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Review Article

Leprosy and Anaesthesia : Peri-operative Concerns in Patients with Hansen's Disease

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Leprosy is a chronic granulomatous disease caused by *Mycobacterium leprae*, with wide spread systemic manifestations. Its prevalence is high in the developing world and it is, in fact, a leading cause of severe neuropathy in the developing world. Hence, the likelihood of encountering leprosy patients in daily anesthesia practice is quite high. Despite this, literature pertaining to anaesthesia in leprosy patients is quite meagre. This article attempts to explore the available literature on leprosy relevant to anaesthesiologists, in order to substantiate recommendations for administering safe and effective anaesthesia in leprosy patients. A thorough pre-operative evaluation is required as leprosy affects almost all organ systems. Intra-operatively, induction and extubation must be smooth and stress response to airway management must be minimised. Nasal manipulations are preferably avoided. Before regional anaesthesia, proper documentation of nerves involved by the disease must be noted and blind nerve blocks must be abandoned. All pressure points and bony prominences must be padded. Special precaution must be taken in preventing hypothermia, neuropathy and myopathy. Drug interactions with anaesthetic agents should also be kept in mind. Social rehabilitation and psychological support during the entire perioperative period for these patients goes a long way in ensuring a successful operative outcome. As there are very few publications on use of different anaesthesia methods in these cases, emphasis should be to document and analyse the experiences so that evidence-based guidelines are available to cater to the special needs of Leprosy Afflicted Persons (LAPs).

Key Words : Hansen's disease, Regional Anaesthesia, Chronic Granulomatosis, Multi-drug Therapy, Neuropathy, Reconstructive Surgery, Leprosy Afflicted Persons (LAPs).

Introduction

Leprosy, first described in ancient Indian texts from the sixth century B.C., is a nonfatal, chronic granulomatous infectious disease caused by *Mycobacterium leprae* (Park 1994). It is named after the Greek word 'Leper', which means 'scaly' and usually affects the dermis of the skin and peripheral nerves, but has a wide range of clinical manifestations. It can be progressive and cause permanent damage if left without treatment. Leprosy has been considered as the leading cause of severe neuropathy in developing countries

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(Ramachandran & Neelan 1987). The characteristic deformities and the recognition in most cultures that the disease is communicable from person to person, have historically resulted in a profound social stigma. Leprosy has been feared over the ages due to these deformities. Norwegian physician, *Gerhard Armauer Hansen*, identified the bacillus in leprosy patients in 1873, making leprosy the first disease ascribed to a bacterial origin. The introduction of Dapsone (diphenyl sulfone, DDS) in 1941 brought the first effective therapy for the disease and multidrug therapy (MDT) was introduced by the World Health Organization (WHO) in 1981 to limit the development of drug resistance. With the widespread use of MDT the prevalence of disease has been drastically reduced all over the world. India had planned to achieve more than 95% reduction to reach elimination (as public health problem) level of prevalence level of below 1/10,000 by 2005. Further, the profile of disease has also changed with paucibacillary disease becoming the dominant fraction. However, despite some successes in reducing the disabilities, the situation has mostly remained stagnant after 2005. On the other hand, there is wider recognition that some of the persons afflicted with leprosy (PALs) will require after care of their limbs and also surgical interventions much after their bacteriological disease has been cured. This number keeps on adding-up every year though with a lower rate than pre-MDT/ pre-elimination years.

Despite high prevalence of leprosy and enormous patient load in the developing world in the past with huge number of surgeries done on them, there are very few reported cases and very limited literature is available regarding anaesthetic implications in Hansen's disease. These patients can present to the Anaesthesiologist for both elective and emergency procedures for leprosy specific problems as well as any disease common to all human beings. The common surgeries performed in these patients include wound debridement, tendon transfers, skin grafting, nerve repairs, oculo-plasty, free-flaps and other reconstructive procedures to restore function and shape to limbs and other organs (Antia 1964, Brand 1964, Ebenzer et al 2012, Fritschi 1973, Joshua & Sarkar 2004, Salafia & Chauhan 2010, Shah & Shah 2016). World Health Organization (Srinivasan & Palande 1996) and Govt of India (Shah & Shah 2016) have been working on strategies to make the reconstructive surgery interventions accessible to LAPs. Surgery for nerve decompression is also a part of therapeutic management of neuritis (Malaviya & Ramu 1982, Srinivasan 1984, Srinivasan & Palande 1996). While during the last 60-70 years, significant amount of innovative work on surgical methods have emanated from India and elsewhere (Antia 1964, Brand 1964, Fritschi 1973, Srinivsan & Palande 1996, Shah & Shah 2016), literature on anaesthesia related aspects is extremely limited (Mitra & Gombar 2000). This article attempts to review the published literature on the anaesthetic considerations in such patients so as to progress towards formulating guidelines regarding anaesthesia in leprosy patients.

