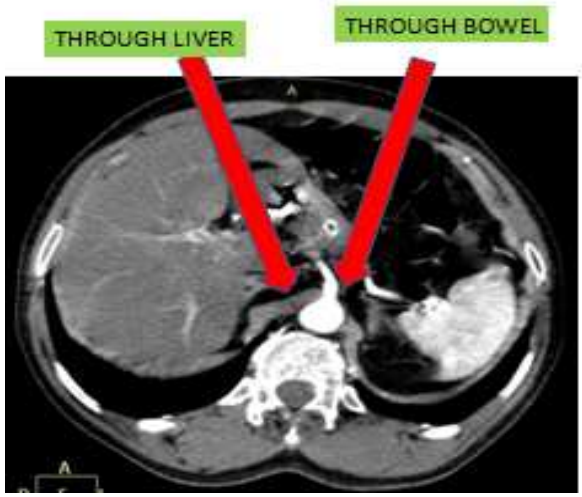
It can be done with any number of needles, the requirement being that the maximum area of the tumor mass should be covered. In contrary to other techniques, as the drug is infiltrated into tissue instead of a free space, there will be high resistance while delivering the drug.

DIRECT INFILTRATION OF THE TUMOR - TRAJECTORY



ORGAN TRAVERSAL TECHNIQUE

This technique is commonly used in an anterior approach as there are too many intraabdominal structures between the anterior abdominal wall and the celiac plexus. In this technique, as the name indicates, the abdominal viscera along the trajectory of the needle are traversed to reach the celiac ganglion.



However care should be taken not to injure the structures like blood vessels, bile duct, biliary radicles, porta hepatis, renal pelvis and fecal filled colonic loops. It is important to rule out any coagulopathies before this procedure.

Some of the complications associated with this technique are pancreatitis (while traversing pancreas), hematoma (Liver) and urinoma (Kidney). Whatever be the approach, there should be sufficient volume and spread of the neurolytic agent for successful treatment.

NEUROLYTICAGENT

– ETHANOL VS PHENOL

NEUROLYTIC AGENT

Ethanol Vs Phenol

Neurolysis is a procedure in which a neurolytic agent is used to destroy the nerves. This can be temporary or permanent. A temporary disruption of neuronal function is called a *block,* whereas permanent disruption is termed *neurolysis.*

Neuronal block, which is temporary, can be achieved with corticosteroids or small doses of local anaesthetics.

Neurolysis, which is permanent requires the infiltration of a neurolytic agent which completely destroys the nerves. Most commonly used neurolytic agents are absolute alcohol (Ethanol) and phenol.

Ethanol is the most commonly used neurolytic agent worldwide. The preferred concentration of ethanol is 100%, which is absolute alcohol. However in practice, it is difficult to get it at this concentration. Even if it is obtained, the concentration decreases with time on storage.

However it has been found that for proper neurolysis a concentration between 50 % to 100 % is sufficient. Another important factor which governs the outcome of the procedure is the diffusion of the neurolytic agent at the desired site.

Ethanol has got a faster onset of action. It was reported for neurolysis in 1931 by Dogliotti. It causes neurolysis by precipitation of proteins within the nerves. Once the lipoproteins and mucoproteins are precipitated, the cholesterol, glycosaminoglycans, phospholipid and cerebrosides are extracted from the nerves resulting in neurolysis.

However it should be noted that the basal lamina of Schwann cell sheath remains intact. This intact basal lamina can proliferate (Schwann cell proliferation) which acts as a framework for regeneration of nerve fibres. This is the reason why neurolysis is ineffective after 6 – 8 months. Ethanol is more effective at ganglion cell level rather than preganglionic or postganglionic fibres.

Ethanol is a low viscous liquid which enables early diffuse diffusion in the space available. Because of its low viscocity it can be easily mixed with local anaesthetics for intraoperative pain management and with contrast for identifying its spread. However there will be transient pain while injecting ethanol due to its irritant nature. More than 90% ethanol that is injected is completely oxidized in the liver by alcohol dehydrogenase.

Phenol is less commonly used. It is a highly viscous liquid used in concentrations of 3 % to 20 %. It has a local anaesthetic effect preventing any pain during injection.

The high viscocity prevents it from being mixed with local anaesthetics and contrast. It spreads slowly, again because of the viscocity with a slow onset of action. When administered, phenol causes coagulation and necrosis of the proteins within the nerves thereby destroying it.

FACTORS	**ETHANOL**	**PHENOL**
Viscocity	Low	High
Concentration	50 to 100 %	3 to 20 %
Preference	Preferred	Less preferred
Onset	Immediate	Delayed
Mechanism	Precipitation	Coagulation
Diffusion	Spreads easily	Spreads sparsely
Injection site pain	Present	Absent
Outcome	Excellent	Moderate

Thus ethanol is the preferred neurolytic agent at a concentration of 50 – 100 %. It is generally used as a mixture with local anesthetic (for anaesthetic effect) and contrast (for visualizing spread).

So far we have seen, what pain meant to our ancestors and what it means to us now and the transformation from older beliefs and ideas to newer concepts under the heading of *JOURNEY OF PAIN – HISTORY REVISITED.*

Then we discussed each and every component of the topic namely "CT GUIDED CELIAC PLEXUS NEUROLYSIS THROUGH ANTERIOR APPROACH " in the form of RATIONALE behind the neurolysis, ANATOMY and PHYSIOLOGY of celiac plexus, various available MODALITIES and why CT GUIDANCE was preferred, VARIOUS APPROACHES to reach the target area and why ANTERIOR APPROACH was preferred and a quick analysis of the various NEUROLYTICS and the preferred neurolytic agent.

With this knowledge, let us now focus on cancer pain in particular and its implications, assessment of pain, various treatment options for treatment of cancer pain, indications and contraindications for the procedure, patient preparation and the steps involved in the procedure, the results and the analysis of the outcome.

PATHOPHYSIOLOGY OF PAIN

PATHOPHYSIOLOGY OF PAIN

CHRONIC PAIN ETIOLOGY IN CANCER

Chronic pain in malignancies may be due to one of the following mechanisms.

Pain directly due to cancer –

- Infiltration or compression of nerve tissue due to tumor
  - ✓ Peripheral nerves
  - ✓ Plexus
- Infiltration of bone by tumor
- Obstruction of hollow viscus
- Obstruction of arteries and veins by tumor
- Stretching of fascia / periosteum
- Inflammation due to necrosis and infection

Pain associated with cancer therapy –

- Following surgery
  - ✓ Acute post operative pain
  - ✓ Nerve trauma
  - ✓ Entrapment of nerves in scar tissue

- Following radiotherapy

✓ Acute lesions of nerves or plexus

✓ Radiation fibrosis of nerves or plexus

✓ Myelopathy of spinal cord

- Following chemotherapy / steroids

✓ Peripheral neuropathy

✓ Aseptic necrosis of bone

METHODS OF TREATING CANCER PAIN

Broadly, the treatment of cancer pain can be divided into

✓ Pharmacological methods

✓ Palliative radiotherapy

✓ Neurolytic / Neurosurgical procedures

The pharmacological methods of treatment of cancer pain have been briefly dealt with along with the *JOURNEY OF PAIN – HISTORY REVISITED*. In short, it is the opiate group of drugs that form the main stay of treatment of cancer pain. However, with time, with progression of the disease, it becomes difficult to strike a balance between drug dose, side effects and pain alleviation.

Palliative radiotherapy is done for terminally ill patients for whom nothing else can be done.

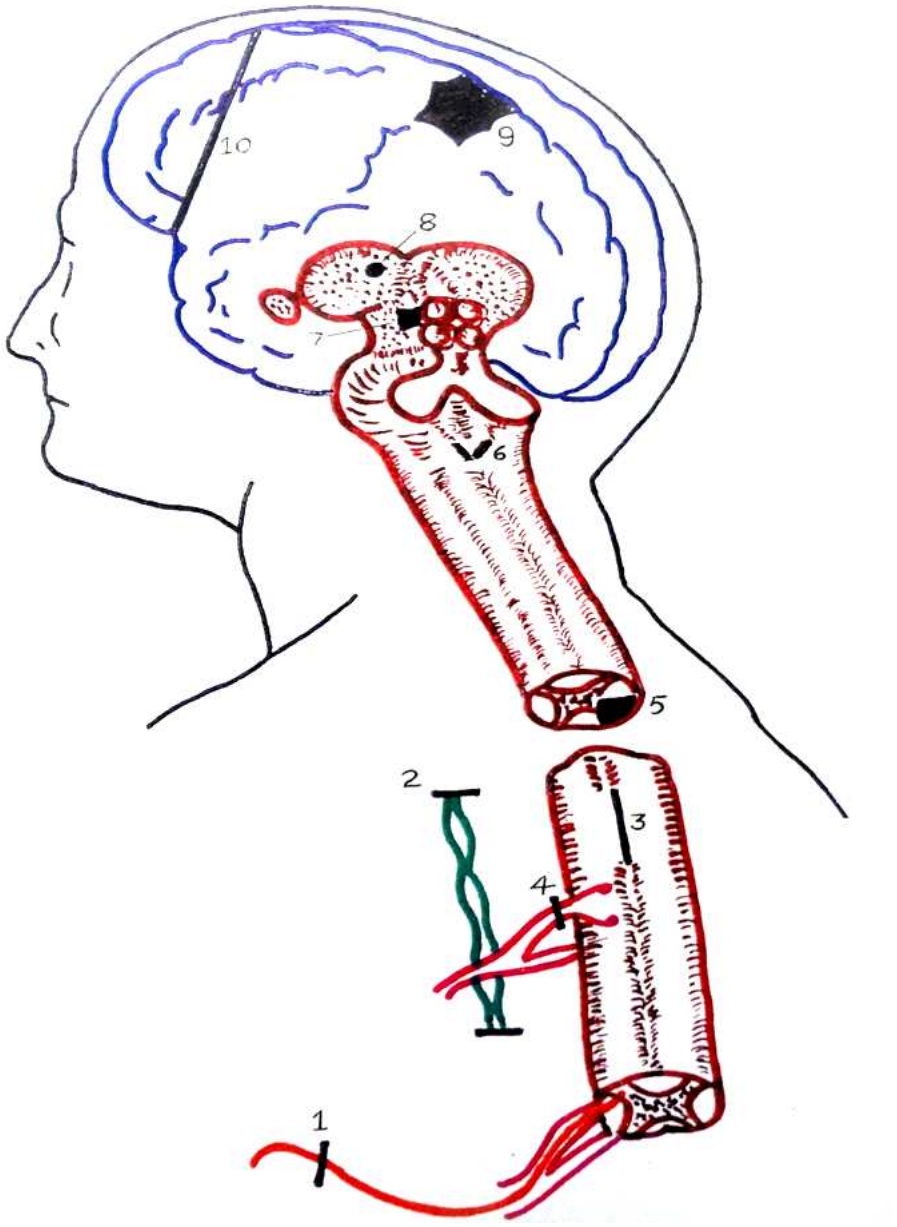
NEUROLYTIC / NEUROSURGICAL PROCEDURES

There are various number of neurolytic / neurosurgical procedures for relieving chronic intractable pain such as –

- ✓ Nerve section
- ✓ Sympathectomy
- ✓ Myelotomy to section spinothalamic fibres in anterior white commissure
- ✓ Posterior rhizotomy
- ✓ Anterolateral cordotomy
- ✓ Medullary tractotomy
- ✓ Mesencephalic tractotomy
- ✓ Thalamotomy
- ✓ Gyrectomy
- ✓ Prefrontal lobotomy

The possibility of controlling otherwise intractable pain by the relatively brief application of a local anesthetic or neurolytis agent makes neural blockade an attractive approach in selected patients. Published

estimates of the percentage of all patients with cancer pain for whom, nerve



NEUROSURGICAL PROCEDURES

1- Nerve section ; 2– Sympathectomy ; 3– Myelotomy to section spinothalamic fibres in anterior white commissure ; 4– Posterior rhizotomy ; 5– Anterolateral cordotomy ; 6– Medullary tractotomy ; 7– Mesencephalic tractotomy ; 8– Thalamotomy ; 9– Cingulate gyrectomy ; 10– Prefrontal lobotomy

block procedures may appropriately be considered vary greatly. Allowing for vagueness in methods of arriving at published estimates, lack of uniformity in clinical conditions treated by neural blockade, and in reported clinical outcomes, it still appears that some 50 to 80 % of patients who receive nerve blocks for cancer pain may benefit.

Neurolytic sympathetic blockade is useful to relieve pain in the arm, head and neck (Stellate ganglion), or leg (Lumbar plexus block), as wel to interrupt the visceral afferent pain pathways mediating pain in the pancreas and other upper abdominal organs (Celiac plexus block)or in the pelvis (Hypogastric block / Ganglion of impar block).

Because of the appeal of nerve blocks for use in intractable pain and their potential for harm as well as benefit, the following guidelines have to be observed –

- Assess thoroughly each patients pain mechanism, in order to apply the most appropriate block via appropriate approach
- Screen patients thoroughly, according to coexistent medical conditions and the ability to understand the risks of the proposed procedure.
- Consider a block, only if the person panning to do is experienced and skillfull.
- Use radiographic control because both ease and safety depend on the precise identification of landmarks.

ASSESSMENT OF PAIN

ASSESSMENT OF PAIN

Assessment of pain pre procedure and post procedure provides some indication of sympathetic block, pain relief can be reported almost immediately after the procedure or can be delayed for several hours in some patients. A large number of scales and questionnaires have been used to measure pain. Three factors are important in assessment of pain are :

- Sensory intensity of pain
- Associated positive or negative mood
- Pain related interference with activities

SENSORY INTENSITY OF PAIN

The commonly used measures of pain intensity are

- ✓ **Category scales**
- ✓ **Visual Analog scales**
- ✓ **McGill's pain questionnaire**
- ✓ **Gracely's verbal descriptor scale**

VISUAL ANALOG SCALE (VAS)

The Visual Analog Scale (VAS), provides a simple efficient and minimally intrusive measure of pain intensity, that has been used widely in clinical and research settings, where a quick index of pain is required for which a numerical value can be assigned. The VAS consists of a 10 cm horizontal or aq vertical line with the two end points labelled “no pain“ and “worst pain ever” (or a similar verbal descriptor representing the upper pole).

The patient is expected to mark on the 10 cm line, a point, that corresponds to the level of pain intensity, he/she currently feels. The distance in centimetres from the lower end of the scale and the patient’s mark is used as a numerical index of the severity of pain.

The VAS is sensitive to pharmacologic and non pharmacologic procedures that alter the experience of pain and correlates highly with pain measured on verbal and numerical rating scales. Instruction to patients to rate the amount of percentage of pain relief using VAS (eg.. following administration of a treatment designed to reduce pain) may introduce necessary bias (eg .. expectancy for change and relies on no memory), which reduces the validity of the measure. It has been suggested, therefore that a more appropriate measures of change may be obtained by having

patients rate the absolute pain at different points in time (eg.. pre procedure and post procedure at different points of time).

A major advantage of VAS as a measure of pain intensity is its ratio scale properties. In contrast to many other pain measurement tools, equality or ratios is implied, making it appropriate to speak meaningfully about percentage difference between VAS measurements obtained either at multiple points in time from independent samples of subjects.

