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Comparison between Radiofrequency ablation and Chemical Neurolysis of Thoracic Splanchnic Nerves for the Management of Abdominal Cancer Pain, Randomized trial

Running head: Radiofrequency and chemical neurolysis of splanchnic nerves for cancer pain.

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Abstract:

Background: Radiofrequency ablation (RFA) of the splanchnic nerves has been reported as a predictable and safe technique for abdominal pain management. We compare between RFA and chemical neurolysis of bilateral thoracic splanchnic nerves in the management of refractory cancer pain.

Methods: The study was conducted on 60 patients aged ≥ 18 years who suffered from abdominal pain (visceral pain, VAS ≥ 4) due to upper abdominal cancers. Participants were randomised into two groups. Group

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I (RF): 30 participants received a bilateral splanchnic nerve block at T10 and T11 levels using RFA. Group II (alcohol): 30 participants received a bilateral splanchnic nerve block at T11 using alcohol. Pain relief was assessed using VAS (0-10) and total daily oral opioid consumption (primary outcome).

Results: Significant reductions of VAS and global perceived effect satisfaction scores (GPES) were observed in both groups compared to baseline levels ($P < 0.001$); Group I had the largest reduction. MST consumption and QOL scores improved significantly in both groups ($P<0.001$). Oral opioid consumption started to reduce at the end of the first post-interventional week for Group I, 0.00 (0 - 45 mg), and at the end of the second post-interventional week for Group II, 20.00 (0 - 135 mg). No major complications were recorded in either group.

Conclusion: Simultaneous bilateral pain block of splanchnic nerves at the levels of T10 and T11 using RFA is more effective than using alcohol at a single level of T11 in cancer patients presenting with upper abdominal pain. The RFA intervention acted faster, provided longer duration analgesia, worked in a higher proportion of patients, and had a better safety profile than the alcohol intervention.

Introduction

Among the many symptoms of cancer, which frequently include physical, psychological and existential symptoms, it can be argued that pain is the symptom that has the biggest impact on the life of the patient. Persistent pain negatively impacts patient quality of life (QOL) and profoundly influences the ability of a patient to comply with

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treatment, return to normal health as a cancer survivor, or reach a peaceful death (van den Beuken-van Everdingen et al., 2007)..

The blockade or ablation of thoracic splanchnic nerves and celiac ganglia plays a major role in the pain management of most upper abdominal disorders, particularly chronic pancreatitis and pancreatic malignancies (Gest and Hildebrandt, 2010).

Pain management in the early part of the 20th century involved extensive use of chemicals for nerve destruction as a means of promoting analgesia (Wojcicki and Milkiewicz 2012).

Radiofrequency ablation (RFA) is a minimally invasive technique that is performed under local anaesthesia and with fluoroscopic guidance. RFA of splanchnic nerves has been reported to be predictable and safe technique for the management of abdominal pain; evidence, however, is rather limited and more research is needed to fully demonstrate its efficacy when compared to chemical neurolysis of splanchnic nerves (Raj et al., 2002).

In this study we compare the efficacy, safety and impact on patient QOL of RFA and chemical neurolysis of bilateral thoracic splanchnic nerves in the management of refractory pain in patients with upper abdominal cancer.

Patients and methods

This study, which is a prospective randomised clinical trial, was carried out in the South Egypt Cancer Institute (SECI) of Assuit

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University, Egypt. The study was registered at www.clinicaltrials.gov with registration numberNCT03063112, and it was conducted according to the 2013 version of the Declaration of Helsinki. The study participants were 60 upper abdominal cancer patients aged ≥ 18 years who suffered from abdominal pain (visceral pain with VAS ≥ 4) due to their cancer. The participants all received injections as a part of palliative care (but not end-of-life care) or at the end of chemotherapy treatment. Participants were randomly assigned to one of two study groups:

- **Group I (RF)**: thirty patients, for whom bilateral thoracic splanchnic nerve block was performed by RFA at two levels, T10 and T11.

- **Group II (alcohol):** thirty patients, for whom bilateral thoracic splanchnic nerves block was performed by using chemical neurolytic agent (alcohol) at one level, T11.