Systemic Manifestations of Leprosy

Leprosy is a systemic disease affecting multiple organs during the bacillaemic phase of the disease. Anaesthesiologists must be aware of its systemic effects to ensure adequate pre-operative evaluation and peri-operative precautions.

Cardiovascular system

There are many reported cases of congestive cardiac failure in leprosy patients (Mathur et al 1976). Lepra reactions are often associated with electrocardiographic changes viz., ST and T wave changes in 16.66%, bundle branch block in 0.7%,

extrasystoles in 3.7% and increased QTc intervals in 44% (Zawar et al 1983). Lepromatous and borderline patients also have considerably higher prevalence of tachycardia and arrhythmias due to cardiac dysautonomia (Katoch & Ramu 1983). Patients with lepromatous leprosy present with a higher incidence of ischemic cardiac disease, despite having elevated levels of high density lipoproteins. This is attributed to changes in small blood vessels feeding the peripheral nerves distributed around the arteries in epicardial adipose tissues, leading to changes in these arteries which promote ischemic cardiac disease (Yajima & Narita 1977).

Autonomic Nervous System

Autonomic function is affected to varying degrees as evident by the incidence of orthostatic hypotension, baroreflex dysfunction and postprandial hypotension in leprosy patients (Kale et al 1984). There is impairment of responses to Valsalva manoeuvre, absence of blood pressure response to standing /sustained hand grip, and heart rate response to single large dose of intravenous atropine in patients with longer duration of disease. Impairment of vagal function is evidenced by absence of reflex bradycardia after Valsalva manoeuvre and loss of heart rate variability to deep breathing. Involvement of the sympathetic nerves is manifested earlier than that of the parasympathetic nerves because of infiltration of dorsal root ganglia and sympathetic chain by the acid-fast bacilli (Katoch 1994). Patients with long standing disease have reduced exercise tolerance and are prone to sudden cardiac arrest and death.

Respiratory System

The respiratory system in leprosy patients is known to be widely affected by the disease. Anatomical involvement of the respiratory tract includes areas frequently dealt by Anaesthesiologists. The nose is a major site of lepromatous infiltration (Chacko et al 1979); followed by pharynx, with uvula being the most affected area. In the larynx, the site of predilection is the free margin of the epiglottis. Involvement of the vocal cords is a late but possible development. Leprous patients have compromised pulmonary chemosensitive function due to affliction of Vagus and sympathetic plexus leading to impaired respiratory function tests, breath holding time and response to cough (Gupta et al 1984). Respiratory dysautonomia was observed in 48% (Gupta et al 1984) of the cases and patients failed to increase Peak Expiratory Flow Rate (PEFR) following adrenaline injection due to hypo-reactivity of pulmonary beta-2 receptors. Impairment of olfaction, followed by complete loss of intranasal sensitivity in long standing cases, has also been described and is secondary to atrophic changes in the nasal mucosa with blunting of the olfactory nerve endings.

Renal System

Renal involvement in leprosy has been reported, especially in lepromatous leprosy, and all types of glomerulonephritis, interstitial nephritis and amyloidosis have been reported (Sainani & Narayan Rao 1974). Membranous glomerulonephritis is the commonest type of glomerular lesion, followed by interstitial nephritis and diffuse proliferative glomerulonephritis. The spectrum of renal involvement encompasses asymptomatic proteinuria, microscopic haematuria, nephrotic syndrome and acute renal failure. Prolonged intake of Dapsone and Rifampicin may also adversely affect renal functions leading to decreased renal clearance.

