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Case Report,

Ultrasound Guided Erector Spinae Plane Block with Ozone & Corticosteroid for the Management of Discogenic Back Pain: A Case Report

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Abstract:

Lumbar fluoroscopic or CT-guided intra-discal ozone injections with or without corticosteroid, have reportedly been a successful back pain-sciatica treatment. Ozone may also enhance the longevity of corticosteroid anti-inflammatory effects. However, growing evidence that the mere act of needle puncturing the intervertebral disc may inadvertently set off an annular degenerative cascade taking several years to manifest, has prompted a search for less invasive yet effective alternatives. Ultrasound Guided (USG) Erector spinae plane (ESPB) blocks may offer a relatively safer, less technically challenging alternative to intra-discal ozone injection by means of diffusing ozone through tissues into the gas-permeable annulus, rather than injecting ozone into the disc itself. ESPB is a relatively new procedure and its use with ozone in DLBP management has not yet been described in the literature. This paper details the management of a 40-year-old male chef suffering from disabling low back pain and unilateral lower limb radiculopathy using an ESBP with Ozone-corticosteroid, with rapid-sustained pain relief, and restoration of sustained work-ADL function on 6 months follow up.

Keywords: Erector Spinae Plane Block, Ozone, Ultrasound

Introduction:

Ozone, also known as reactive oxygen, is composed of 3 oxygen atoms (O_3). It is an unstable gas with a distinctively pungent smell. Since the 1800s, ozone (O_3) has had water and wound disinfection usage, with proven beneficial effects and minimal side effects in the treatment of a number of diseases, including discogenic back pain, [1], and chronic neuropathic pain. [2] More recently, ozone antioxidation effects has been widely used for clinical analgesia, to reduce systemic inflammation and manage disc herniation pain and osteoarthritis of the knee. [3] [4] [5] CT-guided puncture of the intervertebral discs with low concentrations of medical ozone (20 µg-40 µg/ml) offers analgesia-anti-inflammatory effects, via a reduction in serum IL-6, IgG, and IgM expression. [6] Fluoroscopy-guided Lumbar Ozone Disc Injection (FLODI), is also useful modality in managing mechanical disc nerve root compression pain [7], and systemic review and meta-analysis demonstrated that percutaneous FLODI yielded positive results with low morbidity rates. [8] Unfortunately intradiscal injections are known to cause latent complications which may take years to manifest. In fact, cumulative evidence collected since 1948 to the present day, suggests that needle sticks to the inter-vertebral disc (IVD) 'sets the stage for a delayed inatrogenic onset of disc degeneration cascade with evolution to full thickness annular tears, and disc herniations in animal models. [9] [10] [11] [12] [13].

Recent meta-analysis has demonstrated that Erector Spinae Plane Blocks (ESPB), are effective

in decreasing postoperative pain intensity and postoperative opioid consumption in spine surgery. [14] Case reports have also concluded that lumbar ESPBs are technically simple and safe procedures for failed back surgery pain management. [15]. ESBP unlike IVD injections, may be capable of delivering therapeutic ozone to the disc without chance of IVD needle stick injury. It is for this reason that an alternative to intradiscal ozone injection had been trialed in this case report.

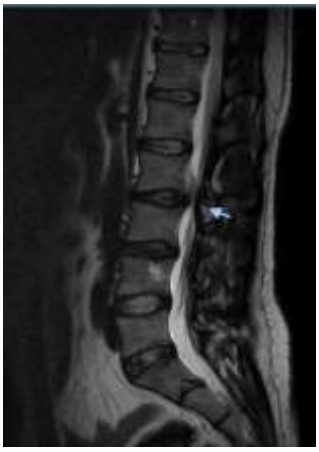
Case Report:

A 40 year old right handed male chef & restaurant owner presented with a history of sudden onset chronic severe back pain, right anterior thigh pain, paresthesia, right scrotal and groin pain, and right leg weakness with difficulty walking, activities of daily living disturbances and an inability to work. The symptoms onset had been 2 weeks before, when he had been paint-balling with his children and felt his back 'click.' He continued working and also played some football, but at the time of initial consultation, he had been off work for 5 days. He had also recently been discharged from a 3 days in-patient stay at a central London hospital, where he had been admitted for pain management and essentially negative urological investigations.