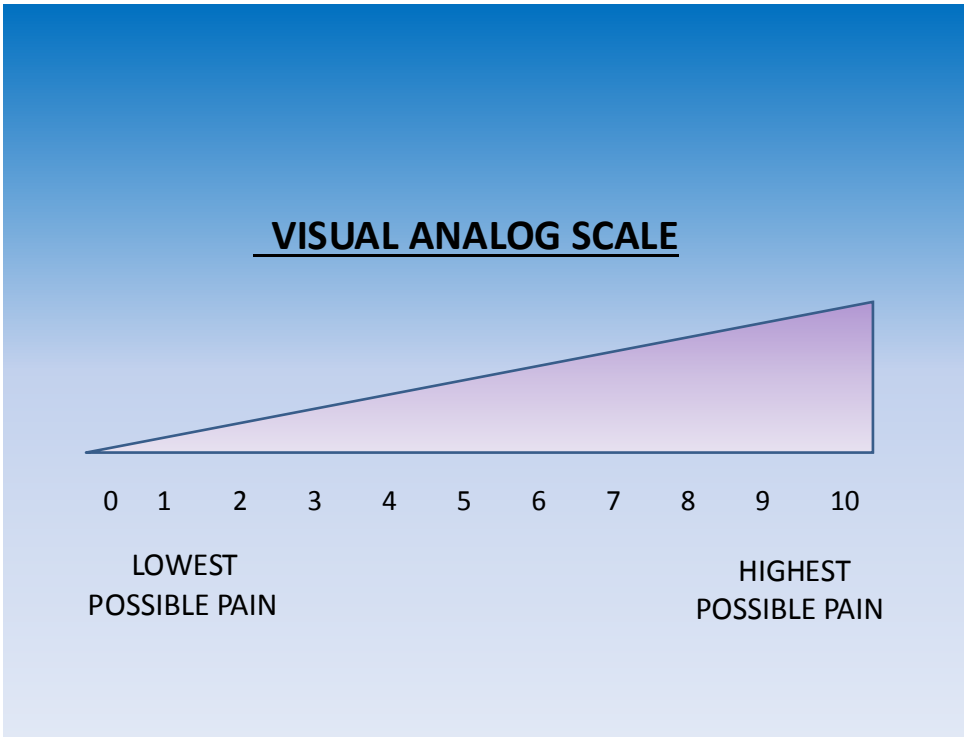
Thus ratio statements, may be made, that described pain in one group of patients as being several times that of another or as being reduced by a certain percentage. The ratio scale property of the VAS also means that the measurements are suitable for assessment using parametric statistics and are means to paramedic inferential statistical procedures.

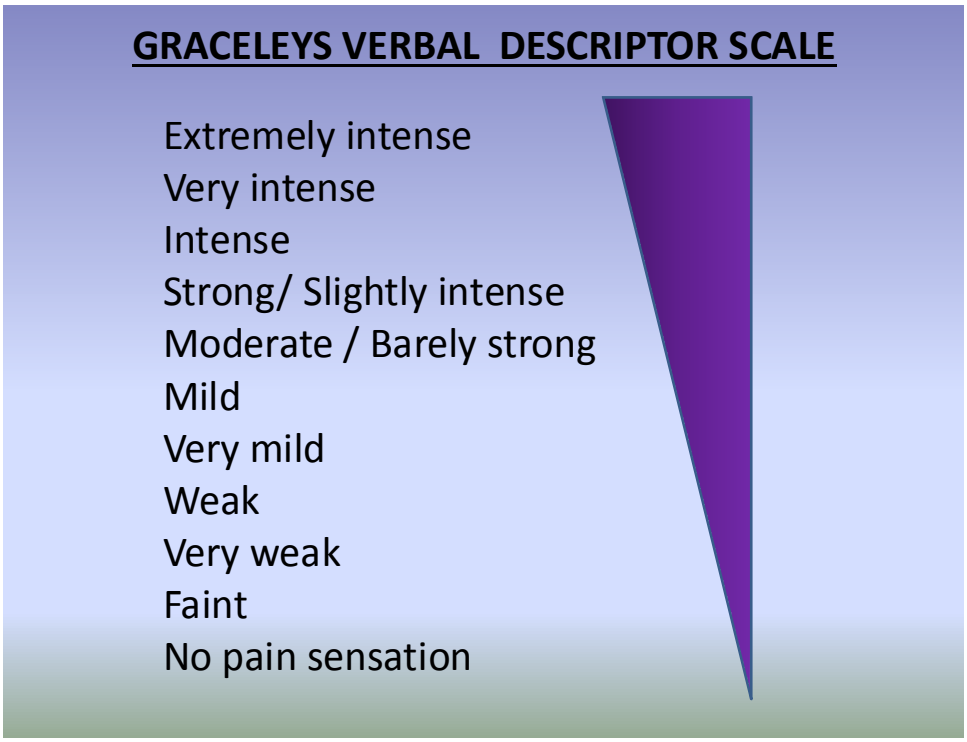
Other advantages of VAS include its ease and brevity of scoring, minimal intrusiveness and its conceptual simplicity (provided adequately clear instructions are given to the patient).

The major disadvantage of VAS is that the assumption that pain s a unidimensional experience. Each pain has unique qualities. To describe pain solely in terms of intensity is inadequate.

PAIN ASSESSMENT METHODS

PAIN ASSESSMENT METHODS





CATEGORY SCALES

The oldest of the standard measures is four point pain intensity category scale. Although this measure is still the most widely used scale, it has been criticized on several counts. Patients have indicated that a four point pain intensity scale does not have enough levels to allow them to accurately describe their pain levels

Pain intensity category scale (4 points)

- Severe - 3
- Moderate - 2
- Mild - 1
- None - 0

Pain relief category scale (5 points)

- Complete - 4
- Lots - 3
- Moderate - 2
- Slight - 1
- None - 0

Compared to the pain intensity category scale, relief category scales have been reported to be more sensitive to small reductions in pain: the

same advantage has been suggested for VAS relief scale over VAS pain scales.

The disadvantages of the McGill pain questionnaire are that it takes five minutes to complete, compared to seconds for VAS and category scales, requires a rich vocabulary and confuses some patients

GRACELEY'S VERBAL DESCRIPTOR SCALE

This also uses verbal descriptors but they are fewer than in McGill questionnaire. It has a list of thirteen pain intensity descriptors. Each word has a numerical equivalent established by cross modality matching methods.

Both the VAS and the Graceley's 13 point VDS were used because of the inherent simplicity and ease of administering the test.

INDICATIONS

INDICATIONS

The indications in general for a celiac plexus neurolysis are :

- **Patients with persistent and intractable upper abdominal pain due to malignancies / Chronic Pancreatitis of inoperable status**

- **Patients with severe nausea and hyperemesis due to Pancreatic cancer**

- **In visceral neuropathy in patients with diabetes, Inflammatory bowel disease (Crohn's disease) and sclerosing cholangitis of AIDS.**

In this study, the procedure has been restricted to intractable upper abdominal pain due to malignancies or chronic pancreatitis only.

Patients with nausea and hyperemesis due to pancreatic cancer were not included in this study, as this study is for evaluating pain relief by this procedure.

CONTRAINDICATIONS

CONTRAINDICATIONS

There are no absolute contraindications for this procedure. All are relative contraindications. They are as follows:

- **Coagulopathies**
- **Hypovolemic status**
- **Ascites**
- **Abdominal aorta aneurysm**
- **Intraabdominal sepsis**
- **Bowel obstruction / Tumors**
- **Gastric outlet obstruction causing stomach distension**

Apart from these general contraindications, there are certain contraindications due to pathologies indigenous to each of the approaches. For example, Discitis and Ankylosing spondylitis are contraindications for an intervertebral disc approach; intraarterial thrombus is a contraindication for transarterial approach.

PATIENT PREPARATION

PATIENT PREPARATION

Patient preparation is very important for a successful outcome. It involves the following:

Patient selection – It is important to select patients properly, as the procedure can help, only in conditions where the pain is mediated through celiac plexus.

Ultrasonogram – It is important to do get an ultrasonogram of the abdomen done so as to rule out any pathologies that can affect the procedure. This can be done on an out patient basis thereby helping in patient selection.

Admission - It is important to have the patients in admission for pre and post procedure care.

Coagulation profile – Patients coagulation profile (BT, CT, PT and INR) should be assessed carefully as with any other intervention procedure.

Hydration status – It is important to assess blood pressure and hydration status as this procedure can lead to hypotension. Hydration with intravenous fluids is done in all patients especially if hypovolemic.

Patient Education – It should be ensured that the patients are explained clearly about the indications, contraindications, preparation, procedure techniques, complications, outcome both in benefits and failure aspect, post procedure care and more importantly pain assessment using VAS.

Vitals and blood parameters – Regular monitoring of vitals with evaluation of ECG, Complete blood count, Renal function tests, Liver function tests and allergic status are done.

Fasting and medications – Patients are advised to fast for 8 hours before procedure. It is advised to change to heparin if on any oral anticoagulants, which should be withheld on the day of procedure along with hypoglycaemic agents. The rest of the medications can be taken as usual.

Consent – As with any other procedure, a written consent is obtained from the patient as well as the guardian.

Intravenous access – Patients should have an intravenous access with an 18 G venflon.

Abdomen preparation – Patients abdomen should be prepared.

X – ray spine – It is essential if an intervertebral disc approach is planned

Doppler and CT angiogram of abdomen – It is done before a transarterial approach.

PROCEDURE REQUISITES

PROCEDURE REQUISITES

- It is made sure that the CT is dedicated for the procedure until it is completed

- Boyle's apparatus in complete shape with adequate oxygen supply is ensured

- Resuscitative measures are kept ready:

✓ Laryngoscope with blades

✓ Endotracheal tubes of appropriate sizes with connectors

✓ Emergency drugs – Inj.Atropine, Inj.Adrenaline, Inj.Ephedrine, Inj.Hydrocortisone, Inj.Diazepam, Inj.Avil and Intravenous fluids.

- Procedure tray – It consists of Surface marker, Povidone iodine, sterile gauze, sponge holding forceps, drape sheets, 2% lignocaine without preservative, 11 surgical blade, 20 G Chiba or Spinal needle, Contrast and neurolytic agent and adhesives.

DESCRIPTION OF THE PROCEDURE

DESCRIPTION OF THE PROCEDURE

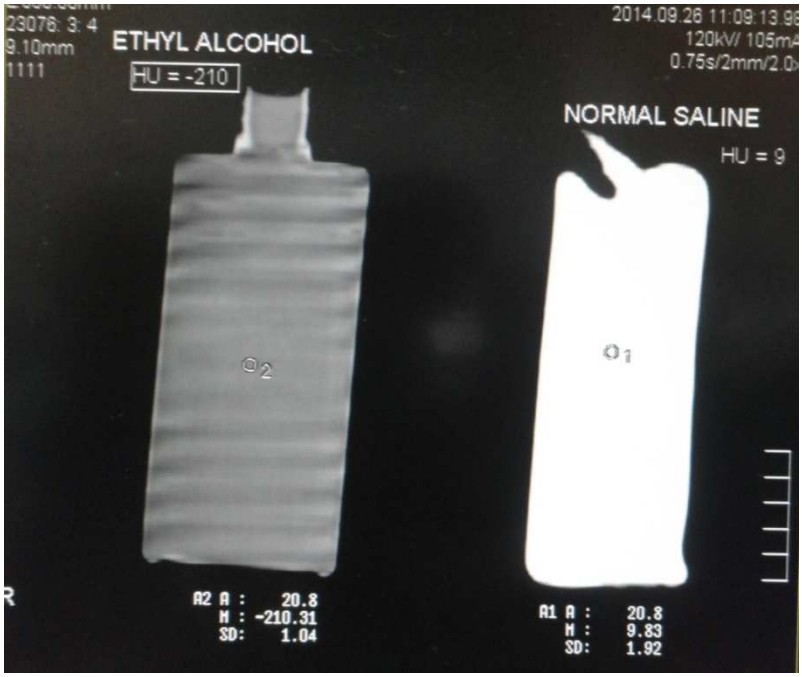
The procedure involves the following steps:

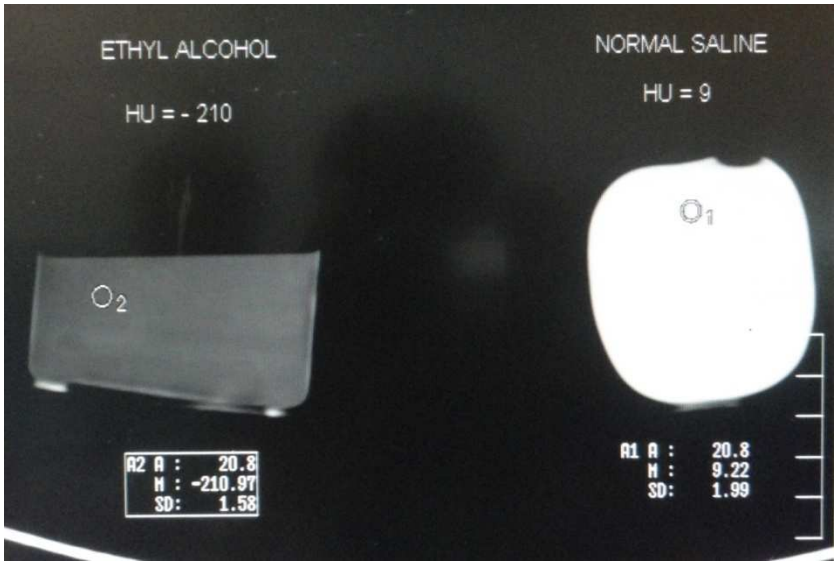
- Pre procedure VAS is obtained.
- Premedication with Inj.Pentazocine and Inj.Atropine
- Patient is positioned supine.
- A surface marker is placed over the patient abdomen at T12 to L2 level.
- A NECT abdomen is performed.
- Celiac artery and celiac plexus are localized and the best axial slice selected.
- The puncture sites are then selected. The surface marker gives the long axis and the CT machine lazer beam of the axial slice gives the horizontal axis.
- From the point of entry, the trajectory is planned (which is the third axis) on the console and depth measured.
- Patient abdomen is painted with povidone iodine and draped.
- Skin and the anterior abdominal wall infiltrated with 2% lignocaine on both sides.
- Puncture site incision is made with 11 surgical blade.
- 20G Chiba or Spinal needle is passed from the puncture site along the trajectory up to the target site, the antecrural space, bilaterally.

- The needle tip is first located with the tip artefact. A negative suction helps to rule out intra arterial placement of needle tip.
- Then a mixture of 3 ml of 2% lignocaine with 1ml of contrast is injected on each side. In this mixture, lignocaine serves two purposes. First, it assesses the needle tip by evaluating the spread. Second, the injected lignocaine, if produces mild reduction in pain, warrants a successful outcome.
- Contrast is added to the mixture, to facilitate the spread of the injected liquid in the target space. As the HU of ethyl alcohol is -210 units, like that of surrounding Fat, its spread cannot be assessed, if it is injected separately.

<u>COMPARISON OF HU OF ALCOHOL AND NS</u>

<u>CORONAL VIEW</u>





AXIAL VIEW

- Once this is confirmed, a mixture of 15 ml of neurolytic agent (Absolute alcohol) and 5 ml of 2% lignocaine is injected on each side. It is important to rule out intra arterial injection by applying negative suction. As the HU of alcohol is - 210 units, its spread can be appreciated only by means of hydrodissection. Lignocaine is added to alleviate any transient pain, associated with alcohol injection and for immediate neurolytic effect.
- The needles are then removed (Before withdrawing, the needles are flushed with saline to prevent spillage of alcohol in the trajectory which is painful) and hemostasis secured with manual pressure if needed and adhesives applied.
- Immediate post procedure pain evaluation with VAS is obtained on the table.

POST PROCEDURE CARE

POST PROCEDURE CARE

- Patient is shifted to the ward and advised strict bed rest for 12 hours.
- Regular monitoring of vitals is done.
- Proper hydration with intravenous fluids.
- Patient can resume normal diet immediately after the procedure.
- A complete neurological examination done at 24 hours post procedure.
- A post procedure pain score – VAS score is obtained at 24 hours.
- Follow up VAS score obtained at 1 week, 1 month and 2 months.

COMPLICATIONS

COMPLICATIONS

There are no major complications associated with the procedure provided it is done with proper care. The associated complications are:

- ***Hypotension*** – This is the commonest complication. This is due to loss of sympathetic tone, due to lysis of the sympathetic ganglion. Adequate hydration before and after the procedure prevents this complication.

- ***Back pain*** – This is primarily due to lysis of sensory nerves of the celiac plexus. Usually settles within 72 hours.

- ***Shoulder pain*** – This is due to diaphragmatic irritation, which settles in 72 hours.

- ***Diarrhoea*** – This is due to unopposed parasympathetic activity after sympathetic neurolysis. It is self limiting.

- ***Local hematoma***

- ***Discitis, lower limb weakness, sphincter dysfunction of bowel and bladder and spinal ischemia*** due to spinal artery infarct are rare but possible severe complications. These can be prevented with proper technique of the procedure.