Hepatobiliary System

Long back, the liver was reported to be involved in advanced lepromatous leprosy as a result of bacteraemia (Bungeler 1943). Hepatic involvement is much less common in tuberculoid type, though small granulomata have been described (Chen et al 1976). The basic lesion of the disease is

multiple, small lepromata in the periportal connective tissue. The lepra reactions are frequently associated with hepatitis and Kupffer cell hyperplasia. Some of the hepatic lesions progress to stellate fibrosis and early cirrhotic changes. Functional derangement is the main feature in lepromatous cases irrespective of the extent and duration of the disease. There is hyperbilirubinaemia and increase in serum globulin with reversed albumin-globulin (A/G) ratio, indicating deranged hepatocyte function and hyperplasia of reticuloendothelial cells (Parvez et al 1980).

Ocular Involvement

The primary ocular lesions of leprosy (those directly due to the bacillus) involve the anterior chamber of the eye. Secondary complications follow damage to the fifth and seventh cranial nerves, causing corneal anaesthesia and ulceration, lagophthalmos, exposure keratitis and, finally, blindness (Ridley 1988).

Musculoskeletal System

The bone changes in leprosy may be specific, when they occur due to direct invasion by *M. leprae* or nonspecific, when the involvement is indirect (Choudhuri et al 1999). Nonspecific involvement is more common and includes osteomyelitis, osteoporosis, atrophy and absorption of the bones. These changes result from the impairment of sensations, repeated trauma, trophic changes and restricted movement of the muscles.

Invasion of granulation tissue also causes tendonitis and neuropathy which leads to insensitivity and myopathy. Infiltration of lepromatous granulation tissue leads to chronic nasal congestion and eventually causes the destruction of nasal cartilage and bone (saddle nose deformity). In advanced tuberculoid leprosy, chronic nonspecific osteitis may necessitate amputation.

Skeletal myositis, a type of interstitial myositis which may produce painful nodules, may be encountered in lepromatous leprosy. Superficial muscles of the limbs are commonly involved (Convit et al 1960). Simple neuropathic disuse atrophy of muscles is also seen frequently. They may also develop abscesses of nerves (most commonly the ulnar), with a cellulitic appearance of adjacent skin. In such conditions, the affected nerve is swollen and exquisitely tender.

A syringomyelia-like, neurodegenerative syndrome, Facial-onset sensory and motor neuronopathy (FOSMN) syndrome, has been infrequently reported in lepromatous leprosy. It is characterised by initial development of paraesthesia and numbness in a trigeminal nerve distribution, which slowly progresses to involve the scalp, neck, upper trunk and upper limbs in sequential order. Motor manifestations, including cramps, fasciculations, dysphagia, dysarthria, muscle weakness and atrophy develop later in the course of the illness.

Haematological System

Patients with leprosy have lower levels of haemoglobin, raised erythrocyte sedimentation rate and lower serum iron levels. The resulting anaemia decreases the oxygen carrying capacity of the blood. (Lapinsky et al 1992)

Endocrine System

Patients with leprosy may present with orchitis and gynaecomastia. These patients have decreased plasma concentration of testosterone, raised levels of gonadotrophin and hypo or aspermia leading to impotence and infertility (Martin et al 1968).

Abnormal calcium homeostasis and hypocalcaemia have been associated with a variety of granulomatous diseases, including leprosy. Extrarenal production of physiologically active 1, 25-dihydroxy vitamin D in granulomatous tissue,

could be the underlying mechanism, possibly (Couri et al 2004).

Secondary amyloidosis is also a recognized complication of lepromatous leprosy. In non-lepromatous patients, amyloidosis may occur as a complication of severe ulceration (McAdam et al 1975).

Obstetric considerations

Many a times, pregnancy is associated with the first presentation or aggravation of the existing disease. It is also known to be a precipitating factor for both Type I and Type II lepra reactions. There have been reports where emergency caesarean section had to be performed due to cardiotocographic pathology (Neuer et al 1996) or due to other complications such as erythema nodosum leprosum (ENL) or leprous neuropathy (Duncan 1996).

Anaesthetic Implications and Management

Leprosy patients have cardiac dysautonomia and impaired myocardial contractility, making them prone to sudden cardiac decompensation because of inability of heart to cater-to stress-inducing events like direct laryngoscopy, tracheal intubation and extubation, acute blood loss and the effect of various drugs. Dysrhythmias are also frequently encountered in these patients. All these changes warrant a detailed cardiovascular examination in the preoperative period. A thorough history, including but not limited to, any episodes of palpitation, syncope, angina or breathlessness on exertion should be taken (Mitra & Gombar 2000). A 12-lead electrocardiogram (ECG) and preferably echocardiography (ECHO) should be obtained. Blood pressure (BP) changes to Valsalva manoeuvre, posture and hyperventilation should also be recorded. Intraoperatively, especially during induction and reversal of anaesthesia, care should be taken to minimize the stress response. Tracheal intubation and extubation should ideally be performed in a deep plane of anaesthesia. Additional pharmacotherapy can be used to blunt the stress response associated with direct laryngoscopy and tracheal intubation. An induction agent causing least haemodynamic instability, like Etomidate, should be preferred. Adequate analgesia should be ensured intraoperatively and the same should continue in the postoperative period as well.