On initial presentation, he struggled to stand and walk, and displayed a marked antalgic limp while offloading the right lower limb; He also had extreme difficulty in transferring requiring his wife's assistance. The pain was extreme and immediate when standing, and relieved by lying down. Sitting was well tolerated. He described a disconnect between his low back and pelvis. Preliminary examination was grossly limited by a pulling pain in his right testicle and a progression of right anterior thigh-adductor pain, and thigh numbness, all of which had progressed over the past few days. His past history included hypermobility syndrome, He underwent urethral stricture dilation in 2004. A recent testicular ultrasound while he was hospitalized noted a testicular varicocele. He continued to experience break-through pain while taking co-codamol, ofloxacin Naproxen, dihydrocodeine, ibuprofen, and applying voltarol gel. He had no allergies to medications, was a non-smoker and drank occasional alcohol. He had worked as a chef and restaurant manager for many years. His is married with two sons and his wife is currently pregnant. There was a history of hypermobility in several family members, and one of his sisters has rheumatoid arthritis.

Initial examination was grossly limited by pain. The right greater than left Slump tests were positive and there was right L4/5 dermatomal paresthesia (numbness) of the right lower limb. Extensor hallucis longus, dorsi-flexor, and peroneal power were all full. Plantars were down going and dorsal pedal pulses intact were intact. Seated straight leg raise was limited to 45 degrees knee extension with crossed signs present. Deep tendon reflexes were symmetrical. Single leg standing on the right was possible on for a few seconds. There was palpable R mid-thoracic to lumbar paraspinal tension. An urgent lumbar MRI was requested and an USG caudal epidural was performed on the day. Unfortunately, on follow up several days latter, he reported that the caudal epidural only afforded a transient and partial pain relieving effect. He continued to experience severe right testicle pain post the CE, which was partially relieved by ibuprofen extra. Amitriptyline or Gabapentin were recommended.

The MRI reported noted a large, right L1-2 disc extrusion. [Figure 1]



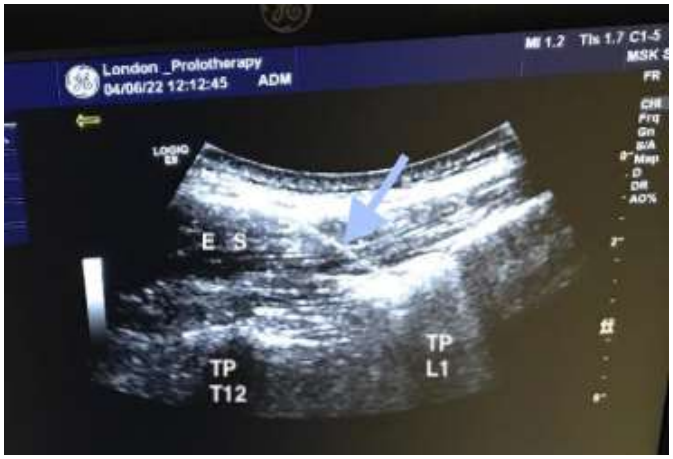


Figure 1: Sagittal T2-weighted MRI LS demonstrated a large L1-2 disc extrusion, Figure 2: USG CSI-Ozone injection R L1 TP-Blue arrow-needle shaft