Patients were excluded from the study if they met at least one of the following criteria:organ failure, coagulation disorders, local infection at the puncture site, sepsis, allergy to the contrast dye or alcohol, severe displacement of intra-abdominal structures, pregnant women, orpsychiatric illness that affected cooperation. In order to avoid bleeding and haematoma formation, prior to receiving the nerve block, patients underwent a complete blood workup as well as testing for prothrombin time, international normalised ratio and bleeding time.

The study was approved by the local ethics committee, and study participants all gave written informed consent after receiving information regarding the study procedures and possible complications.

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Participants were unaware of which study group that they had been assigned to.

Before performing the nerve block, an intravenous cannula (18-gauge) was inserted into a large vein and 500 ml of Ringers lactate was administered in order to avoid hypotension. All participants were sedated with low but incrementally increasing doses of fentanyl (1mic/kg), midazolam (0.01- 0.02 mg/kg) and propofol (0.5-1 mg/kg). Monitoring (ASA standard monitoring) consisted of non-invasive blood pressure, O_2% and continuous ECG. All procedures were carried out under strictly aseptic conditions, with sterile preparation and draping of participant backs.

The study researchers were all experienced in the use of fluoroscopy to guide the administration of nerve blocks in the theatre setting. Computed tomography (CT) offers an alternative means of guiding nerve block administration, but it has a key disadvantage that the patient must be transferred to the radiology department. Fluoroscopy has similar accuracy and ease of use to CT in the context of splanchnic block due to the proximity with bony landmarks and distance from local anatomical variations or local tumour spread.

Study participants were placed in the prone position with a pillow under their abdomen to flatten their spine and widen the intervertebral space. The C-arm was positioned at the side of the patient, perpendicular to their trunk and ipsilateral to the puncture site.

The inferior end plates of T10 toT12 were visualised as a single line in the posterior - anterior (PA) view, after cephalocaudal alignment. The

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C-arm image intensifier was then moved caudally until the projection of the costovertebral angle was in the cephalad position, near the middle of the vertebral body. The C-arm was then rotated by no more than 15 degrees in the oblique direction to the ipsilateral side so that the entry point was within 4cm of the midline; this positioning reduced the risk of pneumothorax.

Radiofrequency lesion

A metal forceps guide was placed on the participant's body in order for the tip of the forceps to project exactly on the lateral edge of the T10 vertebral body, just below the costovertebral angle; this was the skin entry point, which was no more than 4 cm from the spinous processes.

After local infiltration of 2% lidocaine at the puncture site, the RF cannula (Neurotherm RF cannula, 20-gauge, sharp curved, 100 mm length, 10 mm active tip) was inserted and advanced under tunnel vision, using the oblique view to see the end-on appearance of the needle, with the cannula tip facing the body of the vertebra. The cannula was advanced slowly and carefully. The final placement of the cannula was confirmed by viewing a PA image, where the cannula tip was in contact with the lateral border of the vertebra, below the costovertebral angle.

The depth of the cannula was verified using a lateral view and then advanced further, still or approximately in contact with the

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periosteum, until the active tip reached the region at the border between the anterior and middle third of the vertebral body**.**

This procedure was repeated at the T11 level, the stylets of the radiofrequency (RF) cannula were removed; the electrodes were then introduced into the cannula and connected to the RF generator. In order to ensure correct positions of both cannulas at two separate levels, and to exclude somatic nerve involvement, sensory stimulation was performed using a 50 Hz RF pulse of 2 ms width and voltage < 1.5 V; participants were expected to report abdominal pain that was similar to their original symptomatic pain or epigastric pressure. By performing stimulation before RFA of the splanchnic nerves, nearby somatic nerves were excluded from the block. RFA was performed for Group I participants for whom there was negative response of the somatic nerves, with or without epigastric pressure.

Motor stimulation was performed with a 2 Hz RF pulse of 2ms width, and voltage <3 V. Contractions of the intercostal muscles should not occur during the stimulation; contraction of these muscles indicates that the active tip of the electrode is too close to the somatic intercostals nerve. Therefore, in cases where intercostal muscles were observed to contract during stimulation, the electrode was advanced anteriorly by a few millimetres.