- ***No pain relief*** – A proper outcome depends mainly on the amount and the spread of neurolytic agent in the ante crural space. In properly selected patients, if the volume and spread are satisfactory, a good response is warranted.

MATERIALS AND METHODS

MATERIALS AND METHODS

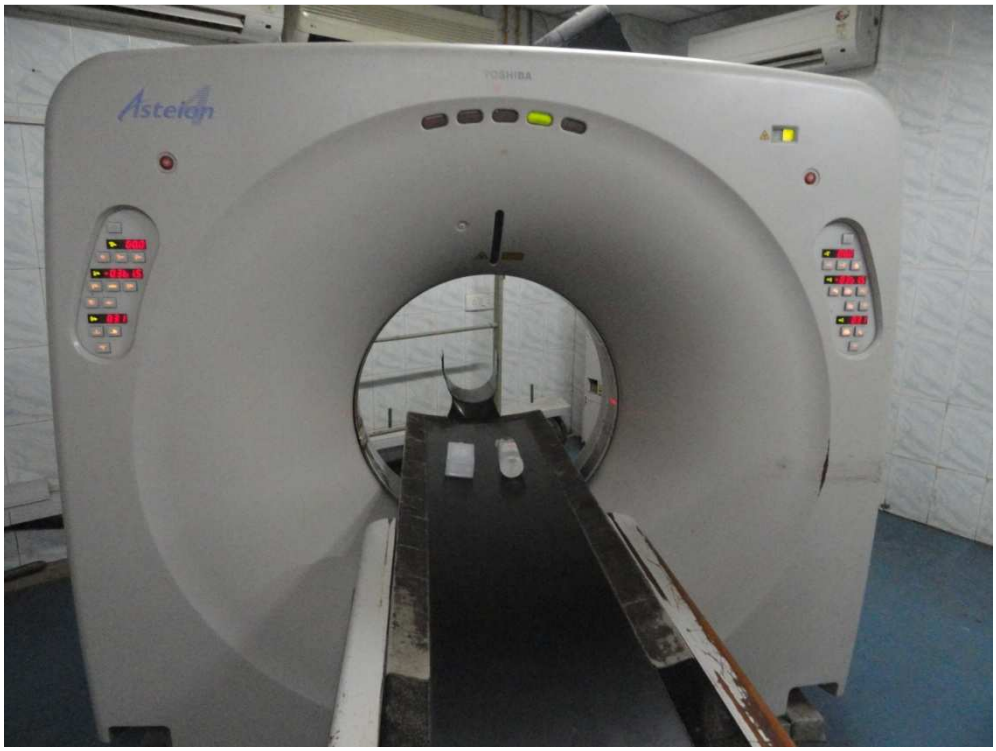
The study is a prospective study, which was done in the ***BARNARD INSTITUTE OF RADIOLOGY, RAJIV GANDHI GOVERNMENT GENERAL HOSPITAL, MADRAS MEDICAL COLLEGE, CHENNAI***, from ***JUNE 2014 TO SEPTEMBER 2014***, after obtaining due permission and clearance from ***THE ETHICAL COMMITTEE***.

The study was done after obtaining permission from ***THE DEPARTMENT OF SURGICAL GASTROENTEROLOGY and THE PAIN CLINIC attached to THE INSTITUTE OF ANESTHESIOLOGY AND CRITICAL CARE***, from where the patients were referred for the procedure.

Procedure done with ***4 slice TOSHIBA CT scanner - ASTEION, located at 203, Tower II, RGGGH and MMC***. Patients were carefully selected using inclusion and exclusion criteria. Patients pre operative instructions verified and proper consent obtained after educating them about the procedure. Pre operative assessment of pain done using VAS.

Patient in supine position, through bilateral paramedian anterior approach, the procedure is carried out as detailed earlier. Immediate post

procedure pain assessment is done on the table. Patient sent to ward with proper



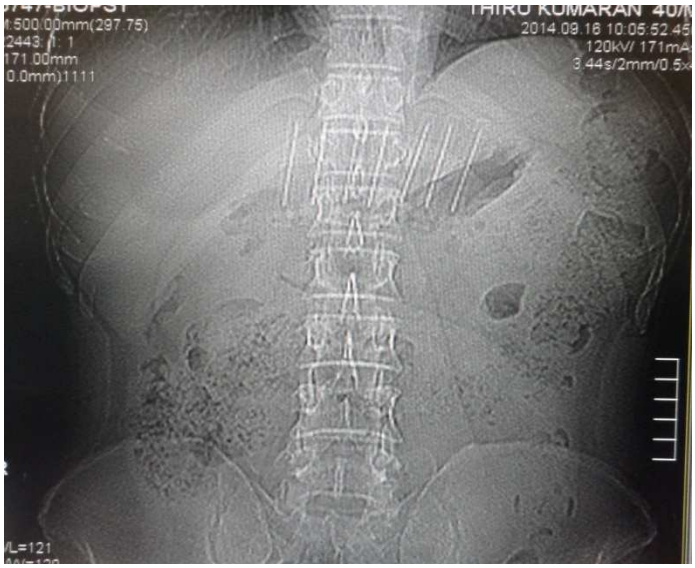
ASTEION – TOSHIBA 4 SLICE CT SCANNER

post procedure instructions as detailed. A complete neurological examination is done at 24 hours post procedure.

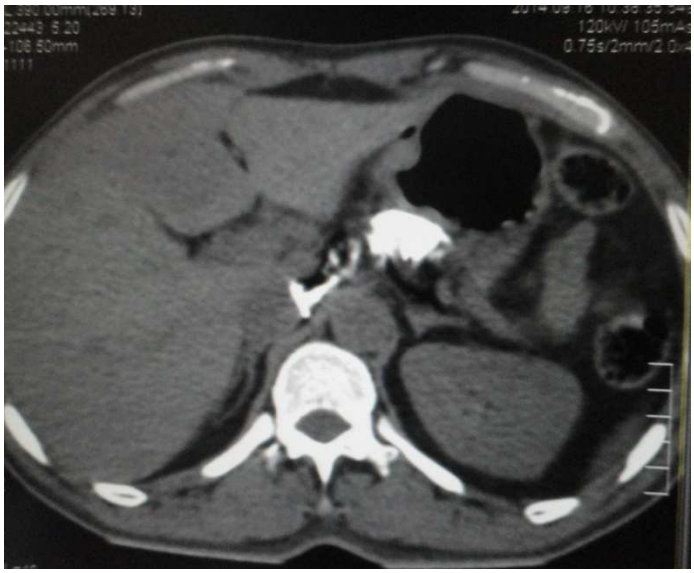
REPRESENTATION CASES

REPRESENTATION CASES

CASE 1

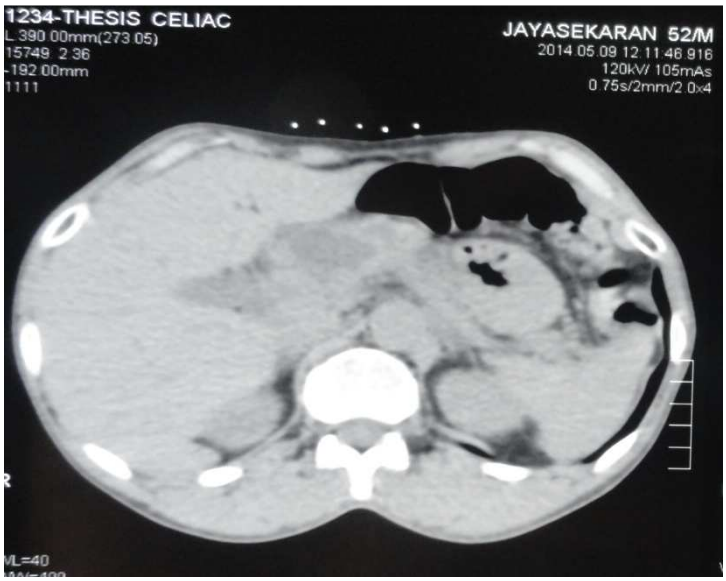


Scout with surface marker

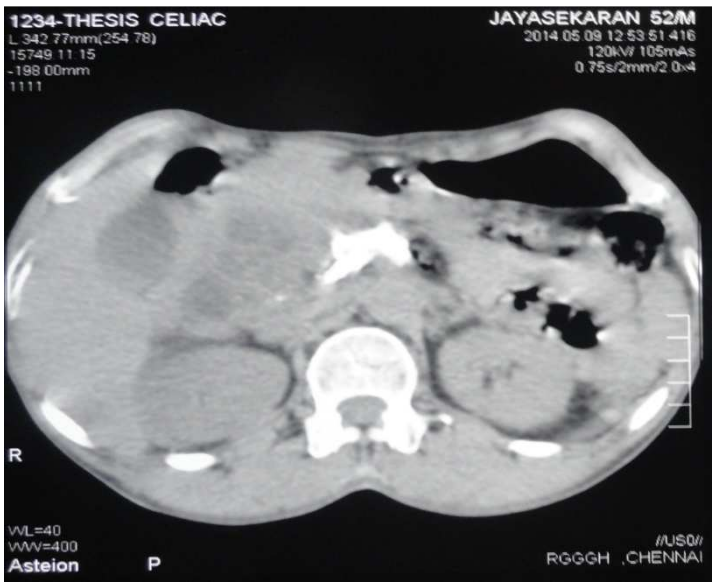


Spread of contrast in the antecrural space post procedure

CASE 2

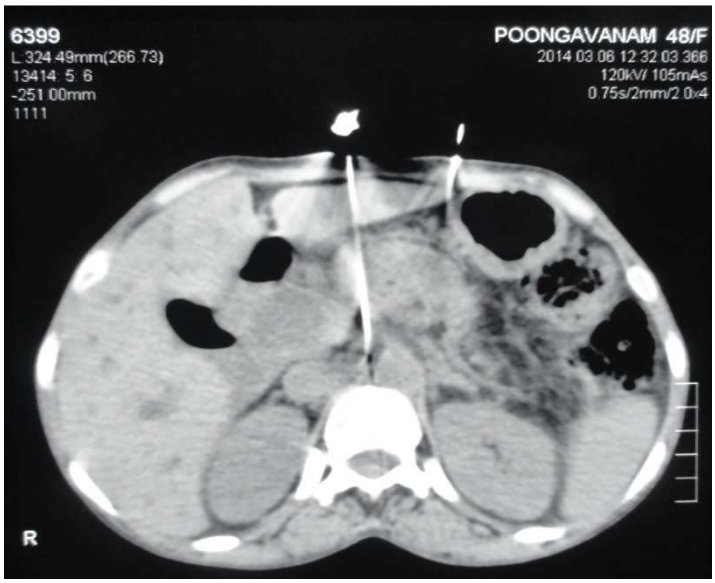


Surface marker placement for planning the trajectory

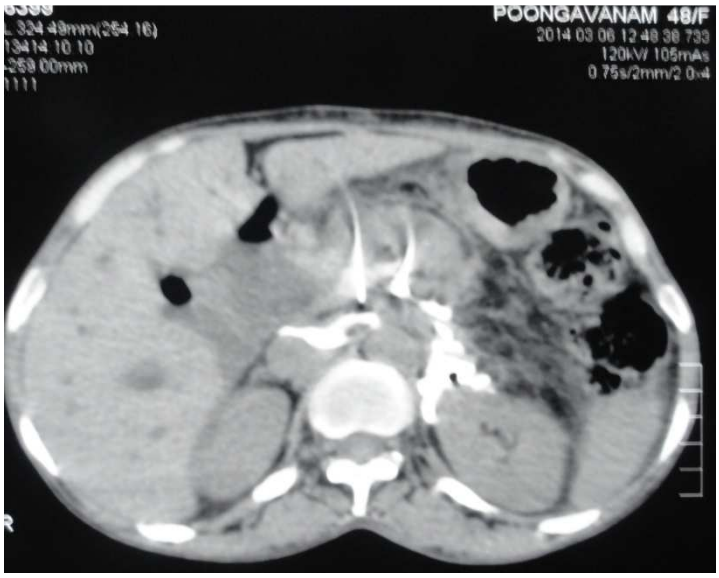


Spread of neurolytic in the antecrural space post procedure

CASE 3

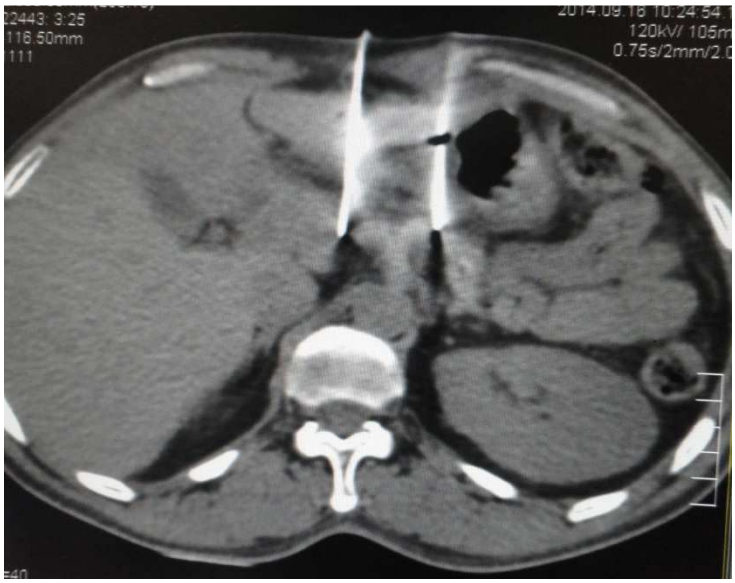


Needle trajectory- antecrural space

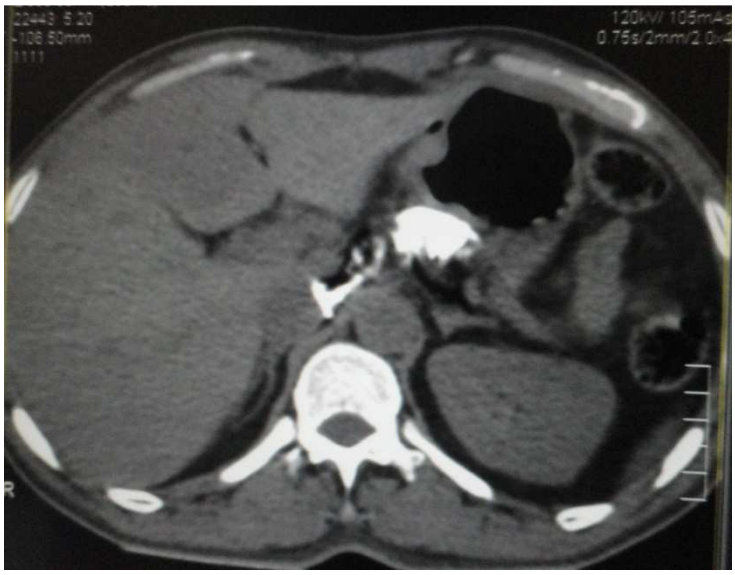


Spread of contrast/ Lignocaine mixture

CASE 4



Needle placement in antecrural space



Spread of neurolytic agent post procedure

EVALUATION

EVALUATION

As the aim of this procedure is to alleviate pain, assessment of pain intensity is primarily done during evaluation. This is done using *VISUAL ANALOG SCALE (VAS).*

Pain intensity assessment is done at different points of time. The first evaluation is done pre procedure. This is followed by immediate post procedure assessment on the table, at 24 hours, at one week, at one month and at 2 months time.

Patients were also evaluated for complications. Hypotension was the commonest of them seen in 18 patients (9 males and 9 females). All these patients settled with intravenous fluids. Back pain was the second most common complication, seen in 14 patients (6 males and 8 females). Shoulder pain was seen in 12 patients (6 males and 6 females).

Diarrhoea, hematoma, Discitis, lower limb weakness, sphincter dysfunction of bowel and bladder and spinal ischemia were not seen as complications in this study, involving 30 patients.

