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BEFORE AND AFTER STRESS EXPERIENCE OVERVIEW: BEFORE AND AFTER THE SPINAL PROCEDURE WAS AN "EXPERIENCE OF LOSS" FOR THE PARTICIPANT.

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Spinal anaesthesia is a method that involves injecting a local anaesthetic agent into the subarachnoid space. It is done to produce numbness of the lower body, which is particularly required during surgeries. The surgical stress response is a complex hormonal change which the body exhibits in response to cortisol secretion, among others. Salivary cortisol is a valid marker of stress and is less blunted after spinal techniques than GA (1,2).

SPINAL ANAESTHESIA

Spinal anaesthesia involves injecting anaesthetic into the cerebrospinal fluid at around L3-L5 in the spine to block sensory and motor nerves quickly for surgeries below the waist. An illustration of lumbar anatomy for spinal injection showing the subarachnoid space (2) is presented. It preserves consciousness and causes less systemic stress than general methods

STRESS RESPONSE IN SURGERY

Undergoing surgery stimulates activation of the hypothalamic-pituitary-adrenal axis, which results in the overproduction of cortisol to mobilize energy and inhibit the inflammatory response. It scales with the severity of the trauma and may cause metabolic changes if not managed (1,3). Cortisol levels rise during surgery due to stressed environment. Use of spinal anaesthesia prevents this rise better than general anaesthesia. Intraoperative rise is less: 478.7 nmol/L vs. 694.7 nmol/L. The changes in salivary cortisol in surgical patients mirror those in serum, thus justifying its use for assessment of non-invasive perioperative stress monitoring (1,2,3).

PREOPERATIVE PHASE

The psychological distress that patients face during the preoperative phase before spinal anaesthesia is intense. There may be a fear of the unknown procedure. Similarly, patients also undergo anxiety related to the procedure. Most of the time, anxiety and fear are regarding complications during surgery. The brain's response to emotions activates HPA axis which triggers stress as body prepares for the threat it is noticing. Cortisol is produced as primary mediator and salivary levels are practical non-invasive measures of activation – usually significantly elevated (e.g. 20–50% increases) in hours prior to anaesthesia due to anticipation stress. The fear of pain associated with the needle's insertion or block not taking place, the intimidating environment of the operating theatre with its sounds and smells, and the lack of sufficient knowledge about the safety and process of spinal anaesthesia add to the response. (2) These things will cause a feedback loop to occur, where unmanaged anxiety will continue HPA axis hyperactivity, delaying cortisol's return to normal even after induction finishes. Research and care use salivary cortisol (1) to diagnose early stress. Preoperative education or anxiolytics can mitigate this by reducing stress.

During spinal anaesthesia, numbness from the waist down occurs in the body which relaxes the body and mind. This process inhibits the stress response from surgery as a result of sympathetic blockade and a reduction in cortisol secretion. Spinal anaesthesia is the injection of local anaesthetic like bupivacaine using a fine needle into the subarachnoid space at the lumbar level (L3-L4 or L4-L5) after sterile skin prep and patient positioning (lateral or sitting). Patients report that the onset of action occurs within 2-5 minutes. Ring blocks then spread upward to block the nerve which supplies the lower abdomen. Furthermore, the block include the pelvis and legs. This allows surgery to be done while the patient is awake and comfortable (2).

SYMPATHETIC BLOCKADE

The administration of anaesthetic interrupts the smooth transmission of sensory, motor and sympathetic nerves. Further, it causes vasodilation, hypotension (which can be managed with fluids and vasopressor), and decreased heart rate variability, due to the drop in norepinephrine release. This blockade acts as a "reset" of the autonomic nervous system that counteracts sympathetic overdrive from anxiety (1).

REDUCED PAIN SENSATION

Decreased Pain Perception

Pain signals stemming from cuts or movements are blocked from travelling to the brain, thereby preventing nociceptive signals to further stimulate the HPA axis and result in cortisone hormone secretion. Patients feel a great warmth and weight in the obstructed parts of their bodies diverting them from fear to relaxation. The spinal techniques have a diminishing effect on the stress reaction mechanism with intraoperative cortisol concentration decreasing constantly after an initial preoperative increase (eg by 20-50%) due to reduction of the sympathetic tone. Findings indicate strong evidence for a reduction in cortisol concentration, as evidenced by the intraoperative saliva samples (decreased from 25 nmol/L to <15 nmol/L) (1,2).