All the above steps were repeated on the other side. The four cannula positions were confirmed from the distribution of 0.5ml of contrast dye in both AP view (Fig. 1) and lateral view (Fig. 2) as follows**:** hugging the lateral edge of thoracic vertebra, free spread up and down, retrocurural spread, no retrograde spread to somatic nerves, did not

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exceed the facetal line, and negative aspiration for air, blood, lymph or cerebrospinal fluid.

Four monopolar RF lesions were created simultaneously at 85°C and then, after a 90 second delay, another lesion was created after a 180 degree needle rotation, along with repeated sensory and motor stimulation. Immediately before the creation of each lesion, 1 ml dexamethasone (4 mg) and 2 ml of 2% lidocaine were administered to reduce postoperative tissue oedema and discomfort and burn pain during lesion creation.

Chemical neurolysis

The same steps as those used in the RF block were performed at the level of the T11 vertebra using a 20-gauge 10 cm Chiba needle but, instead of thermocoagulation, bilateral chemical (alcohol) neurolysis was performed. Needle position was confirmed by observing the distribution of 0.5ml of contrast dye in both AP and lateral views. A total volume of 20 ml (12 ml of 100% alcohol, 6 ml of 2% lidocaine, 2 ml of 8 mg dexamethasone) was injected in two 10 ml doses, one on each side of T11 vertebra. In order to avoid track formation and tissue necrosis due to alcoholspread,1 ml of 0.9% normal saline was injected during needle withdrawal.

Post-injection

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All participants were observed closely and compared for post-injection complications as well as indications of a good sympathetic block and unopposed parasympathetic activity such as hypotension, diarrhoea, and colicky pain. The duration of neurolytic technique and post-procedure hospitalisation were recorded.

Participants were discharged from the hospital after obtaining a normal chest radiograph and normal vital signs were observed by medical personnel and after a total period of six hours. Due to the risk of an undiagnosed pneumothorax, all participants were advised to sleep close to a medical facility on the first night following hospital discharge.

Follow-up assessments and post-intervention data collection were performed by a junior physician in the pain clinic of the institute; this physician was unaware of which study group each participant had been assigned to. The primary data that was collected at the follow-up assessment (primary outcomes) was total daily opioid consumption at an equianalgesic dose of oral morphine (participants had unrestricted opioid access) (morphine sulphate tablets, MST) in mg (according to Janssen pharmaceutics, Inc, 1991 clinical monograph).

The degree of pain relief was assessed using a visual analogue scale (VAS) on a linear scale of 0 to 10 (with 0 representing no pain and10 representing the worst pain) (Kjeldsen et al., 2016).

The secondary outcomes were:

- Patient satisfaction score (global perceived effect satisfaction score, GPES) after pain therapy, on a scale of 1-7 (with 1 representing full pain relief and patient satisfaction, and 7

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representing no pain relief and no patient satisfaction) (Dworkin et al., 2008).

- Quality of life (QOL), assessed by the effect of pain on mood (psychological aspect), activity (functional capacity) and sleep; the short form of the Brief Pain Inventory (BPI) was used (Cleeland, 1991).

QOL assessment included the following parameters, adopted from the short form BPI:

Sleep score [scale of 0-5]: normal rhythm [0], interrupted [1], insufficient [2], disturbed [3], hard by hypnotics [4], or no sleep [5].

Work activity score [scale of 0-5]: in work [0], sick leave [1], home activity [2], limited [3], isolated [4], or bed ridden [5].

Psychological mood score [scale of 0-5]: balanced [0], worried [1], anxious [2], hypochondriac [3], depressed [4], or nervous breakdown [5].

These scores were recorded both before (baseline) and after intervention on the day of intervention (D1), then one week (W1) and two weeks (W2) after intervention, and then monthly starting at the fourth week, for three further months (W4, W8, W12).

Any complications that occurred during or after the pain interventions were recorded (e.g., hypotension, diarrhoea or colicky pain).