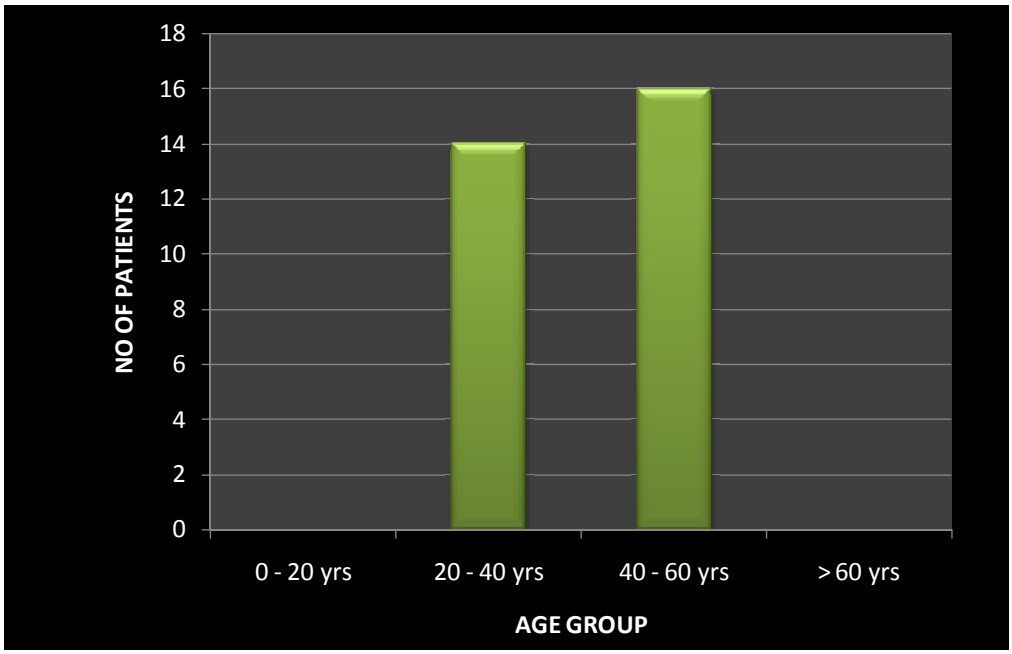
Failure to achieve relief was also not reported in this study indicating a favourable outcome.

STATISTICAL ANALYSIS

STATISTICAL ANALYSIS

AGE GROUP –

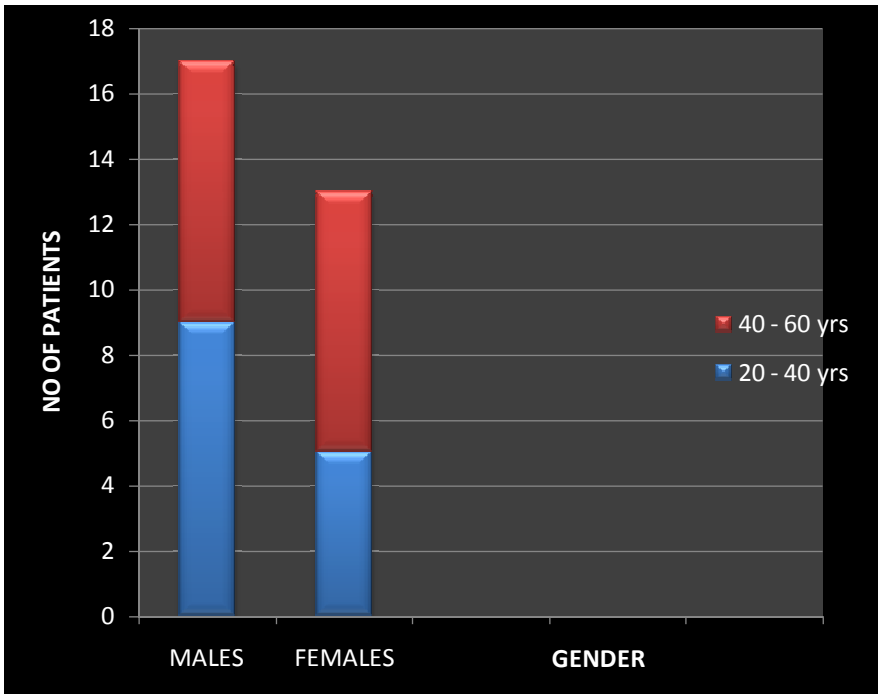
Eligible patients were selected using the inclusion and exclusion criteria. In total, 30 patients were included in the study. Of these 30 patients, 14 belonged to the age group of 20 – 40 years, 16 to 40 – 60 years and no patients were in the age group below 20 or above 60 years.



AGE GROUP CHART

GENDER CHART –

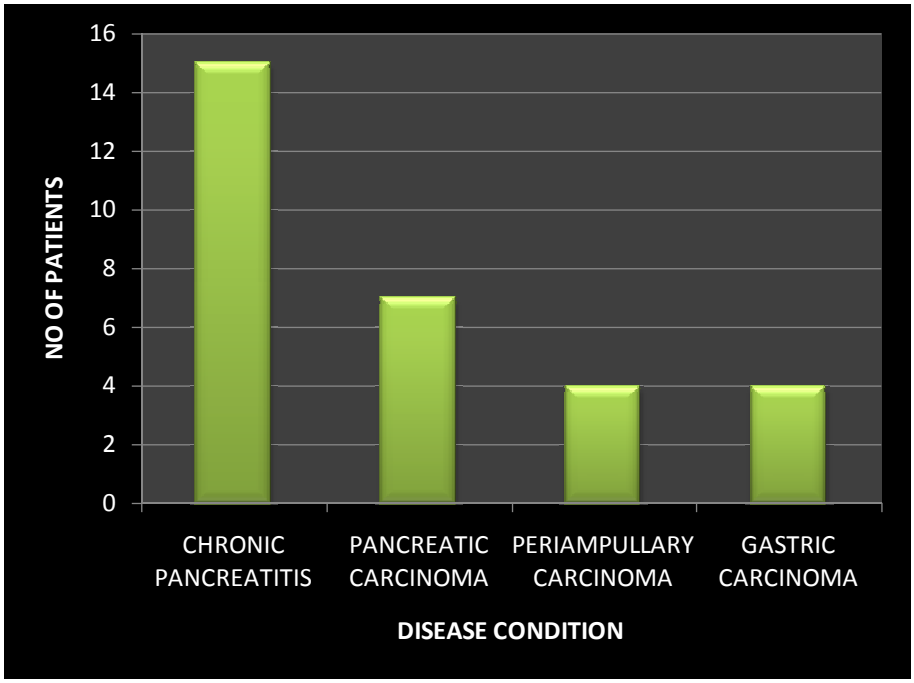
Of the 30 patients, 17 were males and 13 females. Of 17 males, 9 were of 20 – 40 years and 8 were of 40 – 60 years. Of the 13 females, 5 were of 20 – 40 years and 8 were of 40 – 60 years.



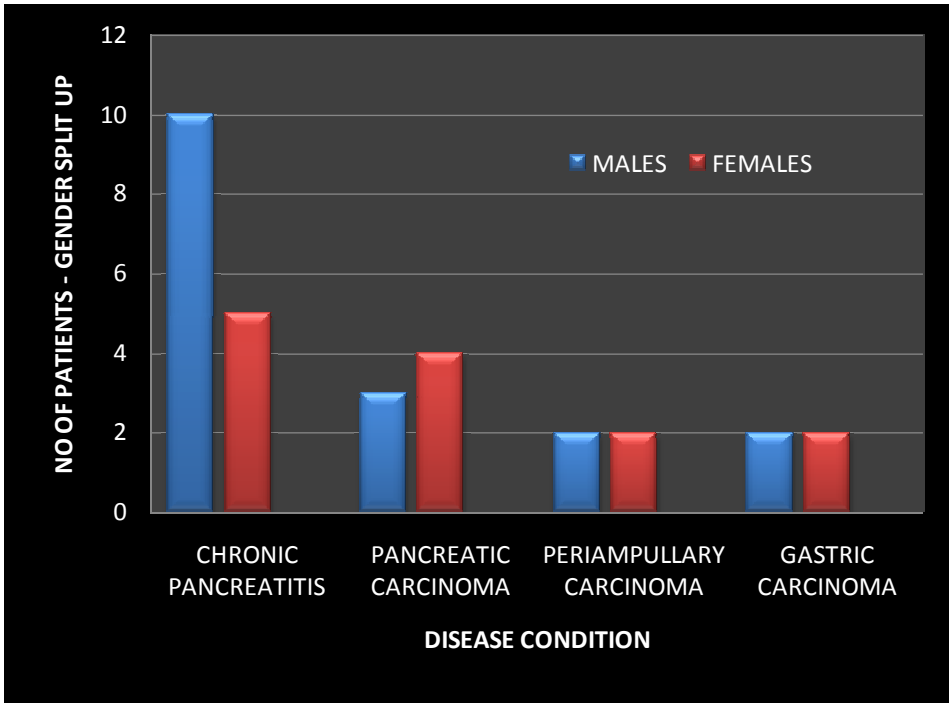
GENDER CHART

DISEASE CHART –

The 30 patients included in the study had four types of diseases namely *CHRONIC PANCREATITIS (TYPE I), PANCREATIC CARCINOMA(TYPE II), PERIAMPULLARY CARCINOMA(TYPE III) and GASTRIC CARCINOMA(TYPE IV).* There were 15, 7, 4 and 4 patients in each of these disease conditions respectively. There were 10 males and 5 females in TYPE I disease, 3 males and 4 females in TYPE II disease, 2 males and 2 females in TYPE III disease, 2 males and 2 females in TYPE IV disease.



DISEASE Vs NO OF PATIENTS CHART



DISEASE Vs GENDER CHART

ANALGESIC DRUGS – OPIATES –

All the 30 patients were on high dose opiates requiring dose escalation every now and then due to poor control of pain. However, none of these patients had any side effects at the time of the study. Patients were carefully selected at an early stage of the disease as it is well known that, earlier the procedure better is the outcome.

The dosage aspect of the drugs, before and after the procedure was not taken into account for the study (Though it is one way of assessing

treatment success) because the type of analgesic treatment was partly governed by availability of drugs at our institution.

PAIN INTENSITY STATISTICS –

The intensity of pain was assessed using VAS. This assessment was done at different points in time namely

- Preprocedure – PP VAS 1
- Immediate postprocedure – VAS 2
- At 24 hours – VAS 3
- At one week – VAS 4
- At one month – VAS 5
- At 2 months – VAS 6

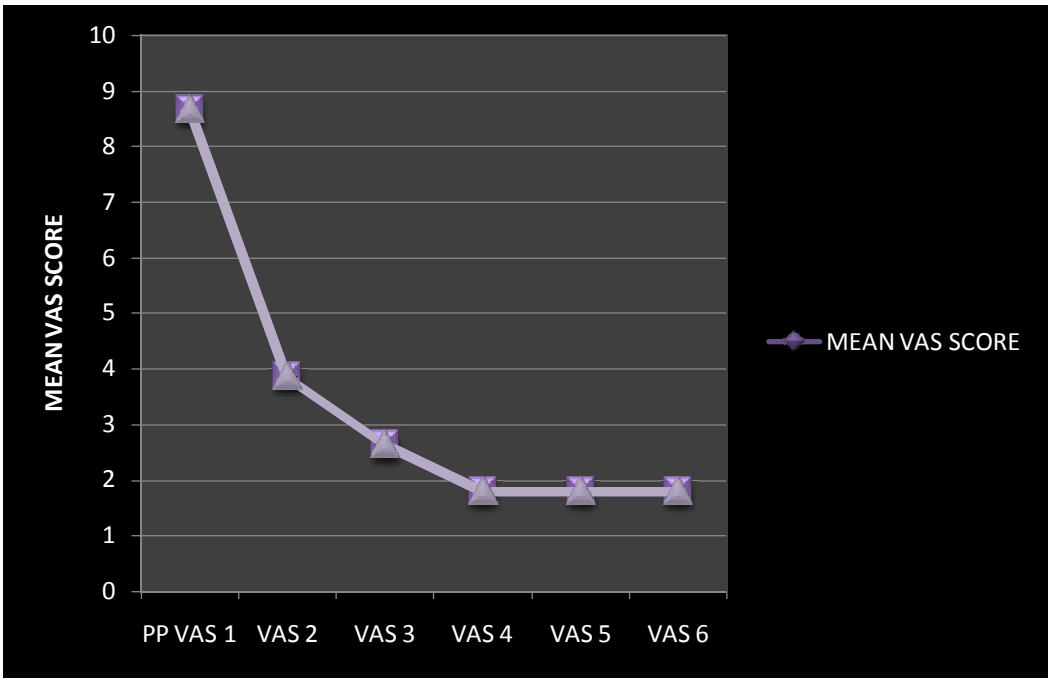
Mean PP VAS score was 8.67 ± 0.322 with a standard deviation of 0.884. Mean of VAS 2 was 3.87 ± 0.23 with a standard deviation of 0.629. Mean of VAS 3 was 2.63 ± 0.21 with a standard deviation of 0.556. Mean of VAS 4, VAS 5 and VAS 6 were 1.80 ± 0.20 with a standard deviation of 0.551.

This indicates that there is significant difference between means of PP VAS 1 and VAS 2, (from 8.67 to 3.87) with a percentage reduction of 1- 3.87/8.67 = 55%, indicating good pain relief. Pain intensity further decreases from 3.87 to 2.63, at 24 hours (VAS 3), percentage reduction of 1-2.63/3.87 = 32%, after the procedure. There is further minimal pain relief from 2.63 to 1.8 at one week (VAS 4), percentage reduction 0f 1-1.8/2.63 = 31%. Further follow up at one and two months showed no pain relief.

VAS					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
1	30	8.67	.884	.161	8.34	9.00
2	30	3.87	.629	.115	3.63	4.10
3	30	2.63	.556	.102	2.43	2.84
4	30	1.80	.551	.101	1.59	2.01
5	30	1.80	.551	.101	1.59	2.01
6	30	1.80	.551	.101	1.59	2.01

The minimum and maximum VAS scores were 7 and 10, 3 and 5, 2 and 4 for PP VAS 1, VAS 2 and VAS 3. For the later VAS, it was 1 and 3 for all assessments.

MEAN PAIN INTENSITY Vs VAS(1-6)



The percentage reduction between PP VAS and VAS 6 is 1-1.8/8.67 = 79%.

The percentage reduction of pain is calculated by the formula

1 - Later value/Former value

VAS	SCORE	
	Minimum	Maximum
1	7	10
2	3	5
3	2	4
4	1	3
5	1	3
6	1	3
Total	1	10

The data does not show much of deviation from the mean, i.e it is non skewed data. Since the same variable is assessed at different points in time, ie repeated measurements of same variable, ANOVA is used for statistical analysis.

ANOVA stands for Analysis of Variance, which is an extension of Paired T-test.

The ANOVA for between groups gives a F value of 544.062 which is statistically significant at 0.000 level.

ANOVA

VAS	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1086.561	5	217.312	544.062	.000
Within Groups	69.500	174	.399		
Total	1156.061	179			

For within groups analysis, POST HOCS test is done for MULTIPLE COMPARISONS.

The mean difference in pain intensity between PP VAS 1 and other post procedure VAS (2 to 6) shows significant alleviation of pain, which were statistically significant at 0.05 level.

The mean difference in pain intensity between VAS 2 and VAS 3 and that between VAS 3 and VAS 4 were also statistically significant at 0.05 level. However, there was no statistically significant difference between VAS 4, VAS 5 and VAS 6.