The lepromatous infiltration of nose, pharynx and larynx in these patients makes their airway difficult to manage. This calls for not only a meticulous airway examination but also for indirect laryngoscopy, to rule out vocal cord involvement, in the preoperative period. Nasal intubation and nasogastric tube placement might be especially difficult owing to nasal congestion and nasal bone resorption (Hernández et al 2009). Even after an unremarkable airway examination, these patients should be considered as anticipated difficult airway and difficult airway cart should be kept ready in the operation theatre (OT). Respiratory dysautonomia leads to impaired pulmonary function tests (PFT) and decreased cough response leading to delayed post-anaesthesia recovery and increased risk of pulmonary aspiration and infection (Uçar et al 2016). History regarding any past episodes of aspiration pneumonitis or frank pneumonia should be taken and these patients should be subjected to PFT in the preoperative period (Mitra et al 1998). Simple measures such as, chest physiotherapy and incentive spirometry should be undertaken early in the preoperative period so as to build up respiratory reserve and increase the vital capacity. Moreover, adequate aspiration prophylaxis should be administered to these patients to minimize the risk of aspiration pneumonitis.

Renal dysfunction is frequently seen, necessitating the need for preoperative renal function tests along with detailed history regarding daily urine output, haematuria and presence of pitting

oedema. The renal clearance is often decreased (Hernández et al 2009) and the dosing of drugs like morphine, non-steroidal anti-inflammatory drugs (NSAIDS), has to be adjusted accordingly.

Leprosy patients are prone to developing leprous or drug induced hepatitis. Cirrhosis might also be seen as a late complication of leprosy. Evidence of jaundice must be thoroughly evaluated. Liver function tests (LFT), serum proteins with A/G ratio and coagulation profile should be ordered to assess the functional status of liver. Special care should be taken while administering anaesthetic drugs with hepatic route of metabolism. In view of possible renal and hepatic abnormalities, it is desirable to employ the use of muscle relaxants which undergo Hoffman degradation (independent of renal or hepatic elimination), viz Atracurium, Cis-atracurium (Sahu et al 2011).

Positioning after anaesthesia requires extra attention as these patients are prone to ocular injuries, exposure keratitis and compression neuropathy. Pathological fractures are also common during positioning due to chronic osteomyelitis and bone resorption (Hernández et al 2009). Ophthalmic examination and relevant radiological examination should be undertaken preoperatively. Similarly, detailed neurological examination and electromyography should be done so as to meticulously document the presence of any pre-existing neurological deficit, myopathy, nerve damage or sexual impotence (Mitra et al 1998). The main peripheral nerve trunks involved in leprosy should be examined and thorough documentation of sensory loss on a body outline chart is required, especially for medico-legal purposes. In particular, palpation of ulnar and lateral popliteal nerves is important. This becomes extremely important in case regional anaesthesia/nerve blocks are employed. Spinal and epidural anaesthesia should be used cautiously in patients with long-standing disease because hypotension and urinary retention are frequent problems (Hernández et al 2009). Neurological deficit can also follow after nerve blocks or regional anaesthesia (Sahu et al 2011). In case of the pre-existing neuropathy and/or myopathy, it is important to avoid the use of blind nerve blocks. The use of ultrasound-guided nerve blocks is recommended to improve accuracy, avoid direct nerve hitting by the needle and to minimise dose of local anaesthetic used. Vasoconstrictor agents in blocks are preferably avoided. Muscle relaxants must be used sparingly in view of pre-existing myositis and interference of these agents with neuromuscular testing done during nerve repairs and other reconstructive surgeries done on leprosy patients. In this regard, the use of intravenous Dexmedetomidine infusion (a potent alpha-2 agonist) is particularly beneficial as it provides both stable haemodynamics and profound analgesia. Further randomised controlled trials are required to substantiate its use in such scenarios.