A right USG ESPB using 40 mg Kenalog in 20 ml Lidocaine (CSI) was therefore performed at the right L1 level noting good cephalad-caudad fascial plain distribution. The syringe was then changed and 50 mg of 36 gamma ozone-oxygen was injected. 'Before getting off the table, he reported 100% pain relief of his LBP and also his groin, thigh and leg pain. He was then able to stand upright and walk completely pain free. His immediate concern then became that the pain would re-occur. The patient was advised to continue his current analgesia, and ADL modifications. He was followed up a week later and then had weekly follow ups. One week following the first right-sided ESPB he reported that he was 50% better, but continued to have right lateral hip pain and minor groin pain snaking down his right anterior thigh to above the knee. He continued to have difficulty with seated SLR. The testicular pain was also a little better and he described this pain as pulsing. The following wee he reported a massive 70% improvement. Inguinal and groin pain had disappeared with residual mid-thigh to above knee, with persistent thoracolumbar paraspinal pain He had worked as a chef for 5 hours 4 days ago and was sore the next today. His plan was to work 5 hours after treatment today stating he must as his staff was tired. Further right paraspinal and right anterior thigh groin ozone injections and some osteopathic manipulations were performed. He continued to have this treatment repeated a few times over the next several weeks during which complete sensation returned to his right thigh and the testicular pain abated. He continued to wear a back support while working and also started arm hanging exercises to stretch his back. He returned to full bicycle commuting and did a ballroom dancing. One month post the ESPB, he reported that the back pain remained greatly improved, but he had now become more aware of the R anterior thigh pain. Over the following several weeks, he followed a graded return to his full chef and restaurant owner duties and family vacation recreational activities. On six-month follow up he reported that other than some right thoracolumbar soreness after excessive standing-walking, he remained otherwise pain free without groin or thigh pain. He continued with a regular stretching and core strengthening maintenance program.

Discussion:

Since disc and endplate permeability-porosity increase with age and degeneration, the implication is that intra-discal cell dysfunction, rather than physical barriers to transport, accelerate disc disease. [16] These facts may also imply that this pathological increase disc permeability in DDD may be capitalized on with ozone ESPB, as diffusion of ozone would actually be facilitated be disc disease, allowing diffusion therapeutic substances into the disc by without actual needle puncture. There is also evidence that combining corticosteroid with Ozone may prolong analgesia, with one study noting oxygen-ozone injection last longer than those of steroid injection to the knee joint. [17], while another study plantar fasciitis injection study noted that corticosteroid was more effective at one week. [18] It was on these premises of physiological mechanisms, iatrogenic disc needle stick safety concerns and ESPB efficacy evidence for managing back pain, that an ESP-Corticosteroid-Ozone block in lieu of intra-discal ozone injection was trialled in this case.

Ozone, also known as reactive oxygen, is composed of 3 oxygen atoms (O_3). It is an unstable gas with a distinctively pungent smell. Ozone has an oxidation capacity, and it is safe for clinical applications. Numerous data have shown that ozone can eliminate oxygen free radicals by activating antioxidant enzymes, and it can maintain and restore the oxidation–antioxidant balance. Ozone interacts with biological molecules via ozone-initiated reactions and lipid oxidation reactions. Recently, ozone has been widely used for clinical analgesia, which is related to its antioxidation effects. [3]

Hormesis is a term used by toxicologists to refer to a biphasic dose response to an environmental agent characterized by low dose stimulation or beneficial effect and a high dose inhibitory or toxic effect. [19]

Provided that the ozone dosage is hormetically correct, ozone is not deleterious, but, acting as a pro-drug, it is actually capable of eliciting a

multitude of useful biological responses, possibly reversing chronic oxidative stress derived from degenerative processes. Indeed, the ozone-therapeutic act is interpreted as an atoxic but real "therapeutic shock" able to restore homeostasis. [20]