POST HOCS TEST

MULTIPLE COMPARISONS

(I) VAS	(J) VAS	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	4.800*	.163	.000	4.48	5.12
	3	6.033*	.163	.000	5.71	6.36
	4	6.867*	.163	.000	6.54	7.19
	5	6.867*	.163	.000	6.54	7.19
	6	6.867*	.163	.000	6.54	7.19
2	1	-4.800*	.163	.000	-5.12	-4.48
	3	1.233*	.163	.000	.91	1.56
	4	2.067*	.163	.000	1.74	2.39
	5	2.067*	.163	.000	1.74	2.39
	6	2.067*	.163	.000	1.74	2.39
3	1	-6.033*	.163	.000	-6.36	-5.71
	2	-1.233*	.163	.000	-1.56	-.91
	4	.833*	.163	.000	.51	1.16
	5	.833*	.163	.000	.51	1.16
	6	.833*	.163	.000	.51	1.16
4	1	-6.867*	.163	.000	-7.19	-6.54
	2	-2.067*	.163	.000	-2.39	-1.74
	3	-.833*	.163	.000	-1.16	-.51
	5	.000	.163	1.000	-.32	.32
	6	.000	.163	1.000	-.32	.32
5	1	-6.867*	.163	.000	-7.19	-6.54
	2	-2.067*	.163	.000	-2.39	-1.74
	3	-.833*	.163	.000	-1.16	-.51
	4	.000	.163	1.000	-.32	.32
	6	.000	.163	1.000	-.32	.32
6	1	-6.867*	.163	.000	-7.19	-6.54
	2	-2.067*	.163	.000	-2.39	-1.74
	3	-.833*	.163	.000	-1.16	-.51
	4	.000	.163	1.000	-.32	.32
	5	.000	.163	1.000	-.32	.32

*. The mean difference is significant at the 0.05 level.

PREPROCEDURE VAS Vs VAS 6(AT 2 MONTHS)- Paired T-test

Mean preprocedure VAS is 8.67 and that of VAS 6 is 1.80 with a negative correlation of -0.425 between these two statistically significant at 0.05 level.

PAIRED SAMPLE STATISTICS

PAIRED SAMPLES		MEAN	N	STANDARD DEVIATION	STD ERROR MEAN
Pair 1	PP VAS	8.67	30	.884	.161
	VAS 6	1.80	30	.551	.101

PAIRED SAMPLES CORRELATIONS

Paired Samples		N	Correlation	Sig.
Pair 1	PP VAS & VAS 6	30	-.425	.019

Paired T-test between these two showed a mean difference of 6.867 ± 0.448 with a standard deviation of 1.224 which is statistically significant at 0.000 level.

PAIRED T-TEST BETWEEN PP VAS 1 & VAS 6

Paired Samples	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	Df	Sig. (2-tailed)
Pair 1 PP VAS1 - VAS 6	6.867	1.224	.224	6.410	7.324	30.720	29	.000

CORRELATION STATISTICS BETWEEN AGE Vs PAIN INTENSITY

Correlation analysis between age and different VAS scores was attempted. ***DIFFERENCE VAS*** in the analysis refers to the difference in the pain intensity score between PP VAS 1 and VAS 6.

Mean age was 42.97 with a standard deviation of 9.156 and the mean difference VAS was 6.87 with a standard deviation of 1.224.

The correlation analysis showed, positive correlation between age and VAS 2 (Pearson correlation of 0.508 significant at 0.0l level). A positive correlation also exists between age and VAS 3 (Pearson correlation of 0.370 significant at 0.05 level) and also with Difference VAS (Pearson correlation of 0.387 significant at 0.05 level).

DESCRIPTIVE STATISTICS

	Mean	Std. Deviation	N
AGE	42.97	9.156	30
PP VAS 1	8.67	.884	30
VAS 2	3.87	.629	30
VAS 3	2.63	.556	30
VAS 4	1.80	.551	30
VAS 5	1.80	.551	30
VAS 6	1.80	.551	30
DIFFERENCE VAS	6.87	1.224	30

There is a positive correlation between PP VAS 1 with VAS 2 (Pearson correlation of 0.476 significant at 0.0l level) and with Difference VAS (Pearson correlation of 0.913 significant at 0.0l level).

There is a negative correlation between PP VAS 1 with VAS 4, VAS 5 and VAS 6(Pearson correlation of -0.425 significant at 0.05 level).

There is a positive correlation between VAS 2 with VAS 3 (Pearson correlation of 0.743 significant at 0.0l level).

There is a positive correlation between VAS 5 and VAS 6 (Pearson correlation of 1.000 significant at 0.0l level).

CORRELATIONS

		AGE	PP VAS1	VAS2	VAS3	VAS 4	VAS 4	VAS 5	DIFF VAS
AGE	Pearson Correlation	1	.352	.508**	.370*	-.295	-.295	-.295	.387*
	Sig. (2-tailed)		.056	.004	.044	.113	.113	.113	.035
	N	30	30	30	30	30	30	30	30
PP VAS1	Pearson Correlation	.352	1	.476**	.164	-.425*	-.425*	-.425*	.913**
	Sig. (2-tailed)	.056		.008	.387	.019	.019	.019	.000
	N	30	30	30	30	30	30	30	30
VAS2	Pearson Correlation	.508**	.476**	1	.743**	.020	.020	.020	.334
	Sig. (2-tailed)	.004	.008		.000	.917	.917	.917	.071
	N	30	30	30	30	30	30	30	30
VAS3	Pearson Correlation	.370*	.164	.743**	1	.203	.203	.203	.027
	Sig. (2-tailed)	.044	.387	.000		.283	.283	.283	.887
	N	30	30	30	30	30	30	30	30
VAS 4	Pearson Correlation	-.295	-.425*	.020	.203	1	1.000**	1.000**	-.757**
	Sig. (2-tailed)	.113	.019	.917	.283		.000	.000	.000
	N	30	30	30	30	30	30	30	30
VAS 5	Pearson Correlation	-.295	-.425*	.020	.203	1.000**	1	1.000**	-.757**
	Sig. (2-tailed)	.113	.019	.917	.283	.000		.000	.000
	N	30	30	30	30	30	30	30	30
VAS 6	Pearson Correlation	-.295	-.425*	.020	.203	1.000**	1.000**	1	-.757**
	Sig. (2-tailed)	.113	.019	.917	.283	.000	.000		.000
	N	30	30	30	30	30	30	30	30
DIFFERENCE VAS	Pearson Correlation	.387*	.913**	.334	.027	-.757**	-.757**	-.757**	1
	Sig. (2-tailed)	.035	.000	.071	.887	.000	.000	.000	
	N	30	30	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

There is a positive correlation between VAS 4 with VAS 5 and VAS 6 (Pearson correlation of 1.000 significant at 0.0l level).

There is a negative correlation between Difference VAS with VAS 4, VAS 5 and VAS 6 (Pearson correlation of -0.757 significant at 0.0l level).

<u>GENDER Vs PAIN INTENSITY STATISTICS –</u>

In this study involving 30 patients, there were 17 males and 13 females.

The mean pain intensity of males are 8.65, 3.94, 2.71, 1.82, 1.82, 1.82 and 6.82 for PP VAS 1, VAS 2, VAS 3, VAS 4, VAS 5, VAS 6 and Difference VAS respectively.

The mean pain intensity of females are 8.69, 3.77, 2.54, 1.77, 1.77, 1.77 and 6.92 for PP VAS 1, VAS 2, VAS 3, VAS 4, VAS 5, VAS 6 and Difference VAS respectively.

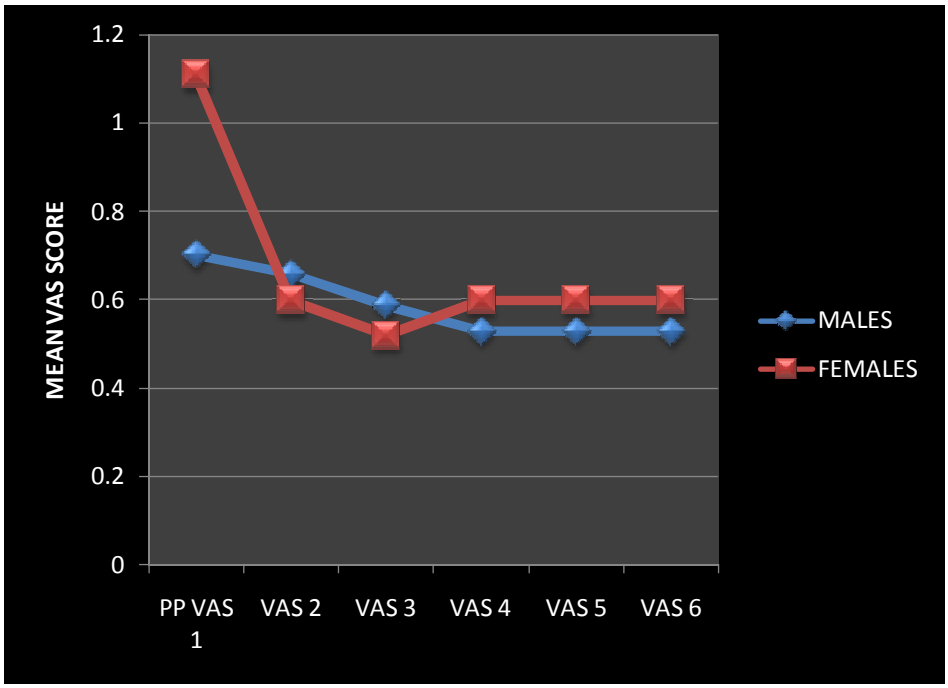
The standard deviation for males are 0.702, 0.659, 0.588, 0.529, 0.529, 0.529 and 1.015 and that for females are 1.109, 0.599, 0.519, 0.599, 0.599, 0.599 and 1.498 for PP VAS to VAS 6 and difference VAS respectively.

GROUP STATISTICS

	SEX	N	Mean	Std. Deviation	Std. Error Mean
PP VAS 1	1	17	8.65	.702	.170
	2	13	8.69	1.109	.308
VAS2	1	17	3.94	.659	.160
	2	13	3.77	.599	.166
VAS3	1	17	2.71	.588	.143
	2	13	2.54	.519	.144
VAS 4	1	17	1.82	.529	.128
	2	13	1.77	.599	.166
VAS 5	1	17	1.82	.529	.128
	2	13	1.77	.599	.166
VAS 6	1	17	1.82	.529	.128
	2	13	1.77	.599	.166
DIFFERENCE VAS	1	17	6.82	1.015	.246
	2	13	6.92	1.498	.415

SEX 1 – MALE / SEX 2 – FEMALE

GENDER Vs MEAN VAS CHART



INDEPENDENT SAMPLES TEST

		Levene's Test for Equality of Variances		t-test for Equality of Means				
				Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
		F	Sig.				Lower	Upper
PP VAS1	Equal variances assumed	5.012	.033	.892	-.045	.331	-.724	.634
	Equal variances not assumed			.899	-.045	.352	-.781	.690
VAS2	Equal variances assumed	.038	.846	.468	.172	.234	-.306	.650
	Equal variances not assumed			.462	.172	.231	-.301	.645
VAS3	Equal variances assumed	.000	.988	.423	.167	.206	-.255	.590
	Equal variances not assumed			.416	.167	.203	-.248	.583
VAS 4	Equal variances assumed	.459	.504	.794	.054	.206	-.368	.477
	Equal variances not assumed			.798	.054	.210	-.379	.487
VAS 5	Equal variances assumed	.459	.504	.794	.054	.206	-.368	.477
	Equal variances not assumed			.798	.054	.210	-.379	.487
VAS 6	Equal variances assumed	.459	.504	.794	.054	.206	-.368	.477
	Equal variances not assumed			.798	.054	.210	-.379	.487
DIFFERENCE VAS	Equal variances assumed	5.424	.027	.830	-.100	.459	-1.039	.840
	Equal variances not assumed			.839	-.100	.483	-1.107	.907

NOT SIGNIFICANT

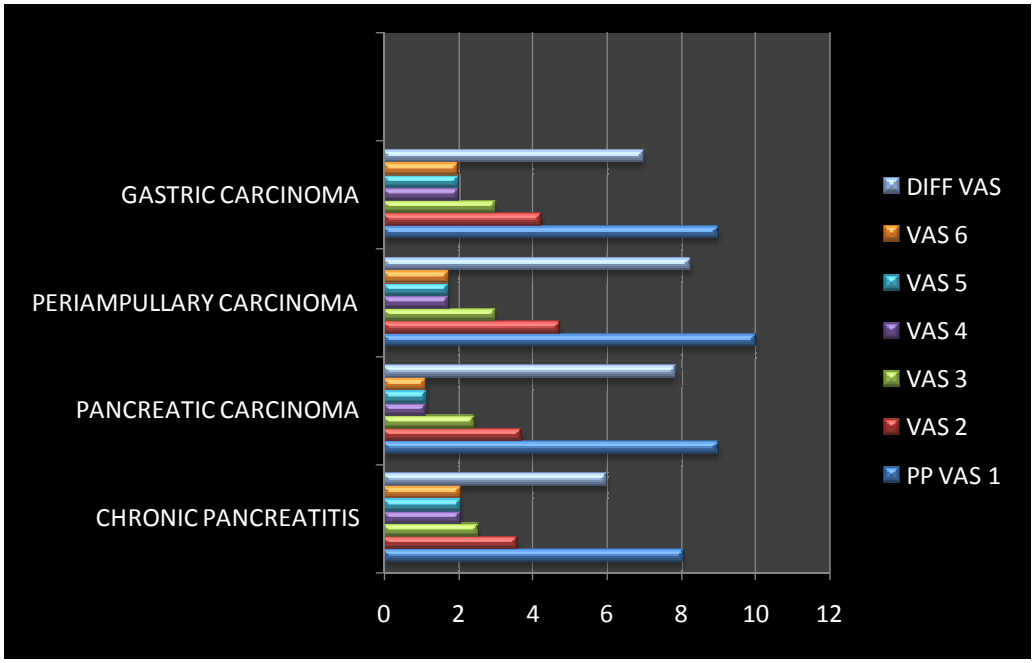
Independent samples analysis between different VAS scores and gender, shows no statistical significance at 0.05 level indicating that gender does not play any significance in the VAS scores or in response to procedure.

DISEASE TYPE Vs PAIN INTENSITY STATISTICS -

Patients involved in this study belonged to four types of disease namely *CHRONIC PANCREATITIS (TYPE I), PANCREATIC CARCINOMA (TYPE II), PERIAMPULLARY CARCINOMA (TYPE III) and GASTRIC CARCINOMA (TYPE IV).*

The mean, standard deviation, minimum and maximum PP VAS 1 values for four diseases are 8.07 ± 0.306, 0.594, 7 and 9 for (Type I), 9.00 ±0.456, 0.577, 8 and 10 for (Type II), 10.00, 0, 10, and 10 for (Type III) and 9.00±0.816, 0.816, 8 and 10 for (Type IV).