Statistical analyses

All analyses were performed using SPSS® (Statistical Package for Social Sciences) software, version 22.0, Chicago, IL, USA. Categorical variables were expressed as frequencies and percentages. Chi-square test was used for testing proportion independence and Fisher Exact tests were

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used if the expected number of observations in 25% or more of the cells was less than five. Mean and standard deviations were used to describe quantitative data, and the median (with its range) was used to describe ordinal data. Student's t-test was used to compare means, the Mann-Whitney U test was used to compare medians of two independent groups, the Friedman test was used to compare medians of more than two dependent or repeated measures, and the Wilcoxon signed-rank test was used to perform pairwise comparisons; all comparisons were Bonferroni corrected. All P-values were two-tailed, and the significance level was set at 0.05.

Sample size calculation

Based on a similar study of Papadopoulos et al., which demonstrated the efficacy of RFA in reducing fentanyl consumption by patients with pancreatic cancer pain, baseline and three-month fentanyl consumption values were measured in Group I (RF) participants (Papadopoulos et al., 2013).

Significance level or probability of type I error = 0.05, power of the test statistics to be 90%, expected within group standard deviation of 400 and a critical difference of 387 (drop in fentanyl consumption) and ratio Sample Size $_{\text{Group II}}$ / Sample Size $_{\text{Group I}}$ = 1, a minimum of 23 patients per group with a total of 46 patients are sufficient to see that effect.

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Results

One hundred and sixty-four patients were assessed for eligibility, of whom60 did not meet the inclusion criteria (mainly due to laboratory abnormalities), and 25 of whom declined to participate. Therefore, the study initially had 79 participants; 38 participants were randomised into Group I (RF) and 41 into Group II (alcohol). Following randomisation, eleven participants (five from Group I and six from Group II) were excluded due to changes in their pain characteristics (development of neuropathic or somatic pain, or distant metastatic pain). Eight participants died in the follow-up period (three from Group I and five from Group II). Therefore, 60 participants were included in the study, 30 in each group.

At enrolment, all participants had a Karnofsky score in the range 70 to 80. Karnofsky score was not mentioned because we used to assess the impact of the intervention on post-intervention parameters such as opioid use and QOL. The two study groups had comparable demographic data in terms of age, gender, diagnosis and post-intervention hospitalisation length (Table1).The time needed to perform the splanchnic block by alcohol was shorter than the time needed to perform the block by RF ($P< 0.001$).

Median VAS values were similar in both study groups before intervention ($P = 0.927$) and on D1 post-intervention ($P = 0.172$). The VAS showed maximum reduction (85.71%) after one week for Group I (RF) participants, and on Day 1(under effect of LA and sedating drugs) and week two for Group II (alcohol) participants (42.85%).

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When compared to the baseline, a reduction of VAS was observed 30 minutes after the intervention for both groups ($P < 0.001$ for both groups). The reduced VAS remained until the end of the three-month follow-up period for Group I (RF) participants. For Group II (alcohol) participants, the initial reduction of VAS lasted for two months, but VAS returned to baseline levels at the three-month follow-up(W12).

Although the VAS reduction was significant in both groups, the VAS values were lower in Group I (RF) than Group II (alcohol) from W1 until the end of follow-up, when they had not returned to baseline values ($P< 0.001$).

A significant reduction in median MST consumption was observed for both groups during the first 24 hours post-intervention when compared to the baseline consumption ($P < 0.001$).The biggest median (range) reduction of MST consumption, 0.00 (0 - 45 mg), started at the end of W1 for Group I (RF), and in W2 for Group II (alcohol), 20.00 (0 - 135 mg).

When compared to baseline levels, the median MST consumption reduced significantly from D1 until the end of the follow-up period in Group I (RF), and from D1 until W2in Group II (alcohol). For Group II (alcohol) there were no further significant reductions after W2.

Median MEAD (morphine effective analgesic dose) levels were the same at baseline ($P = 0.934$) and on D1 ($P = 0.847$) for both study groups. The Group I (RF) intervention resulted in a more reduction in median oral morphine consumption than the Group II (alcohol) intervention from W1 until the end of the study follow-up ($P <$

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0.001).This difference was the greatest at the end of W1, W8 and W12 (P = 0.001).

A reduction of GPES from baseline levels was observed 30 minutes post-intervention in both groups (P < 0.001). GPES remained at a significantly reduced level until the end of the three month follow-up period for Group I (RF) but for Group II (alcohol) it increased after W8 and had returned to the baseline level by W12.