Fluoroscopy-guided Lumbar Ozone Disc Injection (FLODI), appears to be useful modality in managing mechanical disc nerve root compression pain [7], and systemic review and meta-analysis demonstrated that percutaneous FLODI yielded positive results with low morbidity rates. [8] However, the FLODI technique involves piercing the lumbar disc annulus with a needle for intra-discal ozone delivery, and there is growing evidence base that needle-sticks to the intervertebral disc cause inadvertent peripheral annular injury, setting up a cascade of progressive disc degeneration and internal disc derangement. [21] Bovine disc studies noted that relatively minor disruption in the disc from needle puncture injury had immediate and progressive mechanical and biologic consequences with important implications for the use of discography, and repair-regeneration techniques. [22]

Since 1948 cumulative evidence suggests that needle sticks to the disc result in disc degeneration. Post disc needle-stick follow up studies have also noted an evolution to full thickness annular tears, and disc herniations in animal models. [9] [10] [11] [12] [13]

A ten-year post MRI follow up studies of human subjects exposed to lumbar disc needle sticks during provocative discography, had also noted a statistically significant increase in the frequency of disc herniations, annular tears, vertebral endplate defects, disc space narrowing, and a worsening of degenerative disc disease degeneration. [23] Therefore, finding ways to deliver ozone to the disc without damaging it are desirable. Ultra-sound guided-USG-ESPB developed as a surgical-trauma thoracic trunk fascia block technique, and was first proposed by Forero & colleagues in 2016, [24] may offer an alternative solution to intra-discal ozone injections.

Due to the newness of ESPBs, the procedure is controversial and specific discogenic back pain management RCTs are urgently needed. [25] However, recent meta-analysis has demonstrated that ESPB are effective in decreasing postoperative pain intensity and postoperative opioid consumption in spine surgery. [14] Case reports have also concluded that lumbar USG-ESPB are technically simple and safe procedures for failed back surgery pain management. [15].

A cadaver lumbar ESPB with dye noted cephalocaudal spread from L3 to L5 in all specimens with extension to L2 in four specimens. Medial-lateral spread was documented from the multifidus muscle to the lateral edge of the thoracolumbar fascia. There was extensive dye in and around the erector spinae musculature and spread to the dorsal rami in all specimens. There was no dye spread anteriorly into the dorsal root ganglion, ventral rami, or paravertebral space. **The conclusion was that** lumbar ESP injection has limited craniocaudal spread compared with injection in the thoracic region. It has consistent spread to dorsal rami, but no anterior spread to ventral rami or paravertebral space. [26]
However, some case reports have begun to demonstrate the role of ESP blocks in the management of DLBP. [27]

In response to O3 injections rapid dissolution into the aqueous component of plasma, a biologic stress oxidative stress response is induced, which promotes the release of biologically active substrates. [28]

Upon O3 tissue injections, reactive oxonation species (ROS) reactive both with water (H20) and polyunsaturated fatty acids (PUFAS) are formed. Aqueous reactions yield antioxidants such as hydrogen peroxide (H202), super-oxide dismutase (SOD), glutathione peroxidase, (GPO), quinone oxidoreductase (QOR) heme-oxygenase (HO-1), and heat shock proteins (HSP) which yield nitrous oxide (NO) & carbon monoxide (CO), while PUFA lipid ozonation species (LOS), such as malondialdehyde, lipperoxylradicals, hydroperoxides, isoprostanes, 4-hydroxynonenal, and alkenals are also over-expressed [29] [30] Heat shock response provides a cytoprotective state against aging, cancer, neurodegenerative disorders and inflammation with most of these enzymes playing a role as free radical scavengers in a range of degenerative & neurodegenerative diseases. [31]

O_3 can have a role in hormesis by regulating the pro-inflammatory and anti-inflammatory effects of

prostaglandin formation which is of similar nature to nitric oxide. [32]

One of the main therapeutic causes of medical O_3 in DLBP management is a reduction in disc size, which as demonstrated in this case report, may possibly reduce nerve root compression too. Furthermore, disk shrinkage can improve local microcirculation and increase the supply of oxygen by reducing venous stasis caused by disc compression of vessels. O_3 therapy also had analgesic and anti-inflammatory effects in treating disk herniation

In vitro studies on disc material have demonstrated disc shrinkage at an ozone concentration of 28 gamma. [7] However, the time it takes for diffusion of ozone through tissues to reach the disc may indicate that a higher starting dose for ESP may be required than that of direct intra-disc ozone injection, in order to insure this optimal concentration reaches the disc.