DISEASE TYPE Vs MEAN VAS SCORES



DESCRIPTORS

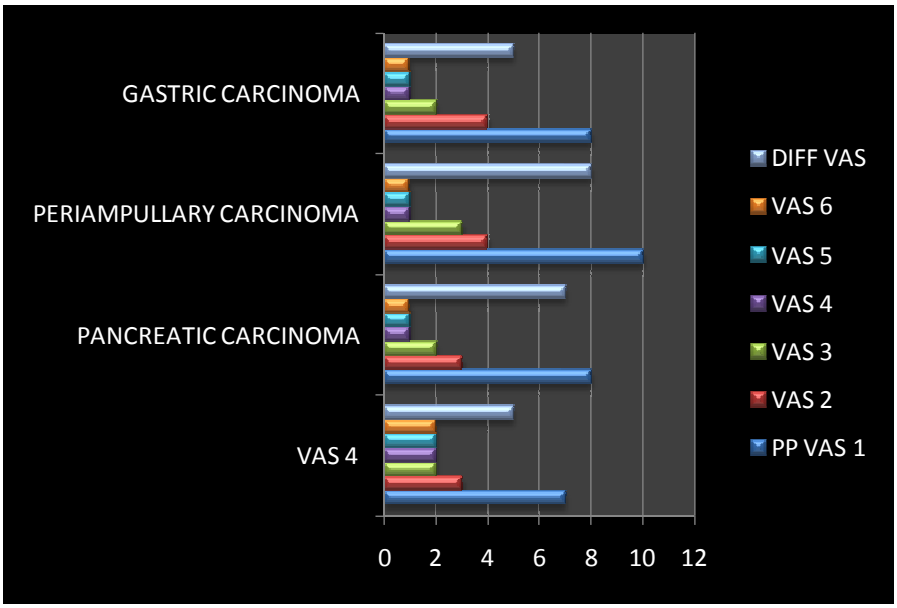
FACTORS		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
PP VAS1	1	15	8.07	.594	.153	7.74	8.40	7	9
	2	7	9.00	.577	.218	8.47	9.53	8	10
	3	4	10.00	.000	.000	10.00	10.00	10	10
	4	4	9.00	.816	.408	7.70	10.30	8	10
	Total	30	8.67	.884	.161	8.34	9.00	7	10
VAS2	1	15	3.60	.507	.131	3.32	3.88	3	4
	2	7	3.71	.488	.184	3.26	4.17	3	4
	3	4	4.75	.500	.250	3.95	5.55	4	5
	4	4	4.25	.500	.250	3.45	5.05	4	5
	Total	30	3.87	.629	.115	3.63	4.10	3	5
VAS3	1	15	11	.516	.133	2.25	2.82	2	3
	2	7	2.43	.535	.202	1.93	2.92	2	3
	3	4	3.00	.000	.000	3.00	3.00	3	3
	4	4	3.00	.816	.408	1.70	4.30	2	4
	Total	30	2.63	.556	.102	2.43	2.84	2	4
VAS 4	1	15	2.07	.258	.067	1.92	2.21	2	3
	2	7	1.14	.378	.143	.79	1.49	1	2
	3	4	1.75	.500	.250	.95	2.55	1	2
	4	4	2.00	.816	.408	.70	3.30	1	3
	Total	30	1.80	.551	.101	1.59	2.01	1	3
VAS 5	1	15	2.07	.258	.067	1.92	2.21	2	3
	2	7	1.14	.378	.143	.79	1.49	1	2
	3	4	1.75	.500	.250	.95	2.55	1	2
	4	4	2.00	.816	.408	.70	3.30	1	3
	Total	30	1.80	.551	.101	1.59	2.01	1	3
VAS 6	1	15	2.07	.258	.067	1.92	2.21	2	3
	2	7	1.14	.378	.143	.79	1.49	1	2
	3	4	1.75	.500	.250	.95	2.55	1	2
	4	4	2.00	.816	.408	.70	3.30	1	3
	Total	30	1.80	.551	.101	1.59	2.01	1	3
DIFFERENCE VAS	1	15	6.00	.655	.169	5.64	6.36	5	7
	2	7	7.86	.690	.261	7.22	8.50	7	9
	3	4	8.25	.500	.250	7.45	9.05	8	9
	4	4	7.00	1.633	.816	4.40	9.60	5	9
	Total	30	6.87	1.224	.224	6.41	7.32	5	9

DISEASE Vs VAS SCORE

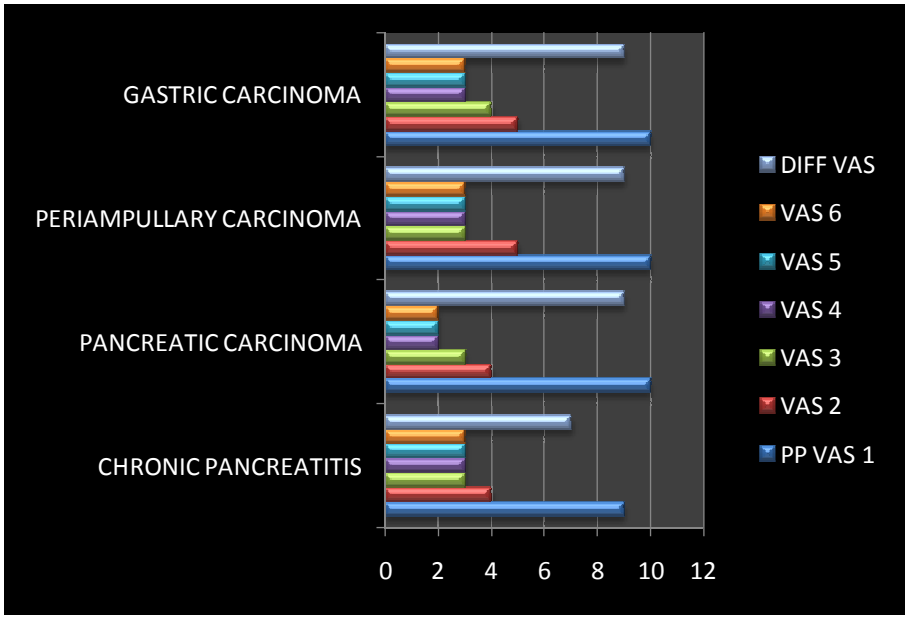
DISEASE	PPVAS 1	VAS 2	VAS 3	VAS 4	VAS 5	VAS 6	DIFF VAS	(1 – 6) % 0F REDUCTION
I	8.07	3.60	2.61	2.07	2.07	2.07	6.00	74
II	9.00	3.71	2.43	1.14	1.14	1.14	7.86	88
III	10.00	4.75	3.00	1.75	1.75	1.75	8.25	82
IV	9.00	4.25	3.00	2.00	2.00	2.00	7.00	78

Mean Preprocedure VAS (PP VAS 1) in the four disease types are 8.07, 9, 10 and 9 respectively. Mean VAS at 2 months follow up for the disease types are 2.07, 1.14, 1.75 and 2 respectively.

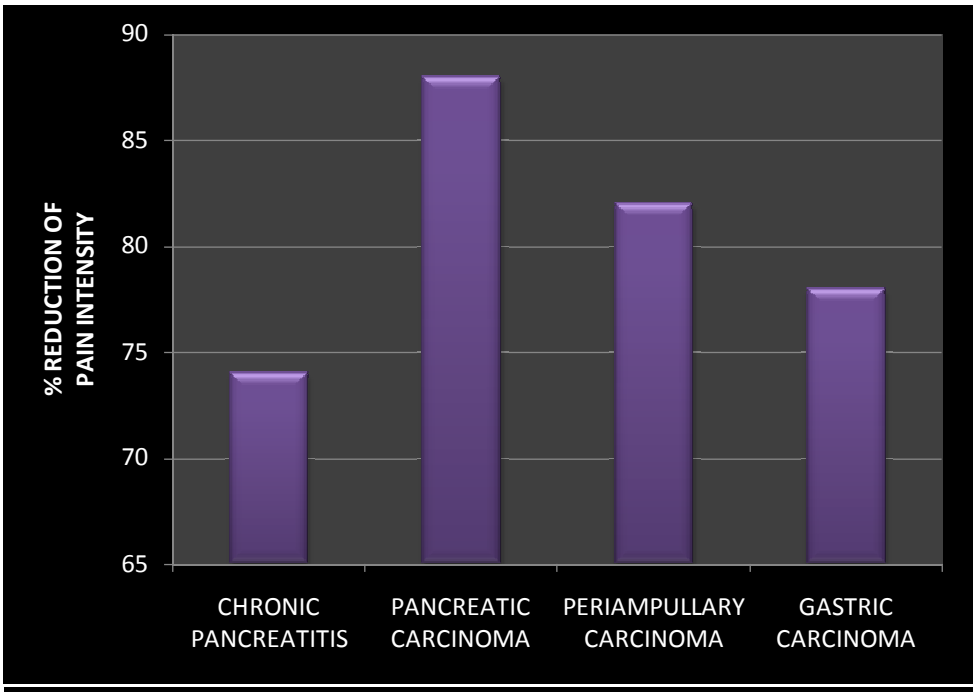
DISEASE Vs MINIMUM VAS



DISEASE Vs MAXIMUM VAS



% REDUCTION OF PAIN Vs DISEASE TYPES



Mean Difference VAS for the disease groups are 6, 7.86, 8.25 and 7 respectively. Percentage of reduction of pain intensity are 74, 88, 82 and 78 % respectively.

Thus the procedure is effective in all four disease groups. Among the four diseases, this **procedure is less effective with least reduction percentage of 74 % for Chronic Pancreatitis, which is an inflammatory condition.**

For malignancies, it is more effective with maximum relief in pancreatic carcinoma with a pain reduction percentage of 88%

ANOVA

As there is analysis of VAS score at different intervals, repeated measures of the same variable, with the different disease types, between subject analysis done using ANOVA.

ANOVA for between subjects for Different VAS score and disease types shows increased F value of 13.23 and 12.729 for PP VAS 1 and Difference VAS both significant at 0.000 level.

The F value for VAS 4, 5 and 6 is 8.130 significant at 0.001 level. For VAS 2, F value is 6.555 significant at 0.002 level.

VAS 3 does not show any significance.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
PP VAS1	Between Groups	13.733	3	4.578	13.323	.000
	Within Groups	8.933	26	.344		
	Total	22.667	29			
VAS2	Between Groups	4.938	3	1.646	6.555	.002
	Within Groups	6.529	26	.251		
	Total	11.467	29			
VAS3	Between Groups	1.519	3	.506	1.768	.178
	Within Groups	7.448	26	.286		
	Total	8.967	29			
VAS 4	Between Groups	4.260	3	1.420	8.130	.001
	Within Groups	4.540	26	.175		
	Total	8.800	29			
VAS 5	Between Groups	4.260	3	1.420	8.130	.001
	Within Groups	4.540	26	.175		
	Total	8.800	29			
VAS 6	Between Groups	4.260	3	1.420	8.130	.001
	Within Groups	4.540	26	.175		
	Total	8.800	29			
DIFFERENCE VAS	Between Groups	25.860	3	8.620	12.729	.000
	Within Groups	17.607	26	.677		
	Total	43.467	29			

For within subjects analysis, POST HOC tests with multiple comparisons done.

POST HOCS TEST

MULTIPLE COMPARISONS

Dependent Variable	(I) DISEASE CODE	(J) DISEASE CODE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
PP VAS1	1	2	-.933*	.268	.002	-1.48	-.38
		3	-1.933*	.330	.000	-2.61	-1.26
		4	-.933*	.330	.009	-1.61	-.26
	2	1	.933*	.268	.002	.38	1.48
		3	-1.000*	.367	.011	-1.76	-.24
		4	.000	.367	1.000	-.76	.76
	3	1	1.933*	.330	.000	1.26	2.61
		2	1.000*	.367	.011	.24	1.76
		4	1.000*	.414	.023	.15	1.85
	4	1	.933*	.330	.009	.26	1.61
		2	.000	.367	1.000	-.76	.76
		3	-1.000*	.414	.023	-1.85	-.15
VAS2	1	2	-.114	.229	.622	-.59	.36
		3	-1.150*	.282	.000	-1.73	-.57
		4	-.650*	.282	.029	-1.23	-.07
	2	1	.114	.229	.622	-.36	.59
		3	-1.036*	.314	.003	-1.68	-.39
		4	-.536	.314	.100	-1.18	.11
	3	1	1.150*	.282	.000	.57	1.73
		2	1.036*	.314	.003	.39	1.68
		4	.500	.354	.170	-.23	1.23
	4	1	.650*	.282	.029	.07	1.23
		2	.536	.314	.100	-.11	1.18
		3	-.500	.354	.170	-1.23	.23
VAS3	1	2	.105	.245	.672	-.40	.61
		3	-.467	.301	.133	-1.09	.15
		4	-.467	.301	.133	-1.09	.15
	2	1	-.105	.245	.672	-.61	.40
		3	-.571	.335	.100	-1.26	.12
		4	-.571	.335	.100	-1.26	.12
	3	1	.467	.301	.133	-.15	1.09
		2	.571	.335	.100	-.12	1.26
		4	.000	.378	1.000	-.78	.78
	4	1	.467	.301	.133	-.15	1.09
		2	.571	.335	.100	-.12	1.26
		3	.000	.378	1.000	-.78	.78
VAS 4	1	2	.924*	.191	.000	.53	1.32
		3	.317	.235	.190	-.17	.80
		4	.067	.235	.779	-.42	.55

	2	1	-.924*	.191	.000	-1.32	-.53
		3	-.607*	.262	.029	-1.15	-.07
		4	-.857*	.262	.003	-1.40	-.32
	3	1	-.317	.235	.190	-.80	.17
		2	.607*	.262	.029	.07	1.15
		4	-.250	.295	.405	-.86	.36
	4	1	-.067	.235	.779	-.55	.42
		2	.857*	.262	.003	.32	1.40
		3	.250	.295	.405	-.36	.86
VAS 5	1	2	.924*	.191	.000	.53	1.32
		3	.317	.235	.190	-.17	.80
		4	.067	.235	.779	-.42	.55
	2	1	-.924*	.191	.000	-1.32	-.53
		3	-.607*	.262	.029	-1.15	-.07
		4	-.857*	.262	.003	-1.40	-.32
	3	1	-.317	.235	.190	-.80	.17
		2	.607*	.262	.029	.07	1.15
		4	-.250	.295	.405	-.86	.36
	4	1	-.067	.235	.779	-.55	.42
		2	.857*	.262	.003	.32	1.40
		3	.250	.295	.405	-.36	.86
VAS 6	1	2	.924*	.191	.000	.53	1.32
		3	.317	.235	.190	-.17	.80
		4	.067	.235	.779	-.42	.55
	2	1	-.924*	.191	.000	-1.32	-.53
		3	-.607*	.262	.029	-1.15	-.07
		4	-.857*	.262	.003	-1.40	-.32
	3	1	-.317	.235	.190	-.80	.17
		2	.607*	.262	.029	.07	1.15
		4	-.250	.295	.405	-.86	.36
	4	1	-.067	.235	.779	-.55	.42
		2	.857*	.262	.003	.32	1.40
		3	.250	.295	.405	-.36	.86
DIFFERENCE VAS	1	2	-1.857*	.377	.000	-2.63	-1.08
		3	-2.250*	.463	.000	-3.20	-1.30
		4	-1.000*	.463	.040	-1.95	-.05
	2	1	1.857*	.377	.000	1.08	2.63
		3	-.393	.516	.453	-1.45	.67
		4	.857	.516	.109	-.20	1.92
	3	1	2.250*	.463	.000	1.30	3.20
		2	.393	.516	.453	-.67	1.45
		4	1.250*	.582	.041	.05	2.45
	4	1	1.000*	.463	.040	.05	1.95
		2	-.857	.516	.109	-1.92	.20
		3	-1.250*	.582	.041	-2.45	-.05

*. The mean difference is significant at the 0.05 level.

With PP VAS 1 as the dependent variable, the mean difference in within subject analysis, is significant at 0.05 level for all disease groups, except for 2 and 4.

With VAS 2 as the dependent variable, the mean difference in within subject analysis, is significant at 0.05 level within 1 – 3, 1 – 4 and 2 – 3 with no significance within 1-2, 2-4 and 3-4.

With VAS 3 as dependent variable, there is no statistically significant difference in the means within the disease groups.

For VAS 4, VAS 5 and VAS 6 as dependent variable, mean difference is significant within 1-2, 2-3, 2-4 and so significance within 1-3, 1-4 and 3-4.

With Difference VAS as dependent variable, mean difference is statistically significant within 1-2, 1-3 and 1-4 with no significance within 2-3 and 2-4.

REPEATED MEASURES ANOVA –

Sphericity is an important assumption of repeated measures of ANOVA. It refers to difference in *VARIANCES* of differences between all possible pairs of groups. If there is no difference, sphericity is maintained.

Sphericity is given by Mauchly's test (α). If $\alpha < 0.05$, sphericity is lost, thereby rejecting the null hypothesis that variances are equal. When

Within Subjects Effect	a			
	Mauchly's W	Approx. Chi-Square	df	Sig.
factor1	.000	.	14	.

Within Subjects Effect	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
factor1	.325	.341	.200

sphericity is violated, F ratio may be erroneously large. To prevent this, three types of corrections are denoted by – ε (epsilon). Farther the epsilon value from 1, farther is the violation.

In this study, sphericity is violated (α – 0.000) and the degree of violation is large given by Greenhouse – Geisser epsilon (ε) – 0.325.

TESTS OF WITHIN-SUBJECTS EFFECTS

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Sphericity Assumed	1086.561	5	217.312	666.571	.000
	Greenhouse-Geisser	1086.561	1.623	669.678	666.571	.000
	Huynh-Feldt	1086.561	1.705	637.323	666.571	.000
	Lower-bound	1086.561	1.000	1086.561	666.571	.000
Error(factor1)	Sphericity Assumed	47.272	145	.326		
	Greenhouse-Geisser	47.272	47.053	1.005		
	Huynh-Feldt	47.272	49.442	.956		
	Lower-bound	47.272	29.000	1.630		

Repeated measures ANOVA gives a **GREENHOUSE-GEISSER F value of 669.571 which is significant at 0.000 level**.