For Group I (RF), median GPES values decreased maximally (by 85.76%) after W1and continued to decrease until the end of the study follow-up period. For Group II (alcohol), median GPES values had decreased to 41.68% at W2 and continued to until they had reached near-baseline values at the end of the study follow-up period.

Pre-intervention median GPES values were similar in both study groups (P = 0.678), and they were not significantly different at D1 (P = 0.08). The median GPES value became significantly different between the groups at W1, when Group I (RF) showed a more GPES reduction than Group II (alcohol); this difference continued until the end of the study follow-up and median GPES values did not return to baseline values for either group (P < 0.001).

Pre-intervention QOL scores were similar in both groups (P = 1.00), and there were no significant QOL differences between the groups in D1. QOL could not be measured on D1 due to the effects of sedation, local anaesthetics and the occurrence of complications such as abdominal colic in most Group I (RF) participants and paresthesia with colic in Group II (alcohol) participants, both of which decreased

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QOL scores. QOL scores improved significantly for both groups when compared to the baseline values. This improvement appeared from W1 until W12for Group I (RF) and from W2 until W8 for Group II (alcohol), never returning to baseline values.

QOL scores were significantly lower in Group I (RF) compared to Group II (alcohol) from W1 until the end of the study follow-up period, except at W2 when a non-significant difference was observed.

Complications are detailed in Table 2.

- Transient paresthesia: zero participants from Group I (RF) and21 participants from Group II (alcohol) (70%) ($P < 0.001$), caused by alcohol spreading towards thoracic sensory nerves that pass paravertebrally, near the splanchnic ganglions.
- Abdominal colic: 22 participants from Group I (RF) (73.3%) and nine participants from Group II (alcohol) (30%) ($P = 0.001$).
- Diarrhoea, hypotension, injection pain and backache: observed in both groups, but with no significant difference between the groups ($P = 0.28$).
- No other complications were recorded.

Discussion

The results of our study reveal that blocking the splanchnic nerves bilaterally using RFA in the same session at a double level (T10 and T11) reduces pain more effectively than by using alcohol at a single level (T11). These results were obtained by measuring VAS and oral morphine consumption, with corresponding improvements in GPES and QOL.

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Pain is felt by approximately 80 – 85% of patients with non-operable pancreatic cancer, and conventional analgesics usually fail to produce satisfactory pain relief **(**Lee et al., 2012). A recent study by Papadopoulos et al. (2013) treated patients who had severe abdominal pain due to end-stage pancreatic cancer with systemic opioids (transdermal fentanyl or morphine) in addition to adjuvant drugs for one month until they were referred for interventional pain management because pain relief was insufficient.

One might expect the splanchnic nerve block (SNB), which administers alcohol with a single needle, to provide effective pain relief because the alcohol diffuses both up and down along the vertebrae to reach multiple levels of splanchnic nerves, thus causing a large area of neurolysis (Swerdlow 1978). However, the spreading of alcohol to adjacent structures, such somatic nerve roots, the artery of Adamkiewicz, or neuroaxially, may lead to more serious complications such as paresthesia or paraplegia (Jain et al., 1989).

In our study, the SNB in Group I was performed by a retrocrural approach under fluoroscopic guidance using RFA at the T10 and T11 levels. The advantage of using the T10 level is that it is located at the site of intersplanchnic connections between the greater splanchnic nerve and the lesser splanchnic nerve, as observed in 13 out of 38 patients in a study by Naidoo et al. (2001). T10 is also the location of the intermediate splanchnic ganglion,which is usually found in the lower part along the course of the GSN at the interval between GSN and LSN (Mitchell, 1953). Therefore, an SNB at this level may help in ablation of two major supply nerves and the intermediate splanchnic ganglion. In our study the initial

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lesion was created at 85°C for 90 seconds and another lesion was then created after a 180 degree needle rotation to ensure complete ablation; this procedure assisted the realisation of the best possible outcome. In contrast, Raj et al.(1999) performed SNB at the T11 and T12 levels, at a temperature of 80°C for 60 seconds, using curved needles in a tangential manner and large sized electrodes with long active tips.