In 2018, the first application of lumbar ESPB was for the postoperative analgesia of hip arthroplasty was published [33] This study noted an injection point deeper and more lateral, lumbar ESPB is more challenging to perform and to more difficult to sonographically visualize when compared to thoracic applications [34] The lumbar ESPB targets the potential space between the paraspinals muscle fascial envelope (Spinalis, Longissimus Thoracis, IIiocostalis bundle) and the deeper lumbar transverse processes. Both thoracic & lumbar ESPBs are typically performed with an in-plane probe orientation, with dynamic monitoring fluid spread expansion between erector spinae fascia away and deeper thoracic transverse processes. Unique intercostal perforating channels then facilitate anaesthetic diffusion into the deep paraspinal space, yielding circumferential thoraco-abdominal wall sensory nerve blocks of the dorsal and ventral rami of the thoracic and abdominal spinal nerves. However, studies have demonstrated differences in the relevant anatomy of thoracic and lumbar blocks. [35]

The anatomy of the thoracic nerves also differs between the two areas. Spinal nerves continue as the dorsal ramus and ventral ramus (intercostal nerves) after leaving the epidural foramen. However, in the lumbosacral region, the ventral ramus merges to form the lumbar and sacral plexuses. While the dorsal ramus split into the lateral and medial branches in the thoracic area, in the lumbosacral area they separate into the medial, intermediate, and lateral branches, the dorsal ramus of the lumbosacral nerves merges within themselves to form the cluneal nerves which are responsible for the sensory innervation of the waist and buttocks. Therefore, the sensorial anatomy of the lower abdomen and lower extremity is more complicated than the thoracoabdominal region. Consequently, craniocaudal spread of ESPB is more limited in the lumbar region when compared to the thoracic region, and 5 ml of local anaesthetic is recommended at each TP lumbar level [36]

Lumbar ESP injection is customarily performed at the L4 level and injectant spread for this technique has been documented in multiple studies. [26] [33] [37] [38] [39] [40] Chung et al administered ESPB using a 20 mL mixture for pain management in lower extremity complex regional pain syndrome. Balaban et al performed ESPB with 30 mL mixture for postoperative analgesia in total knee arthroplasty. Fluoroscopic imaging demonstrated spread to L2-S1 levels in both lumbar ESBP cases. [37] [38]. In a study, a higher volume single injection (40ml), was used to demonstrate the spread of LA between L1-S4. [39]

De Lara González et al reported their findings in 6 cadavers after bilateral lumbar ESPB (total:12 blocks) was performed using a 20 mL LA mixture. In all applications, the spread of the LA mixture was observed between L2-4 in the craniocaudal plane. In nine applications, the spread included L5 caudally and in one application L1 cranially. The first question regarding lumbar ESPB is whether LA spreads to the anterior of the transverse process. In nine injections this anterior spread was observed, with spread to the medial border of the psoas muscle in seven and spread to the L3 and L4 spinal nerves in two injections. [40] Harbell et al performed nine lumbar ESPB on five cadavers using 20mL at the L4 transverse process level and reported staining of the multifidus and longissimus muscles following six injections. In only one injection the spread was reported to have been observed posterior to the lumborum muscle. No spread to the anterior of the transverse process was reported. [26]

Reports from cadaveric anatomic studies are essential for understanding the mechanism of

action of plane blocks. However, due to their nature, cadaveric studies have a significant limitation. Even when fresh cadavers are used, tissue tension decreases due to the loss of vitality. Therefore, the spread of injectate in cadavers most probably does not accurately represent the spread that would occur under normal conditions. [36]. Other literature has demonstrated methods of both in-plane and out of plane USG-ESPB techniques. [27]