A detailed medication history should be obtained. Dapsone, used in the treatment of leprosy may cause haemolytic anaemia, methaemoglobinaemia, agranulocytosis, hepatitis, peripheral neuropathy, psychosis and lepra-reaction. Rifampicin is an inducer of hepatic cytochrome P_{450} enzymes and increases the requirement of anaesthetic agents. Apart from causing abnormalities in liver enzymes levels, Rifampicin may also produce some intermittent toxic syndromes, e.g. flu syndrome, shock syndrome, and rarely thrombocytopenic purpura (Mandell & Sande 1990). All such side effects lead to impaired clotting, decreased oxygen carrying capacity and increased risk of infection (Mitra & Gombar 2000). Thus, patients receiving these drugs should be subjected to complete haemogram and coagulation profile. Thorough post-operative care and observation is mandatory as any of these

complications, including drug reactions can be precipitated in that period. Complete peri-operative asepsis, personal protective gear for all health-care personnel and prophylactic antibiotics should be considered in the perioperative period.

Leprosy is an infectious disease with low pathogenicity (Kaur et al 1984). The nasal mucosa of lepromatous cases harbour millions of *M. leprae* which are discharged during sneezing. The bacilli can also exit through ulcerated or broken skin of infected patients. Local application of rifampicin drops or spray destroys most of the bacilli within a short period (Jacobson 1994). This may be especially relevant for anaesthesiologists before taking up such patients for surgery or for treatment in intensive care units. Patients with lepra reactions can present to the intensivist and may require multi-disciplinary approach to management.

All the suggestions in the preceding paragraphs are based on general principles of anaesthesia as applicable to all cases with known systemic and organ specific afflictions reported in leprosy patients. Most of these abnormalities were observed in pre-MDT years when the treatment was life-long in advanced Hansen's disease. The proportion of such involvement is likely to be lower in the cases manifested / treated during the recent years. Further, most of leprosy-specific surgeries required local anaesthesia or regional block. It will be desirable to study these aspects in the current scenario.

Access of appropriate anaesthesia services to PALs

It is well known that there is a gap between the need and actual access to reconstructive surgery services for leprosy in India. Despite the efforts of Govt of India through NLEP (National Leprosy Eradication Programme), shortage of infrastructure and human resource remain important barriers. Camp-based approach has been found to be cost effective for providing various services for treatment of plantar ulcers, repair for lagophthalmos, tendon and flap surgeries, amputations etc (Bhat et al 2016). Mega-camp approach has also been found be acceptable by Govt of India (Shah & Shah 2016). It is implicit that services for providing safe and optimum anaesthesia to these persons are also to be expanded simultaneously.

Conclusions and Looking at the Future

There is paucity of literature regarding anaesthetic considerations in leprosy patients, despite being a common entity in developing nations. Moreover, with ever increasing migration/ immigration and global travel for tourism and professional purposes, finding such patients in anaesthesia or critical care practise in the developed nations may no longer be rare. Adequate patient counselling regarding social stigma and improving personal hygiene can be initiated in the pre-anaesthetic phase, in addition to assessment for peripheral nerve involvements and multi-system afflictions. Drug interactions of anaesthetic agents with MDT drugs as well as their adverse effects on various body systems have to be kept in mind. Future research and studies focussing on this disease and anaesthetic implications based on actual experiences can provide deeper insights into the realms of framing standard guidelines and recommendations for their overall peri-operative management. Even after the disease will be totally eradicated, the persons afflicted with leprosy who will be otherwise cured from infection will need surgical interventions. It is essential to generate data about experiences with different anaesthetic methods/ strategies for ensuring their best contribution to success of surgery to these persons. Mitra & Gombar (2000), while reviewing the subject could find only 18 relevant papers on this subject in PubMed and other data bases.

Situation has not changed much during the last two decades after that. While identifying factors associated with outcomes of surgery contributions or problems associated with anaesthesia methods are hardly discussed (Ebenzer et al 2012). This is not deliberate but is taken for granted. As leprosy patients have local and systemic problems associated with disease, such analysis will be important. Proper documentation will help in choosing the best technique, improving the existing methods where-ever required and then ensuring the training of health care personnel involved in providing the services for anaesthesia specially in camps, district hospitals / medical colleges in remote and peripheral areas of the country.

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