

THE USE OF MAGNETIC RESONANCE IMAGING (MRI) IN IDENTIFYING POST-TRAUMATIC STRESS DISORDER

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INTRODUCTION

Research has shown that stressful or traumatic experiences associated with law enforcement in the South African Police and Correctional services can lead to Post-traumatic Stress Disorder (PTSD). In 2001 Peltzer examined the extent to which current and continuous exposure to traumatic experiences contributed to traumatic stress responses among 66 South African police officers. A modified version of the *Stressful Incidents in Police Work Scale* (Carlier & Gersons 1992) was used, as well as the *Post-Traumatic Symptom Scale (PTSS-10)* (Weisaeth 1989). Results indicated that subjects had, on average, experienced 52.5 stressful incidents (SD = 9.4), ranging from 38 to 70 stressful incidents. Kopel and Friedman (1997) found that among Internal Stability Unit members of the South African Police 49 percent met the Impact of Event Scale criteria for a diagnosis of PTSD. In 1994 Burgers noted that 36 percent of the riot police and 41 percent of black police suffered from PTSD. Suicide statistics among members of the police force is alarming when comparing the incidence of suicide among police officials in 1991 (60 out of every 100 000) with that of the general population (5 out of every 100 000) (Nel & Burgers 1998). As a result of this kind of exposure to psychological threat, literally hundreds of officers in the South African Police and Correctional Services annually claim permanent occupational disability. Furthermore, they apply to be declared medically unfit and discharged as permanently unfit for further service on grounds of Post-traumatic Stress Disorder and associated Major Depressive Disorder. It is very difficult to distinguish between a pre-existing personality or adjustment disorder and residual symptoms

of exposure to prolonged or severe stress. Furthermore, symptoms of Post-traumatic Stress Disorder are easily simulated or self-induced by prolonged alcohol abuse and members' preference for a risk-taking lifestyle. It is therefore suggested that Police and Correctional Services management consider alternative screening measures for dealing with these applications.

In South Africa, law enforcement authorities spend millions of rands (local currency) to investigate the psychiatric and psychological profiles of members exposed to traumatic experiences, which includes costly hospitalisations, psychiatric and psychological assessments, and sick leave prior to medical board hearings of injuries sustained on duty, and/or permanent occupational disability. Pending the opinion of the Board, the member may be compensated under the Military Pension Act by the Compensation Commissioner (injury on duty), and thus monetary gain might be a motivational factor in the increase of such claims. Based on evidence from the literature, as discussed in this paper, we suggest that magnetic resonance imaging (MRI) could be employed successfully as part of a psychiatric and psychological assessment of officers wishing to leave the police force and correctional services due to alleged major depression and PTSD.

LITERATURE REVIEW

According to the American Medical Association (1993), impairment can be described as an alteration of an individual's health status, or deviation from normal in a body part or organ system and its functioning. Permanent disability can be seen as a disability that has become static

or stabilised during a period of time sufficient to allow optimal tissue repair, and one that is unlikely to change in spite of further medical or surgical therapy. It is also seen as an alteration of an individual's capacity to meet personal, social, or occupational demands, or statutory or regulatory requirements, because of the impairment. According to regulations of the American Social Security Administration (SAA), as confirmed by the American Medical Association (1993), the following three concepts underlie permanent disability:

- One should be able to determine the impairment by means of medical assessment procedures;
- The impairment should prevent the individual from discharging his duties and responsibilities as a police officer (or correctional services officer) in terms of the South African Police Act 7 of 1958;
- The duration of such impairment should equal or exceed at least twelve months.

Assessment of the degree of impairment is done by taking into account the following four criteria:

- Impairment of activities of daily living;
- Markedly impairment of social functioning;
- Markedly difficulty in concentrating, failing memory, slowed thinking, and lack of perseverance;
- Markedly impairment and decomposition in occupational functioning.

According to the DSM-IV, residual functional capacity is determined by the individual's performance in the following areas (APA 1994):

- Concept formation (comprehension) and memory;
- Sustained attention and perseverance;
- Social interaction;
- Situational adjustment ability within the occupational context.

Malingering is the intentional production of false or grossly exaggerated physical or psychological symptoms, motivated by external incentives such as (within the South

African context) inability to adapt to the socio-political changes within the work place, avoidance of affirmative action associated with RDP (Reconstruction and Development Programme) initiatives that are prevalent in the post-apartheid era, avoiding work, obtaining financial compensation, evading criminal prosecution, or securing better living conditions. According to the DSM-IV, malingering should be strongly suspected if any combination of the following is noted (APA 1994):

- Medicolegal context of presentation, e.g., the person's being referred by his or her attorney to the physician for examination;
- Marked discrepancy between the person's claimed stress or disability and the objective findings;
- Lack of cooperation during the diagnostic evaluation and in complying with the prescribed treatment regimen;
- The presence of Antisocial Personality Disorder.