Customary lumbar ESP blocks with fluid, allow for continued visualization of fascial plane separation and fluid expansion under ultrasound guidance. Small amounts of air injected under ultrasound guidance, have been used to monitor needle tip position for other types of injections. [41] However, injecting a bolus of ozone gas (image 2) may result an immediate hyperechoic loss of anatomical detail. This may be overcome by first injecting a small amount of gas to visualize expansion of the lumbar fascial planes. If in doubt, a small amount of normal saline (2-5 ml) may also be injected first to confirm needle tip placement and inter fascial plane expansion. ESPB contraindications include infection at the site of injection in the paraspinal region and patient refusal. Anticoagulation may be a relative contraindication to ESPB, although there are no consistent guidelines. [42]

Intradiscal ozone injection has also been associated with (Antons' Syndrome) ischemic stroke [43], Other ozone injection contraindications may include G-6P deficiency. [44] However, ESPBs carry a very low risk of complications, as sonoanatomy is easily recognizable and there are no structures in close proximity at risk of needle injury. [45] [46]

A comparative 306 patient RCT Ozone to corticosteroid intraforaminal injection study found that Ozone offers superior low back & sciatica pain relief. [47] Others studies have reported that ozone injections have significantly less recovery time and complication rates (1%), but with similar pain reduction functional restoration outcomes as comparison to lumbar discectomy, with pain and function outcomes are similar to the outcomes for lumbar discs treated with surgical discectomy, but the complication rate is much lower (<0.1%) and the recovery time is significantly shorter. [8],

The transverse process acts as a bony anatomical barrier, which prevents inadvertent needle entry into deeper structures. An ESPB preserves bladder function and motor neuron function enabling early mobilization. Since motor function is unaltered, immediate postoperative neurological evaluation of spinal cord function is possible. Epiduroscopy is another option that may allow the physician to directly visualize the adhesions in the epidural space; this has also been reported to be effective [48]. USG caudal epidural particularly safe in a transverse plane needle perpendicular to the epidural space approach [49], are also used for back pain relief. However, both of these procedures are more invasive than ESPB and the former can only be performed at specialized institutions (Japan). For these reasons, ESPB may be less invasive injection option. [15]

The optimal ozone concentration of intradiscal ozone injection appears to be 28 gamma.[7] However, as ESPB aims to manage discogenic low back pain (DLBP), studies measuring ESP to disc ozone concentration degradation in relation to gas transit time may be needed.

Conclusion:

Orthopedic medical ozone injections via subcutaneous, intramuscular, intraarticular, intradiscal, intraforaminal, periganglionic and periradicular methods, have demonstrated anti-inflammatory, analgesic, and antioxidant effects in many musculoskeletal disorders including low back pain, lumbar disk herniation, cervical pain, cervical disk herniation, failed back surgery syndrome, degenerative spinal disease, knee osteoarthritis, meniscal injuries, sacroiliitis, plantar fasciitis and carpal tunnel syndrome, with rare adverse effects if judiciously used according to precisely defined guidelines. [50] The main restrictions for the use of O2-O3 are: pregnancy, hyperthyroidism, thrombocytopenia, and ozone allergy.[51]

As USG-ESPB is a relatively new procedure its use with ozone in DLBP management had not previously been described in the literature. Anatomical variance between the thoracic and lumbar spine dictate variability in injectant spread and level-specific modifications in injection technique. Though ESPB is used primarily to manage acute trauma or spinal per-surgical pain, it may also be used to management acute low back pain-sciatica and DLBP. Ozone ESPB may therefore have a role in regenerative medicine as a safer alternative to the current practice of intradiscal ozone injection. Quality studies are

needed to explore the therapeutic potentials of ESPB-Ozone.

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