PATIENT BECOMES MORE CALM

The main feature is a quick relieve psychological calming effect. The patient connects his dexmedetomidine to the anesthetic machine, and the patient quickly becomes sluggish. After the block is formed, the patient changes from pre-operative tachycardia, sweating, anxious to become drowsy but still conscious, and says he feels like he is floating and feeling relieved. The sympathetic nerve block helps reduce muscle spasms by decreasing catecholamine levels in the blood. Patients engage in more conversations and feel more comfortable, with their anxiety levels dropping from 40 out of 100 to just 5 out of 100. This causes the patient to cooperate more easily and require less oxygen. It also enables the patient to recover quickly due to low cortisol levels that maintain immunity. (1,2)

Under spinal anaesthesia, during intra-operative period, the patient is conscious, analgesic, physiological stability and stress levels are significantly lower than that of other procedures under general anaesthesia.

PATIENT AWARENESS AND ANXIOLYSIS

The patient will be conscious and communicative, and lucid and will retain memory because the local anaesthetic temporarily blocks pain pathways allowing for the surgery to be performed painlessly. Moreover, this will not cause drowsiness, disorientation or emergence delirium. Also, the local anaesthetic will induce an element of control over patient management to diminish psychological stress (1,2) (4).

PREDICTABLE HEMODYNAMIC PROFILE

After the injection, the hemodynamic profile remains stable, because the blockage of sympathetic nerves causes slight hypotension of around 10% to 25% and bradycardia. This can be balanced by intravenous infusion only or use of a vasopressor agent like ephedrine in a small amount. The effect of vasopressor agents on hemodynamics is much more stable, when compared to the hypertension. The general anesthesia leads to variable changes due to endotracheal intubation. Breath functions including spontaneous respiration with normocapnia will not be affected. Reducing anxiety for dental work.

Spinal techniques have a powerful effect on the surgical stress triad, which is neuroendocrine, metabolic, and inflammatory stress. Spinal techniques produce a segmental blockade of the nerves that reduces catecholamine secretion, such as reductions of 50-70% of epinephrine/norepinephrine and cytokine storms compared to the systemic activation caused by general anaesthesia. Due to this, there is the preservation of anabolism, reduction of insulin resistance and complication rates (2,4,5,6).

LEVELS OF CORTISOL: SPECIFIC STABILIZATION/REDUCTION

Cortisol patterns during surgery under spinal anaesthesia are more favourable as levels are stabilised or reduced to preoperative baseline levels and not increased (often by 50-100%) as seen with general anaesthesia (1,2) (7).

Stress will ensure salivary/serum cortisol will remain high before the blockage (e.g., 20-40 nmol/L for saliva). However, following the injection, the levels of cortisol remain unchanged or decrease by about 15-40% due to feedback inhibition of the HPA axis. For example, the average spinal group level (478 nmol/L) is lower than the general group intraoperative increase (694 nmol/L). Those who had spinal surgeries had lower ACTH and cortisol levels in their saliva. The details of the caesarean surgery in preeclampsia segmental spinal anesthesia with plain bupivacaine. Spinal anesthesia around 200 ng/mL cortisol level constant. Additives dexmedetomidine or fentanyl faster drop to 120–150 ng/mL. Result No hemodynamic instability or hyperglycemic rebound. Curettage research indicates that spinal (9,10) (4).

The use of epidurally enhanced spinal anesthetics aggravates this situation. There are marked intraoperative decreases ($p<0.05$) compared to preoperative values. Salivary measurements respond to block density. Dense blocks show a 25-33% decrease while patchy blocks maintain slight increases. The early initiation of PIA and the subsequent suppression in MIA seems to common to involvement of the HPA axis (1,6,11). The trend does not change to the end with these extended times (60 minutes or more), and circadian nadir is not overridden. The metabolic impact is lower by about 20-30% and recovery is quicker. This trend, supported by

serial blood draws (at baseline, mid-procedure, and ultimately), makes salivary cortisol a dependable measurement in spinal surgery to indicate stress management efficiency. (1,5,6) (6).