It is thus clear that symptoms may be misleading or grossly exaggerated. Assessment instruments that are currently widely used by psychiatrists include Anxiety Rating Scales, Depression Inventories, Impact of Event Scales, and Health Status Questionnaires. These, and even objective and standardised assessment instruments are easily subjected to manipulation and results could be grossly inaccurate. We therefore suggest that magnetic resonance imaging (MRI) be employed as part of the psychiatric and psychological assessment of officers wishing to leave the police force and correctional services due to (alleged) major depression and PTSD. The use of magnetic resonance imaging, and especially functional brain imaging techniques, has led to considerable advances in our understanding of brain processing of human visceral sensation (Aziz et al. 2000). Furthermore, it provides a remarkable opportunity for assessing and diagnosing Post-traumatic Stress Disorder, as these techniques link the neural basis of human brain functioning, as well as specifically defined brain areas, with symptoms of Post-traumatic Stress Disorder and Major Depressive Disorder (Medoff and Tagamets 2000).

Background to MRI

During the past 100 years, the field of biomedical imaging has developed from Röntgen's original discovery of the x-ray to the imaging tools of today, such as magnetic resonance imaging, computed tomography, positron emission tomography, and ultrasonography (Tempany & McNeil 2001).

Continuing developments in neuro-imaging make it possible to delineate both the structural and functional anatomy of the human brain *in vivo* in increasingly greater detail. Neuro-imaging has proven useful in confirming the clinical diagnosis of certain neuropsychiatric conditions, and as an aid to understanding certain brain-behaviour relationships. Contemporary neuro-imaging techniques could broadly be divided under two headings, namely structural neuro-imaging, which includes techniques such as computed tomography (CT) and magnetic resonance imaging (MRI), and functional neuro-imaging, which includes positron emission tomography and single photon emission computed tomography. The use of especially functional brain imaging techniques has led to considerable advances in our understanding of brain processing of human visceral sensation (Aziz et al. 2000) and provides a remarkable opportunity for studying the neural basis of human brain function. Usually the goal of these studies is the localisation of specific task components to defined brain areas (Medoff & Tagamets 2000). Traditionally the MRI uses radio waves and a strong magnetic field rather than x-rays to provide remarkably clear and detailed pictures of internal organs and tissues.

The role of the hippocampus medial prefrontal in PTSD

The hippocampus and medial prefrontal cortex play important roles in memory and emotional regulation, and dysfunction in these areas may underlie memory deficits and pathological emotions in PTSD (Bremner 1999). Furthermore, pre-clinical research conducted over the past decade has shown that experimental stressors (e.g. restraint stress or social stress) can result in functional and

morphological changes within the hippocampus in rodents and primates (Sapolsky et al. 1990; Sapolsky 1994; Gould 1994). There are also many reports in the literature noting that hippocampal damage leads to the memory problem in humans and other primates (Squire & Zola-Morgan 1991; Miller et al. 1993; Zola-Morgan & Squire 1993; Zola-Morgan et al. 1994; Alvarez et al. 1995). Various authors commented on significant memory impairment in patients with PTSD (Sutker et al. 1991; Bremner et al. 1993a, 1995a; Gurvits et al. 1993; Uddo Vasterling et al. 1993; Yehuda et al. 1995). McEwen in 1997 also noted that hippocampal shrinkage is usually accompanied by deficits in declarative, episodic, spatial and contextual memory performance and the hippocampal changes provide a neural substrate for changes in cognitive function that have been recognised to accompany these conditions associated with PTSD.

Elevations of glucocorticoids, because of stress-induced augment the extra cellular accumulation of excitatory amino acids (EAAs), such as glutamate and result in hippocampal damage (Moghaddam et al. 1994; Stein-Behrens et al. 1994). The result is reduced cell sprouting and neuronal cell death, particularly in the CA3 region (Stein-Behrens et al. 1994) as well as impaired learning and memory (Luine et al. 1994; Alvarez et al. 1995; Bodnoff *et al.* 1995).

MRI used for PTSD diagnoses

Many researchers have determined that there is radiological evidence of hippocampal damage in patients presenting with PTSD (Bremner et al. 1995b, 1997; Gurvits et al. 1996).

Bremner and coworkers in 1995b, indicated that male combat veterans with PTSD had reduced MRI-derived right-sided hippocampal volume compared to control subjects and, moreover, that certain aspects of their memory deficit were correlated with hippocampal volume. Reduced hippocampal volume in male combat veterans with PTSD was also suggested by Gurvits et al., (1996).

Bremner et al. (1997) also demonstrated a 12 percent reduction in left-sided hippocampal volume in a mixed sample of men and women who experienced PTSD as a result of abuse in childhood.