To minimise the risk of pneumothorax, after alignment with the patient' spine, we moved the C-arm to a 15 degree oblique position to ensure close approximation of needle to the paravertebral space, as recommended by Puylaert et al. (2011). This resulted in a final entry point at the junction of the rib and vertebra at a distance of 3 - 4 cm paravertabrally, sufficiently far away from the lung.

Although the needle was sharp, in contrast to the blunt needle that was used by Papadopoulos et al.(2013),the curved needle, when used with fluoroscopy as described here, did not result in any reported cases of pneumothorax. It should be noted that adequate clinical experience and patient information, particularly concerning where to stay on the first night after discharge, were critical to the success of the intervention.

Boas (1989) recommended the use of 6% to 10% phenol for splanchnic nerve block due of a number of advantages over alcohol: phenol (i) can be combined with iodinated contrast medium (Omnipaque, which remains stable for up to three months), (ii) has a local anaesthetic effect, (iii) has a more rapid onset than alcohol, and (iv) causes less neuritis than alcohol (Boas, 1989; Raj, 2004).

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In the present study, we chose to use 60% alcohol rather than phenol for two main reasons. Firstly, phenol has a stronger affinity for vascular than neurologic tissue. Secondly, phenol is not available 'off-the-shelf' since it is photo-sensitive and must, therefore, be freshly prepared for each patient by a pharmacist (Nour-Eldin, 1970).

There are two potential reasons for the longer time required to perform RFA than alcohol neurolysis. Firstly, four needles were inserted to achieve the bilateral block of two levels. Second, three minutes were needed to create the lesions (an initial 90 seconds, then another 90 seconds after the simultaneous 180 degree rotation of the four needles) while, for the Group II (alcohol), a single level bilateral needle insertion was performed with just ten seconds required for the injection of alcohol on each side.

The present study used the same method as Papadopouloset al, (2013) which carried on 35 pancreatic cancer patients and used the same approach and lesion setting parameters of RFA for SNB, but at levels of T11 & T12. The authors reported a mean time required to perform the block of 65 minutes (range 60–90), comparable to the results for Group I (RF) in the present study.

For Group I (RF) in our study, RFA resulted in reduced median VAS, opioid consumption (MST), patient satisfaction (GPES) and QOL scores (sleep, work and mood) from D1 and the reduction remained significant until the end of the study follow-up period. All scores increased slightly at the W12 follow-up due to disease progression, but they remained significantly lower than the pre-intervention values.

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Our results are in agreement with those of Papadopoulos et al. (2013), who found pain and consumption of fentanyl to be significantly reduced and QOL to be significantly improved for all patients during the first four post-interventional months when compared to baseline values. The authors noted a slight, but not statistically significant, increase in opioid consumption and deterioration of QOL five months post-intervention (Papadopoulos et al., 2013).

In another study, Garcea et al. (2005) applied RFA to the splanchnic nerves to treat ten patients with chronic pain due to chronic pancreatitis; they reported that, at the 24 month follow-up, these patients had decreased pain scores and opioid consumption, they had reduced need for hospital admissions due to acute pain, and other key parameters, such as mood and QOL, were also improved.

Verhaegh et al. (2012), in a study of eleven patients with chronic pancreatitis, performed percutaneous RFA of the splanchnic nerves at the T11 and T12 levels, creating two lesions (60 second duration, 80°C RFA); the procedure was repeated on the opposite sidein cases of bilateral pain. The mean numerical rating scale (NRS) decreased significantly across the entire patient group, with most patients reducing or stopping their use of analgesic drugs after the intervention; three patients did not respond to the intervention and continued their pre-interventional analgesic use (Verhaegh et al., 2012).

In our study, the neurolytic block resulted in a significant reduction of VAS and GPES scores of the Group II (alcohol) participants at W8, but pre-interventional scores were restored by W12. MST and QOL scores showed a significantly reduction from D1 up to W2, with no

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further reductions after this timepoint; baseline levels were not restored during the study follow-up period. Four participants, all of which had pancreatic cancer, reported complete pain relief.