Postoperative spinal anaesthesia gives better pain relief for longer duration, less stress activation, and faster recovery, especially when pain is kept under control.

PAIN RELIEF CONTINUES

Depending on the agent and the dose of the agent used, analgesia lasts for about 2 to 6 hours. The sensory block gradually begins to wear off. Multimodal adjuncts, including NSAIDs and opioids, keep the patient calm and reduce breakthrough pain that may cause stress emergence (2,3). Low-stress reaction blunted intraoperative stress are blunted as evidenced by lower cytokine levels, maintained nitrogen balance and lower risk of infection compared to a prolonged catabolism from general anaesthesia. (3,12).

Patients who have their cognitive function intact and may experience little nausea, get up and mobilise faster (2-4 hours instead of 6-12), reach normothermanship faster and get discharged from hospital sooner. (2,13).

Salivary Cortisol: There was a significant decrease i n salivary cortisol post-operatively when pain was effectively controlled after spinal anaesthesia. Levels often fall by half from peaks and return to normal more quickly than serum levels. In pain that's predictable and controlled, cortisol levels drop. For instance, there was a threefold reduction in preeclamptic caesarean section levels from preoperative highs to 145.5±45.8 ng/mL at two hours post-block. Dexmedetomidine increased the effectiveness of plain spinal when reduced. Declines in spinal groups are steady, with levels 30 min after surgery lower than levels during the surgery. This differs from general anaesthesia where high levels are maintained related to the amount of trauma. (2,3).

Managing pain is essential. When people experience pain, it can affect their body in a way. The pain transfers signals to the body for a purpose. According to some studies, people tend to have low saliva production when they are in a lot of pain. People experiencing pain, for instance, have 116 nmol/L of saliva which may not be enough. Once pain levels are under control saliva levels will come back to normal. This occurs even when the individual does not feel stressed.

We have observed this in individuals who have undergone surgery. The pain level is much less after the surgery in 24 hours. It's a sign that the pain medicine is working.

Pain management such as this is essential for people who have had surgery. It assists them in feeling improved and returning to usual. Musculoskeletal surgery is always coupled with pain control. Neostigmine given by the epidural decreases the levels of the stress marker in saliva. The decline in levels is associated with a reduction in pain experienced, as measured by the Visual Analog Scale or VAS and this reduction is seen at 2 hours after the treatment.

The spinal treatment shows that patients who have the treatment as it should be done discharge from the recovery room with normal SAA and cortisol levels. People with pain flares typically take more than 24 hours to return to their normal epidural neostigmine adjuncts levels.

(11,14).

Mechanisms of Analgesia inhibit afferent stress signals and restore feedback inhibition of CRH/ACTH. Spinal's legacy blockade prolongs this while returning circadian gets uninhibited. The trajectories show that the spinal injury and sham control have a steep nadir ($p=0.025$) after serial sampling (0, 2, 6 and 24 hours. It is found to be statistically significant vs the general control case. This helps with immune recovery, glycaemic control, and psychological calm. (1,2,12).

NON-INVASIVE

Cortisol in saliva is a non-invasive biomarker that can be used for assessing perioperative stress in real time and it has advantages compared to blood. Salivary cortisol works on the simple passive drool into a tube (1-2 mL, 2-5minutes), eliminating needles, pain and venipuncture stress which artificially inflates readings. Ideal for anxious surgical patients for serial monitoring. (1).

EASY TO COLLECT

The only required equipment of the system are swabs and tubes. The system remains stable for a limited time at room temperature. Tests like ELISA and LCMS and MS can be done with a 2-hour turnaround. According to references 15 and 16, the system can be useful for medical professionals working in outpatient and at bedside settings.

REFLECTS REAL-TIME STRESS

Unbound diffusion of free cortisol to saliva shows a serum-free fraction relationship with acceptable correlation coefficients between 0.7 and 0.95. The method involving HPA measurements between 15 and 30 minutes after stress tests is highly sensitive to the rapid physiological changes caused by fear and pain. (1,17).