F ratio can also be calculated using MANOVA – multivariate analysis. **Wilk's Lambda F value is 376.313 which is statistically significant at 0.000 level.**

MULTIVARIATE TESTS

Effect		Value	F	Hypothesis df	Error df	Sig.
factor1	Pillai's Trace	.977	376.313[a]	3.000	27.000	.000
	Wilks' Lambda	.023	376.313[a]	3.000	27.000	.000
	Hotelling's Trace	41.813	376.313[a]	3.000	27.000	.000
	Roy's Largest Root	41.813	376.313[a]	3.000	27.000	.000

TESTS OF WITHIN-SUBJECTS CONTRASTS

Source	factor1	Type III Sum of Squares	Df	Mean Square	F	Sig.
factor1	Linear	566.800	1	566.800	1054.666	.000
	Quadratic	474.067	1	474.067	620.419	.000
	Cubic	41.082	1	41.082	196.325	.000
	Order 4	2.411	1	2.411	41.211	.000
	Order 5	2.201	1	2.201	36.206	.000
Error(factor1)	Linear	15.585	29	.537		
	Quadratic	22.159	29	.764		
	Cubic	6.068	29	.209		
	Order 4	1.696	29	.058		
	Order 5	1.763	29	.061		

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	2114.939	1	2114.939	2759.305	.000
Error	22.228	29	.766		

Thus there is statistically significant reduction in pain intensity within the groups indicating success of the procedure.

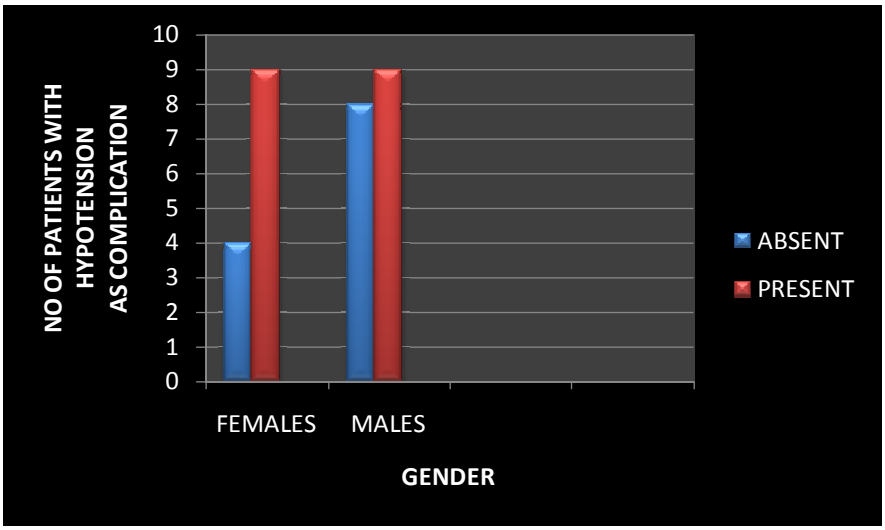
ANALYSIS OF COMPLICATIONS –

Three complications namely Hypotension, Back pain and shoulder pain were observed. Let us analyse if these were dependent on GENDER or DISEASE type.

GENDER Vs HYPOTENSION

CROSS TAB

			HYPOTENSION		
			ABSENT	PRESENT	Total
SEX	F	Count	4	9	13
		% within HYPOTENSION	33.3%	50.0%	43.3%
		% of Total	13.3%	30.0%	43.3%
	M	Count	8	9	17
		% within HYPOTENSION	66.7%	50.0%	56.7%
		% of Total	26.7%	30.0%	56.7%
	Total	Count	12	18	30
		% within HYPOTENSION	100.0%	100.0%	100.0%
		% of Total	40.0%	60.0%	100.0%



CHI SQUARE TEST

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.814[a]	1	.367		
Continuity Correction[b]	.277	1	.599		
Likelihood Ratio	.824	1	.364		
Fisher's Exact Test				.465	.301
N of Valid Cases	30				

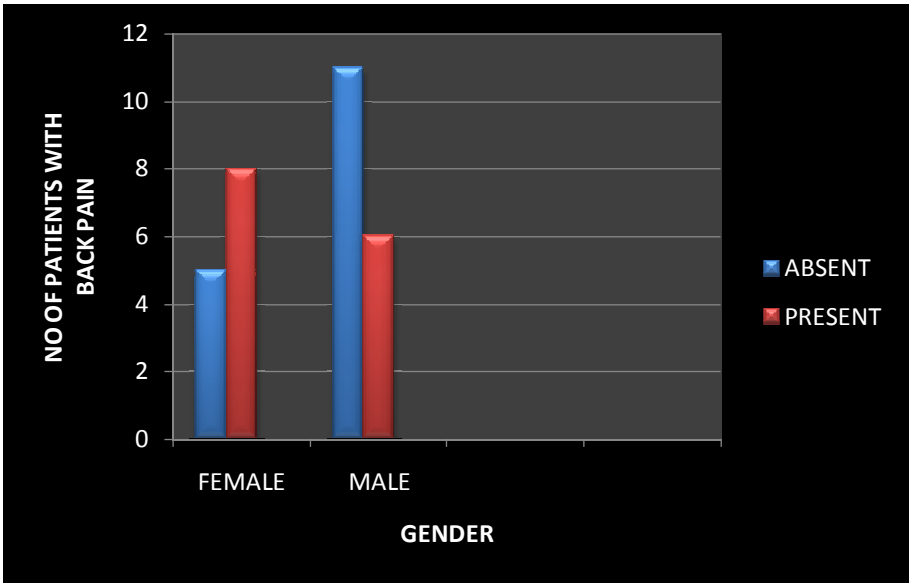
9 out of 13 females and 9 out of 17 males had hypotension. **Pearson Chi Square value is 0.367, hence statistically insignificant i.e they are independent**.

GENDER Vs BACK PAIN

CROSS TAB

			BACK PAIN		
			ABSENT	PRESENT	Total
SEX	F	Count	5	8	13
		% within BACK PAIN	31.3%	57.1%	43.3%
		% of Total	16.7%	26.7%	43.3%
	M	Count	11	6	17
		% within BACK PAIN	68.8%	42.9%	56.7%
		% of Total	36.7%	20.0%	56.7%
	Total	Count	16	14	30
		% within BACK PAIN	100.0%	100.0%	100.0%
		% of Total	53.3%	46.7%	100.0%

8 0ut of 13 females and 6 0ut of 17 males had back pain with a p value of 0.153 with no statistical significance. Hence **back pain is independent of gender.**



CHI-SQUARE TESTS

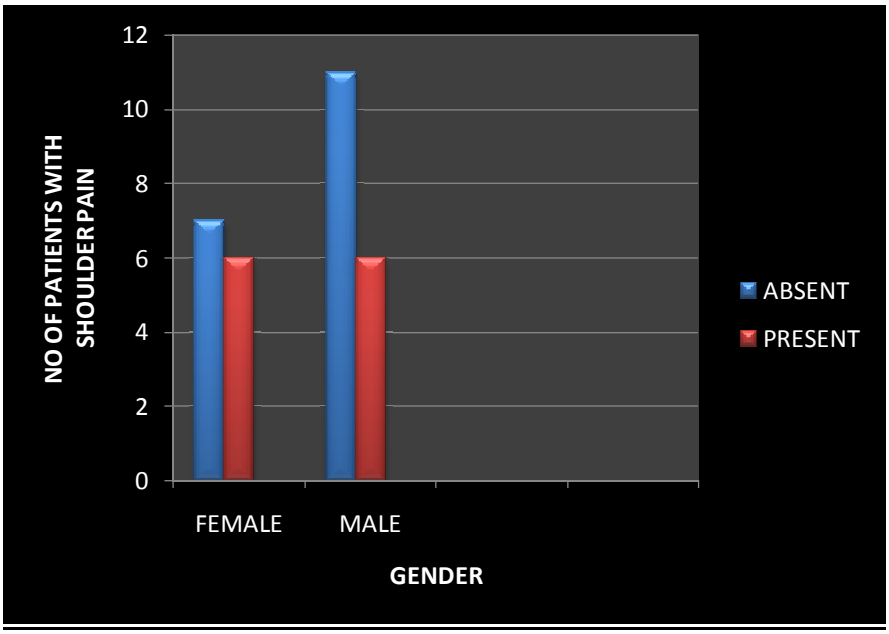
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.039[a]	1	.153		
Continuity Correction[b]	1.121	1	.290		
Likelihood Ratio	2.058	1	.151		
Fisher's Exact Test				.269	.145
N of Valid Cases	30				

GENDER VS SHOULDER PAIN

6 out of 13 females and 6 out of 17 males had shoulder post procedure. Pearson Chi square value is 0.547. Hence statistically insignificant i.e **gender and shoulder pain are independent.**

CROSS TAB

			SHOULDER PAIN		
			ABSENT	PRESENT	Total
SEX	F	Count	7	6	13
		% within SHOULDER PAIN	38.9%	50.0%	43.3%
		% of Total	23.3%	20.0%	43.3%
	M	Count	11	6	17
		% within SHOULDER PAIN	61.1%	50.0%	56.7%
		% of Total	36.7%	20.0%	56.7%
	Total	Count	18	12	30
		% within SHOULDER PAIN	100.0%	100.0%	100.0%
		% of Total	60.0%	40.0%	100.0%



CHI SQUARE TESTS

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.362[a]	1	.547		
Continuity Correction[b]	.051	1	.821		
Likelihood Ratio	.361	1	.548		
Fisher's Exact Test				.711	.410
N of Valid Cases	30				

HYPOTENSION Vs AGE & DIFFERENCE VAS

GROUP STATISTICS

	HYPOTENSION	N	Mean	Std. Deviation	Std. Error Mean
AGE	PRESENT	18	48.83	6.706	1.581
	ABSENT	12	34.17	3.271	.944
VAS DIFFERENCE	PRESENT	18	7.06	1.434	.338
	ABSENT	12	6.58	.793	.229

INDEPENDENT SAMPLES TEST

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
AGE	Equal variances assumed	13.338	.001	7.011	28	.000	14.667	2.092	10.382	18.952
	Equal variances not assumed			7.966	26.150	.000	14.667	1.841	10.883	18.450
VAS DIFFERENCE	Equal variances assumed	10.701	.003	1.036	28	.309	.472	.456	-.461	1.406
	Equal variances not assumed			1.157	27.298	.257	.472	.408	-.365	1.309

Let us now analyse the complications Vs age and Difference VAS scores**.**

P value for age Vs hypotension is 0.000, which is statistically significant indicating that age and hypotension are dependent variables.

P value for Difference VAS score Vs Hypotension is insignificant.

BACK PAIN Vs AGE & DIFFERENCE VAS

GROUP STATISTICS

	BACK PAIN	N	Mean	Std. Deviation	Std. Error Mean
AGE	PRESENT	14	50.93	6.044	1.615
	ABSENT	16	36.00	4.412	1.103
	PRESENT	14	7.29	1.437	.384
	ABSENT	16	6.50	.894	.224

INDEPENDENT SAMPLES TEST

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
AGE	Equal variances assumed	2.845	.103	7.794	28	.000	14.929	1.915	11.005	18.852
	Equal variances not assumed			7.632	23.518	.000	14.929	1.956	10.887	18.970
VAS DIFFERENCE	Equal variances assumed	6.275	.018	1.823	28	.079	.786	.431	-.097	1.669
	Equal variances not assumed			1.768	21.193	.092	.786	.444	-.138	1.710

P value for age Vs back pain is 0.000, which is statistically significant indicating that age and Back pain are dependent variables.

P value for Difference VAS score Vs Back pain is insignificant.

SHOULDER PAIN Vs AGE & DIFFERENCE VAS

GROUP STATISTICS

	SHOULDER PAIN	N	Mean	Std. Deviation	Std. Error Mean
AGE	PRESENT	12	52.50	4.890	1.412
	ABSENT	18	36.61	4.539	1.070
VAS DIFFERENCE	PRESENT	12	7.25	1.422	.411
	ABSENT	18	6.61	1.037	.244

INDEPENDENT SAMPLES TEST

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
AGE	Equal variances assumed	.060	.808	9.110	28	.000	15.889	1.744	12.316	19.462
	Equal variances not assumed			8.971	22.471	.000	15.889	1.771	12.220	19.558
VAS DIFFERENCE	Equal variances assumed	2.698	.112	1.425	28	.165	.639	.448	-.280	1.557
	Equal variances not assumed			1.337	18.661	.197	.639	.478	-.362	1.640

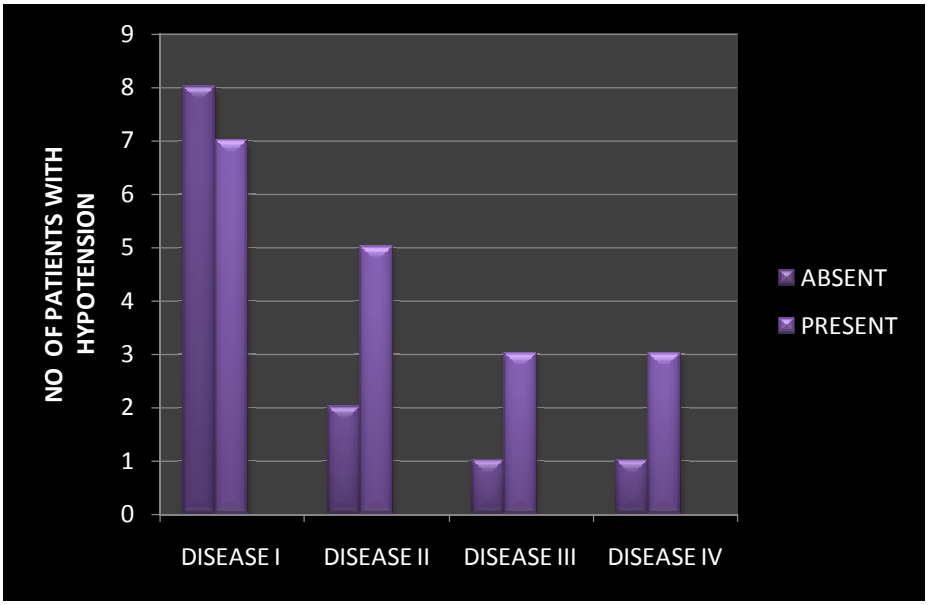
P value for age Vs shoulder pain is 0.000, which is statistically significant indicating that age and shoulder pain are dependent variables.

P value for Difference VAS score Vs shoulder pain is insignificant.