Varnken et al. (2001) demonstrated a significant improvement in both the functional and physical aspects of QOL after chemical celiac plexus block CPB/SNB in patients with pain due to cancer who were under a pharmacological treatment regimen. These patients did not show any pain relief in the two weeks following neurolysis. This finding contrasts with the results of our study, probably due to individual characteristics of the patients such as personality, euthenics and cultural and religious background (Vranken et al., 2001; Kawamata et al., 1996).

The D1 median levels of VAS, MST consumption, GPES and QOL were unchanged when compared to pre-intervention (baseline) levels for both groups in the present study. The reductions that were observed in the period W1 to W12 were significant in both groups, with a greater reduction seen in Group I (RF) compared to Group II (alcohol).

De Leon-Casasola(2000) suggested that pain blocks can fail due to the pain associated with cancer being somatic, visceral, or neuropathic in origin.

One of the earliest and largest studies that investigates RFA success rates is that of Raj et al. (2002), who performed SNB using RFA in 107 patients with abdominal pain of malignant and non-malignant origin. They reported that up to 40% of their study participants experienced excellent pain relief, consistent with the results of the present study. Also consistent with the results of both the present study

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and that of Raj et al. is the study of Verhaeghet al., who reported a complete pain block (NRS = 0) in two patients, an excellent pain block (> 75% reduction in pain score) in six (33%) patients, and a good pain block (> 50% reduction) in 14 (78%) patients.

Koyyalagunta et al. (2016) performed a retrospective chart review of 93 patients who underwent SNB in order to compare the relative effectiveness of alcohol and phenol. The authors reported a success rate of chemical SNB and results that are comparable with those of the present study. Furthermore, the authors found no significant difference in the rate of response from patients who underwent neurolysis using alcohol vs. phenol.

In the present study, most pain block side effects were transient (lasting <seven days), resolving spontaneously without treatment; the side-effects, therefore, did not affect the overall acceptance and efficacy of the intervention. Specifically, hypotension was managed by the administration of intravenous fluids and no major complications were recorded (e.g.; pneumothorax or paraplegia).

A number of complications have been reported from the use of RFA for SNB in the literature. Papadopoulos et al. (2013) reported temporary diarrhoea in eleven patients and temporary intestinal colic in five patients. Garcea et al. (2005) reported self-resolving diarrhoea and Verhaegh et al. (2012) reported temporal hypoesthesia of the flank. Koyyalagunta et al. (2016), who used chemical neurolysis for SNB, reported that two patients suffered from symptomatic hypotension, which they treated with intravenous fluids.

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We conclude that, in cancer patients presenting with upper abdominal pain, a simultaneous bilateral pain block of the splanchnic nerves at the double level of T10 and T11 using RFA is more effective than using alcohol at a single level of T11, as demonstrated through VAS, GPES, oral morphine consumption and quality of life (sleep, work activity and psychological state) scores as a proxy for pain. The RFA intervention acted more rapidly, provided a longer duration analgesia, worked in a higher proportion of patients, and had a better safety profile than the alcohol intervention. Nonetheless, we found the alcohol intervention to provide a good alternative to the RFA intervention for treatment of upper abdominal cancer pain.

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Figure legend:

Fig (1) AP view showing distribution of dye which hugging lateral borders of T10&T11 vertebrae bilaterally

Fig (2) Lateral view showing distribution of dye longitudinally at anterior part of the T10&T11 vertebrae

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Table (1) Demographic data of patients included in this study

		Groups				
		RFG		AG		P value
		Mean ± SD		Mean ± SD		
Age (years)		57.30 ± 14.02		60.03 ± 13.32		0.17
Duration of procedure (Minutes)		56.70 ± 8.45		47.40 ± 10.03		< 0.001*
Length of hospital stay (Hours)		7.80 ± 2.40		8.20 ± 2.70		0 .92
		No	%	No	%	
Sex	-Females	14	46.0	13	43.3	
	-Males	16	54.0	17	53.7	0.90
Diagnosis	-Adrenal gland	0	0.0	1	3.3	
	-Duodenal	1	3.3	1	3.3	
	-Gall bladder	4	13.3	1	3.3	
	-Hcc	5	16.7	5	16.7	
	-HFL	4	13.3	4	13.3	
	-Esophagus	1	3.3	2	6.7	
	-Pancreas	10	33.3	13	43.3	
	-Peritoneal mass	0	0.0	1	3.3	
	-Retro-peritoneal mass	1	3.3	0	0.0	
	-Right colon	1	3.3	0	0.0	
	-Stomach	2	6.7	2	6.7	
	-Suprarenal mass	1	3.3	0	0.0	