BRIEF COMPARISON WITH BLOOD CORTISOL

Salivary cortisol is a reflection of the bio-available or free cortisol. Blood cortisol on the other hand is 90% bound to proteins (albumin and cortisol binding globulin) which is not bio-active. Salivary cortisol sampling is not affected by sampling stress like blood is (venipuncture rises venous blood cortisol 20-50%). Salivary cortisol results in a short time (1-2 min versus 10-20 min for blood). Salivary cortisol has shown greater activity at detecting pain/stress (post-op salivary 116 nmol/L suboptimal results versus serum 511 nmol/L stable results). The blood is absolute quantification but troublesome to the patients. Salivary measurement gives a strong correlation ($r>0.9$) but exaggerated minor changes (e.g. 47 vs 116 nmol/L pain related) (1) (16).

SIGNIFICANT DECREASES WITH PAIN CONTROL

Engaging in pain management can lead to significantly lowered salivary cortisol levels. These levels typically peak at between 30 and 70 percent of their highest value when levels of VAS<3 indicate HPA inactivity (1). Patients undergoing abdominal aortic aneurysm surgery have been found to make 116 nmol/L of salivary (vs. 47 nmol/L intermittent, serum ~510 nmol/L both) PCA morphine. Their hemodynamic stability controlled their condition. Considers a controlled design a valuable option. The adjuncts caused Preeclamptic Spinals to drop from 145 ng/mL post-op levels to three times that of the non-adjuncts, which reduced their VAS rating effectiveness. According to a study, neonatal anxiety increased along with the scores, which returned to normal after management ($p<0.05$) (1).

The early use of salivary tests is shown to be a better predictor of remission than serum tests, which are affected by surgery. According to the findings of the stress tests, it appears that the highest levels of salivatory production occurs as early as 20 to 30 minutes after the event. Moreover, the salivatory production returns to normal 10 hours after the event is over. These were verified through testing with the LC-MS-MS against the ELISA methods. The results obtained through the wearable sweat sensors matched the results of ongoing salivatory, which is the gold standard assay. (18).

Analgesia achieves its effect by blocking nociceptors. In turn, this prevents the production of CRH and ACTH. The study relates the results of POD1 6AM to serial salivary assessment, which drops when controlled. Research finds faster normalization improves patient recovery outcomes in better way. Salivary testing is an active modulator of pain and stress response systems as evidenced by research studies on aneurysm pain and responder stress tests (1,18).

CLINICAL IMPORTANCE

Because it provides measurable results that help improve the surgical process and patient outcome, monitoring salivary cortisol is of great clinical importance in spinal anaesthesia procedures (1). The test assesses anxiety level using hyperactive HPA conditions. These conditions can be seen when preoperative salivary level ranges between 25 and 50 nmol/L. It indicates which patients require anxiety treatment and educational programs to prevent upcoming cortisol increase and consequent arrhythmia problems. Real-time feedback demonstrates anaesthesia effectiveness. If there are post-injection decreases of 15 to 40 percent, then clinicians achieved the proper block density. When this occurs, there is a decrease in stress, and when the pattern is ongoing, they must adjust the dose or switch treatment. Further, they must change this in order to stop an unrecognised pain response (1,2,16).

Tailored pathways improve patient care with their customized treatment process that includes the use of music therapy and dexmedetomidine for high-cortisol patients. The quick return to normalcy of the test results (POD1 < baseline) shows ability to predict shorter PACU stays coupled with lower PONV and metabolic stability. It has a better predictive capacity than subjective VAS (4,18,19). The study adopts serial sampling to test or audit a representative sample in the investigation of the stress-reducing methods (17).

CONCLUSION

Spinal anaesthesia offers several benefits as it slows down sympathetic pathways which hinder neuroendocrine actions from the start of incision until the patient becomes better (1,2,5). The patient's journey illustrates this. The relief elicited by surgery results in a pre-operative cortisol surge due to anxiety, and then an intraoperative stabilization. This then decreases by 20-50% before patients enjoy a rapid post-operative recovery. This is via pain control, which doesn't just relieve pain. It also results in relaxed behaviour, immunity, and metabolic balance. All this is superior compared to general anaesthesia (1,6). Cortisol in saliva is a real-time, non-invasive biomarker that reflects changes in the level of the active hormone, allowing researchers to monitor progress. According to the study, which validates that spinal treatment can decrease stress (1), therapeutic enhancements, as well as the creation of evidence-based perioperative methods, can be proposed.

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