ANALYSIS OF COMPLICATIONS Vs DISEASE TYPE

HYPOTENSION Vs DISEASE TYPE

			HYPOTENSION		
			ABSENT	PRESENT	Total
DISEASE	1	Count	8	7	15
		% within HYPOTENSION	66.7%	38.9%	50.0%
		% of Total	26.7%	23.3%	50.0%
	2	Count	2	5	7
		% within HYPOTENSION	16.7%	27.8%	23.3%
		% of Total	6.7%	16.7%	23.3%
	3	Count	1	3	4
		% within HYPOTENSION	8.3%	16.7%	13.3%
		% of Total	3.3%	10.0%	13.3%
	4	Count	1	3	4
		% within HYPOTENSION	8.3%	16.7%	13.3%
		% of Total	3.3%	10.0%	13.3%
	Total	Count	12	18	30
		% within HYPOTENSION	100.0%	100.0%	100.0%
		% of Total	40.0%	60.0%	100.0%



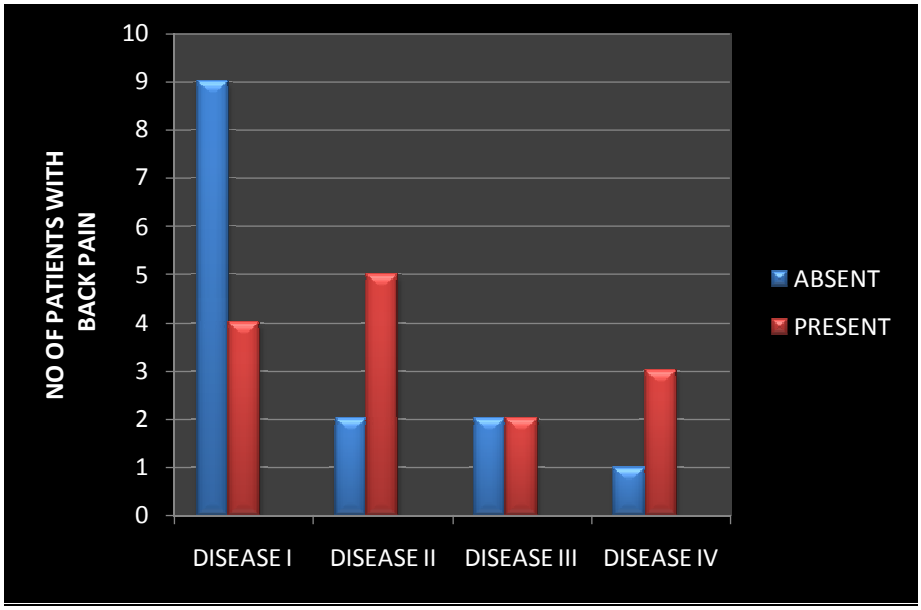
CHI-SQUARE TESTS

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.242[a]	3	.524
Likelihood Ratio	2.280	3	.516
Linear-by-Linear Association	1.676	1	.195
N of Valid Cases	30		

Disease type Vs hypotension analysis gives a Pearson Chi Square value of 0.524 which is statistically insignificant meaning both are independent.

BACK PAIN Vs DISEASE TYPE

			BACK PAIN		
			ABSENT	PRESENT	Total
DISEASE	1	Count	11	4	15
		% within BACK PAIN	68.8%	28.6%	50.0%
		% of Total	36.7%	13.3%	50.0%
	2	Count	2	5	7
		% within BACK PAIN	12.5%	35.7%	23.3%
		% of Total	6.7%	16.7%	23.3%
	3	Count	2	2	4
		% within BACK PAIN	12.5%	14.3%	13.3%
		% of Total	6.7%	6.7%	13.3%
	4	Count	1	3	4
		% within BACK PAIN	6.3%	21.4%	13.3%
		% of Total	3.3%	10.0%	13.3%
	Total	Count	16	14	30
		% within BACK PAIN	100.0%	100.0%	100.0%
		% of Total	53.3%	46.7%	100.0%



CHI SQUARE TESTS

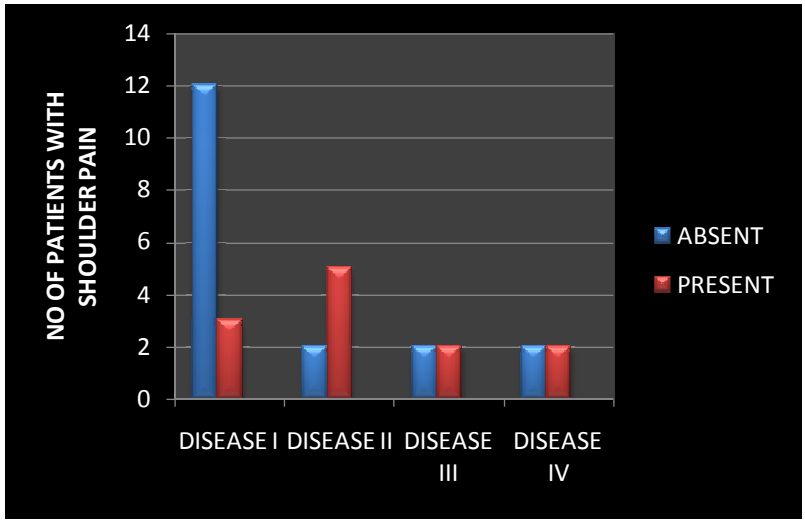
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.443[a]	3	.142
Likelihood Ratio	5.638	3	.131
Linear-by-Linear Association	3.264	1	.071
N of Valid Cases	30		

Disease type Vs back pain analysis gives a Pearson Chi Square value of 0.142 which is statistically insignificant meaning both are independent.

SHOULDER PAIN Vs DISEASE TYPE

			SHOULDER PAIN		
			ABSENT	PRESENT	Total
DISEASE	1	Count	12	3	15
		% within SHOULDER PAIN	66.7%	25.0%	50.0%
		% of Total	40.0%	10.0%	50.0%
	2	Count	2	5	7

		% within SHOULDER PAIN	11.1%	41.7%	23.3%
		% of Total	6.7%	16.7%	23.3%
	3	Count	2	2	4
		% within SHOULDER PAIN	11.1%	16.7%	13.3%
		% of Total	6.7%	6.7%	13.3%
	4	Count	2	2	4
		% within SHOULDER PAIN	11.1%	16.7%	13.3%
		% of Total	6.7%	6.7%	13.3%
	Total	Count	18	12	30
		% within SHOULDER PAIN	100.0%	100.0%	100.0%
		% of Total	60.0%	40.0%	100.0%



CHI SQUARE TESTS

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.714[a]	3	.126
Likelihood Ratio	5.902	3	.116
Linear-by-Linear Association	2.048	1	.152
N of Valid Cases	30		

Disease type Vs shoulder pain analysis gives a Pearson value of 0.126 which is statistically insignificant meaning both are independent.

CONCLUSION

CONCLUSION

1) *Mean percentage reduction of pain intensity between preprocedure VAS score and Immediate post procedure VAS score, immediate post procedure and 24 hours score, 24 hours and 1 week score and preprocedure and 2 months score are 55%, 32%, 31% and 80% respectively, all of which were statistically significant.*
2) *The pain intensity score remained static from 1 week to 2 months post procedure.*
3) *A negative correlation with statistical significance was observed between preprocedure score and 2 months score.*
4) *A positive correlation with statistical significance was seen for Age with Immediate postprocedure, 1 day and Difference VAS score.*
5) *A positive correlation with statistical significance was seen between preprocedure and Immediate post procedure, Immediate post procedure and 24 hours, 1 week with 1 and 2 months, 1 month and 2 months, preprocedure and difference VAS scores.*
6) *A negative correlation with statistical significance is seen for preprocedure with 1 week score, Difference score with 1 week, 1 month and 2 months.*

7) *Gender does not have any statistical significance in the VAS scores or in the response to procedure.*
8) *For preprocedure VAS score, the mean difference in within subject analysis is statistically significant for preprocedure VAS and immediate post procedure score.*
9) *For Immediate post procedure score, the mean difference in within subject analysis is statistically significant for preprocedure with 24 hours and 1 week and for immediate postprocedure score with 24 hours score.*
10) *For 24 hours score, , the mean difference in within subject analysis is not statistically significant for any of the scores.*
11) *For Difference VAS score, the mean difference in within subject analysis is statistically significant for preprocedure with immediate post procedure, 24 hours and 1 week.*
12) *For Difference VAS score, the mean difference in within subject analysis is not statistically significant for immediate post procedure with 24 hours and 1 week.*
13) *There is difference in the Variances of differences between all possible pairs of groups with statistical significance indicating, there is a true reduction in pain intensity post procedure.*
14) *Procedure was more effective for malignancies than inflammatory condition.*

15) *Maximum percentage reduction in pain, of 88% was seen with pancreatic carcinoma.*

16) *Least percentage reduction in pain, of 74% was seen with Chronic pancreatitis.*

17) *Hypotension was the commonest complication seen in 18 patients (9 males and 9 females). All these patients settled with intravenous fluids.*

18) *Back pain was the second most common complication, seen in 14 patients (6 males and 8 females).*

19) *Shoulder pain was seen in 12 patients (6 males and 6 females).*

20) *Absence of pain relief was not reported in this study.*

21) *Complications were independent of Gender and Difference VAS score.*

22) *Complications were dependent on Age with statistical significance.*

LIMITATIONS –

1) *Sample size is only 30.*
2) *Number of patients in each disease type are not equal and also too small in the third and fourth type and hence the results cannot be generalised.*
3) *Follow up is done only up to 2 months. Hence the long term benefits or worsening of pain beyond 2 months is not known.*

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PROFORMA

BARNARD INSTITUTE OF RADIOLOGY

INTERVENTIONAL RADIOLOGY DIVISION

CT guided neurolytic procedures

Name: ***Age:*** ***Sex:***

Address: ***Mobile:***

I.P.No: ***Ward:***

Department:

Indication:

Diagnosis:

History of present illness:

Past history:

Treatment history:

Details of Analgesic medication:

Drug	***Dosage***	***Duration***

Evaluation of pain Pre procedure:

Site: ***Intensity:***

Visual Analog Scale (VAS)

No pain 0 …….. 10 Worst possible pain

Graceleys Verbal Descriptor Scale:

0 ……10

Procedural/Post procedural complication:

Follow up:

Time Interval	***VAS***	***GVDS***	***Category scale***	***Analgesic Dose***	***Remarks***
IMMEDIATE					
24 HOURS					
1 WEEK					
1 MONTH					
2 MONTHS					
6 MONTHS					

Repeat of procedure (if any):

Date: ***Signature***

Place:

MASTER CHART

CT GUIDED CELIAC PLEXUS NEUROLYSIS

S.NO	AGE	SEX	DISEASE	VISUAL ANALOG SCALE							COMPLICATIONS		
				PPVAS 1	VAS 2	VAS 3	VAS 4	VAS 5	VAS 6	1-6	HYPOTENSION	BACK PAIN	SHOULDER PAIN
1	28	M	I	9	4	3	2	2	2	7			
2	34	F	I	8	3	2	2	2	2	6			
3	39	M	III	10	5	3	2	2	2	8	Present		
4	42	M	I	8	4	3	2	2	2	6	Present		
5	58	F	III	10	5	3	2	2	2	8	Present	Present	Present
6	32	M	I	8	3	2	2	2	2	6			
7	59	M	III	10	5	3	1	1	1	9	Present	Present	Present
8	41	F	I	7	4	3	2	2	2	5	Present		
9	34	M	I	8	3	2	2	2	2	6			
10	33	F	I	7	3	2	2	2	2	5			
11	44	M	I	8	4	2	2	2	2	6	Present		
12	47	F	II	9	4	3	1	1	1	8	Present	Present	Present
13	31	M	I	9	3	2	2	2	2	7			
14	38	F	II	9	4	2	2	2	2	7			
15	48	M	I	8	4	3	3	3	3	5	Present	Present	Present
16	52	F	IV	8	4	3	3	3	3	5	Present	Present	Present
17	33	M	I	9	4	3	2	2	2	7			
18	40	F	IV	10	4	2	1	1	1	9	Present	Present	
19	57	M	IV	9	5	4	2	2	2	7	Present	Present	Present
20	43	F	I	8	3	2	2	2	2	6	Present	Present	
21	37	M	II	8	3	2	1	1	1	7			
22	39	F	III	10	4	3	2	2	2	8			
23	55	M	II	9	4	3	1	1	1	8	Present	Present	Present
24	45	F	I	8	4	3	2	2	2	6	Present	Present	Present
25	33	M	I	8	4	3	2	2	2	6			
26	56	F	II	10	3	2	1	1	1	9	Present	Present	Present
27	53	M	II	9	4	2	1	1	1	8	Present	Present	Present
28	54	F	II	9	4	3	1	1	1	8	Present	Present	Present
29	46	M	I	8	4	3	2	2	2	6	Present	Present	Present
30	38	M	IV	9	4	3	2	2	2	7			

WORK SHEET

AGE GROUP			
YEARS	MALE	FEMALE	TOTAL
< 20	0	0	0
20 – 40	9	5	14
40 – 60	8	8	16
> 60	0	0	0

COMPLICATIONS									
	DISEASE I		DISEASE II		DISEASE III		DISEASE IV		TOTAL
CONDITION	M	F	M	F	M	F	M	F	
HYPOTENSION	4	3	2	3	2	1	1	2	18
BACK PAIN	2	2	2	3	1	1	1	2	14
SHOULDER PAIN	2	1	2	3	1	1	1	1	12
TOTAL	8	6	6	9	4	3	3	5	44

DISEASE CODING				
DISEASE	CODE	TOTAL	MALE	FEMALE
CHRONIC PANCREATITIS	I	15	10	5
PANCREATIC CARCINOMA	II	7	3	4
PERIAMPULLARY CARCINOMA	III	4	2	2
GASTRIC CARCINOMA	IV	4	2	2

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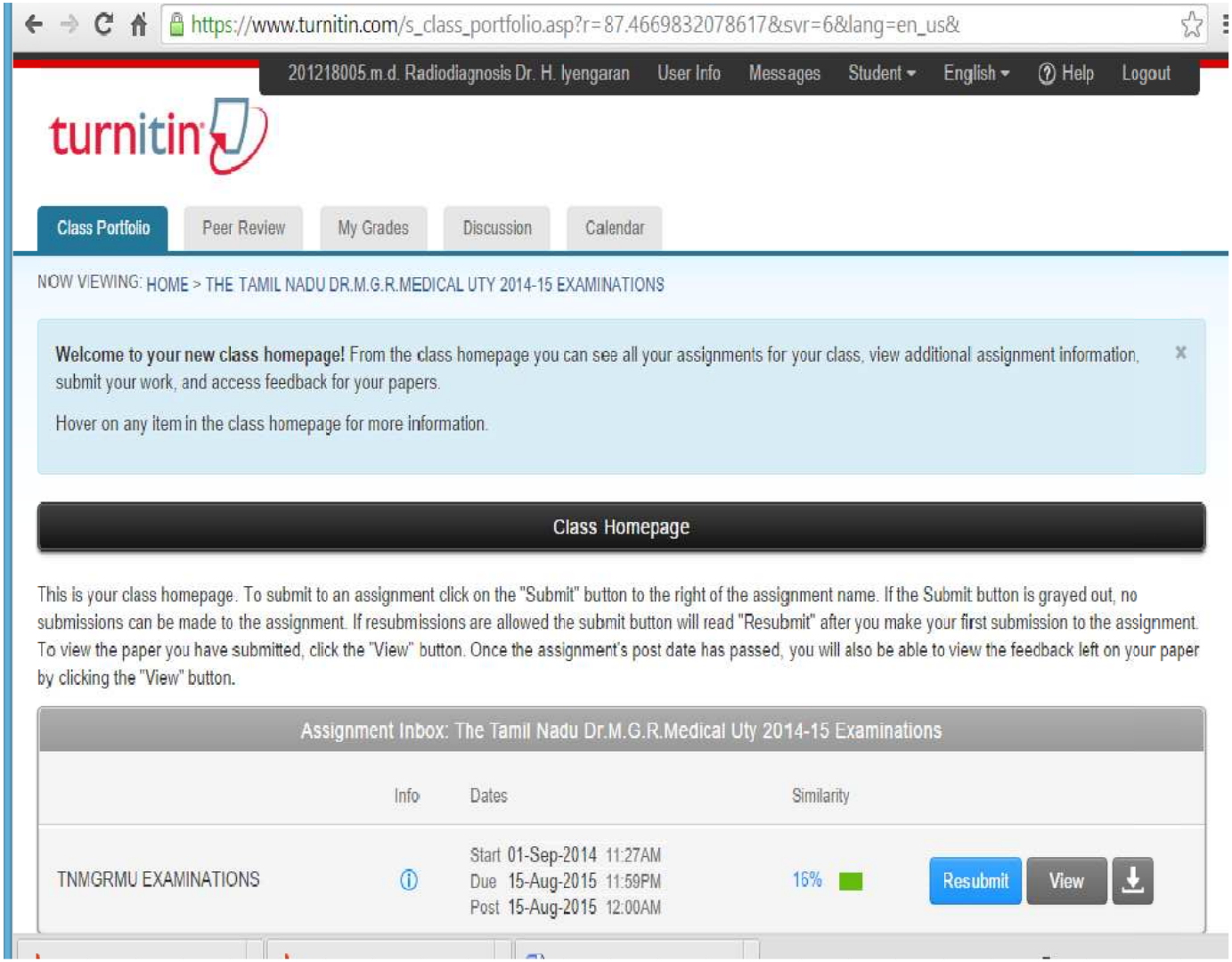
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