In 1999 Bremner reported that positron emission tomography (PET) studies indicated a dysfunction of medial and orbital prefrontal cortex during PTSD symptom provocation and in response to traumatic reminders (Bremner 1999). Decreased benzodiazepine receptor binding was found in the medial prefrontal cortex as measured with neuro-imaging in PTSD.

Stein and coworker in 1997 employed MRI-based measurements to assess hippocampal volume in women who experienced PTSD due to childhood sexual abuse (Breslau et al. 1993; Kessler et al. 1995) in comparison to a control group of non-victimised women. The authors hypothesised that women who experienced CSA would have smaller hippocampi than the non-abused subjects.

In 2001 Villareal and King also reported that MRI volumetric studies have indicated decreased hippocampal volumes in PTSD. In addition to this, proton magnetic resonance spectroscopy studies report decreased N-acetyl aspartate (NAA) ratios and absolute concentrations in the medial temporal lobe. Furthermore, Villareal and King noted that, although still controversial, these findings from volumetric and spectroscopic studies are thought to represent decreased neuronal density of the hippocampus. Functional imaging studies document different patterns of limbic and paralimbic structure activation in PTSD compared with controls. Of theoretical importance are findings of failure to activate the anterior cingulate as well as amygdala activation during symptom provocation studies. Also, increased amygdala activation was found with a behavioural task targeted to this structure. The authors also presented a neurobiological model that proposes that, central to symptom mediation, a dysfunction of the anterior cingulate occurs, resulting in a failure to inhibit amygdala activation and/or an intrinsic lower

threshold of amygdala response to fearful stimuli. The model further proposes that hippocampal atrophy is a result of the chronic hyperarousal symptoms mediated by amygdala activation.

To complement magnetic resonance imaging, and functional brain imaging techniques, blood and urine samples might also be requested. As a result of exposure to prolonged or acute stressors, the hypothalamus secretes substances called corticotrophin-releasing factors (CRF), which induce the anterior pituitary gland to secrete adrenocorticotrophic hormones (ACTH). The ACTH then circulates in the blood and eventually reaches the cortex region of the adrenal gland. The adrenal cortex of the adrenal gland in return produces corticoids as a direct response to the level of ACTH in the blood. Two categories of corticoids, namely mineralocorticoids and glucocorticoids, seems to dominate the output of the adrenal cortex. Mineralocorticoids assist the body in regulation of mineral levels, specifically sodium, potassium, and chloride. Since these minerals play a vital role in neuron functioning, disturbances in mineralocorticoids have an impact on cognitive functioning. Furthermore, glucocorticoids are elevated during periods of stress, as they promote the conversion of stored proteins and fats to glucose, which is important for increased energy and the repair of damaged tissue. In particular, 17-hydroxycorticosteroid (17-OHCS) can be extremely useful as a physiological index of psychological stress, and can be measured through blood or urine samples. The 17-OHCS levels can be used as an index of how stressed an individual feels at any particular time (Levinthal 1983). Furthermore the hypothalamus activates the adrenal medulla of the adrenal gland to secrete adrenalin and noradrenalin (also referred to as epinephrine and norepinephrine respectively), resulting in increased palpitations, constriction of blood vessels, and increased muscle tone. Except for the CRF from the hypothalamus, ACTH production is also controlled by the output of adrenalin and noradrenalin by the adrenal medulla (Levinthal 1983). These levels can also be measured

through blood samples to confirm a diagnosis of PTSD.

CONCLUSION

In the light of South Africa's limited resources, unnecessary loss of manpower and a "money-drain" from law enforcement services should be prevented. Since disability claims due to Post-traumatic Stress Disorder are steadily increasing, and since symptoms of Post-traumatic Stress Disorder are easily simulated due to external motivational factors, a multidisciplinary team of independent physicians, psychiatrists, psychologists, and neurologists should assess individuals presenting with PTSD, claiming occupational disability. We thus recommend the use of magnetic resonance imaging, functional brain imaging techniques, as well as blood sampling as complementary assessment regimen in the diagnosis of PTSD. In this way the multiple and related contributions of medical, psychological, and neurological professionals can render valid, clear, and reliable data to assist decision-making authorities during Medical Board hearings concerning disability claims on the basis of PTSD.

Law enforcement authorities are also advised to refer members who have been exposed to severe and/or prolonged stressors for a scan once such members start experiencing symptoms, in order to detect impairment at an early stage of deterioration. Annual screening of affected individuals could thus be implemented as a preventive routine, ensuring that intervention is started in time. Although magnetic resonance imaging and functional brain imaging techniques are expensive, such a preventive regimen by far outweighs the financial burden of law enforcement members being discharged as permanently unfit for further service on grounds of Post-traumatic Stress Disorder and associated Major Depressive Disorder.

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