RFG: Radiofrequency group

AG: Alcohol group

NO: Number of patients

HCC: Hepatocellular carcinoma

HFL: Hepatic focal lesion

P value is significant <0.05*

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Table (2) shows the complications were occurred in the RF and alcohol groups.

		Groups				
		RF		Alcohol		P value *
		No	%	No	%	
Paresthesia	No	30	100.0	9	30.0	
	Yes	0	0.0	21	70.0	< 0.001*
	Total	30	100.0	30	100.0	
Colic	No	8	26.7	21	70.0	
	Yes	22	73.3	9	30.0	0.001*
	Total	30	100.0	30	100.0	
Diarrhea	No	17	56.7	21	70.0	
	Yes	13	43.3	9	30.0	0.28
	Total	30	100.0	30	100.0	
Hypotension	No	21	70.0	20	66.6	
	Yes	9	30.0	10	33.4	0.96
	Total	30	100.0	30	100.0	
Injection pain	No	18	60.0	20	66.6	
	Yes	12	40.0	10	33.4	0.52
	Total	30	100.0	30	100.0	
Backache	No	26	86.7	28	93.3	
	Yes	4	13.3	2	6.7	0.82
	Total	30	100.0	30	100.0	

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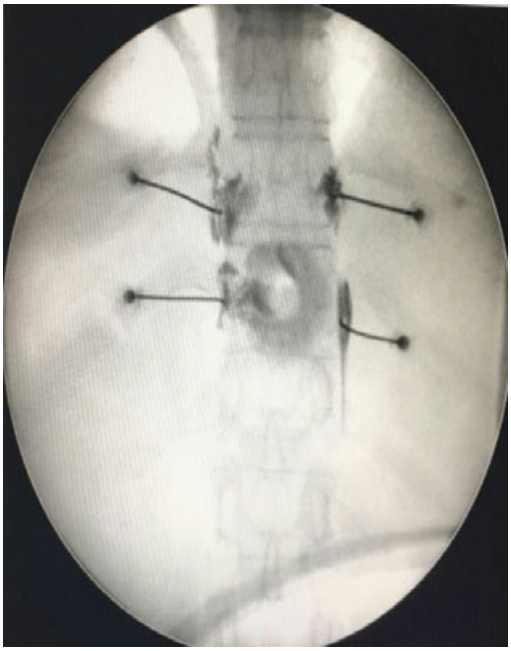

Fig (1) AP view showing distribution of dye which hugging lateral borders of T10&T11 vertebra bilaterally

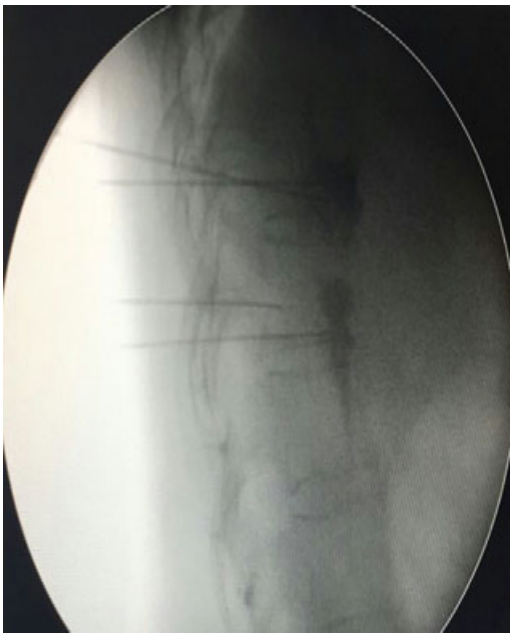

Fig (2) Lateral view showing distribution of dye longitudinally at anterior part of the T10&T11 vertebra

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