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Brain Injury and Cerebral Lateralization

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1. Introduction

The aim of my manuscript will be to explicate the associations among cerebral lateralization, especially left-handedness, decreased longevity, the age of menopause, asymmetries in the bone mineral densities, the asymmetries in common carotid artery intima-media thickness and the risk of sudden death of brain infarction.

2. Left-handedness and decreased longevity

Life span studies[1,2,3,4,5,6,7,8] have shown that the population percentage of left-handers diminishes steadily, so that they are drastically underrepresented in the oldest age groups. This population trend suggests the reduced longevity of left-handers[9]. Coren and Halpern (1991) suggest that some of the elevated risk for left-handers is apparently due to environmental factors that elevate their accident susceptibility. Also, left-handedness may be a marker for birth stress related neuropathy, developmental delays and irregularities, and deficiencies in the immune system due to the intrauterine hormonal environment. Halpern and Coren (1990) have argued that left-handedness is associated with a younger age at death[10].

Coren (1989) and Halpern and Coren (1991) reported that left-handers were more susceptible to accident-related injuries and more left-handers died in accidents than right-handers[11,12]. Zverev and Adeloye (2001) reported that left-handedness as a risk factor for head injuries obtained during confrontation activities[13]. Also, an increased prevalence of left hand preference was noted in a population of patients having traumatic brain injuries (MacNiven, 1994)[14]. Dane, Karsan and Can (1999) showed that left-handers may be more susceptible to sport-related injuries[15]. Graham and Cleveland (1995) and Wright, Williams, Currie and Beattie (1996) suggested that left-handedness appears to be a risk factor for injury among adolescent school athletes[16,17]. Also, left-handed locomotive drivers were more likely to be involved in accidents (Bhushan & Khan, 2006)[18].

Also, Canakci, Akgul, Akgul, and Canakci (2003) reported that left-handed participants had a significantly higher dental trauma risk than right-handedness[19]. Dagistan, Gursoy, Cakur, Miloglu, Harorli, and Dane (2009) also studied the relation of left-handedness and risk of dental trauma in professional boxers[20]. The left-handed boxers had the higher dental trauma risk than right handed ones. Also, the rate of left-handedness was elevated in men diagnosed with fractures than for all other male patients (Stellman, Wynder, DeRose & Muscat, 1997)[21] and it was demonstrated that the non right-handers were at greater risk for bone breaks and fractures (Coren & Previc, 1996)[22].

Coren (1989) suggested that environmental biases against left-handers were the most likely reason for the increased injury risk in left-handers[23]. Really, furniture, doors of homes, playground apparatus for children, and automobile designs are based on right-handed world. Also, it has been suggested that the biological differences between right- and left-handers might play a role in increased injury risk of left-handers. Graham, Dick, Rickert and Glenn (1993) reported that the proportion of hospitalized left-handed children for injury treatment was larger than the proportion of right-handers and suggested that left-handedness is a risk factor for unintentional injury in children and adolescents in a pediatric emergency department population[24].

It has been claimed that the biological differences in terms of ear advantage[25,26] (Dane & Bayirli, 1998; Aydin, Dane, Ozturk, Uslu, Gumustekin, & Kirpinar, 2001), eye preference[27,28,29] (Dane & Gumustekin, 2002; Dane, Gumustekin, Yazici, & Baykal, 2003; Dane, 2006), nasal cycle[30,31] (Dane & Balci, 2007; Searleman, Hornung, Stein, & Brzuszkiewicz, 2005), and reaction time[32] (Dane & Erzurumluoglu, 2003) between right- and left-handers may contribute to the higher rate of injury in left-handers than in right-handers. Because, contradistinctions in intrinsic biological factors such as ear advantage, eye preference, nasal cycle and reaction time in left-handers may be associated with reversal perception of environment in comparison with right-handers and therefore increased accident related injuries.

However, there are also studies which show no elevated injury risk[33,34] (Peters & Perry, 1991; Hicks, Pass, Freeman, Bautista, & Johnson, 1993). Also, it has been reported that the risk of hand injury was similar for right- and left-handers and individuals with consistent hand preference, regardless of side, were more likely to injure their preferred hand when compared to mixed preference types[35] (Porac, 1993).

3. The age of menopause and left-handedness

It was reported that the early menopause occurs more often in left-handed than right-handed women[36,37,38,39] (Leidy, 1990; Nikolova, Negrev, Stoyanov, & Nikolova 1996; Dane, Reis, & Pasinlioglu, 1999; Dane, Kumtepe, Pasinlioglu, & Aksoy, 2004). It has been suggested that the early menopause in left-handed women may result from the differences in the immune activity between the right- and left-handers[39]. The cell-mediated immune activity and cell-mediated immune hypersensitivity (tuberculin reaction) were stronger in left-handed than right-handed women[39]; the age of menopause negatively correlated with tuberculin reaction and percentages of CD4+ and CD8+ lymphocytes[39], indicating that autoimmune reactions against hormone receptor sites[40] (Escobar et al., 1982) or oocytes[41,42] (Maclaren & Blizzard, 1985; Rabinowe et al., 1989) may cause early menopause. In some studies, it has been also reported that immune activity was powered in left-handed persons than in right-handed ones[43,44,45,46] (Dane & Tan, 1994; Köylü et al., 1996; Battcock et al., 1990; Ertunç et al., 1997).

4. The bone fractures and left-handedness

The bone mineral density is a marker of the collagen content of bones. Therefore, the higher bone mineral densities in the right-handers compared to the left-handers may be associated with the higher collagen content of bones of the right-handers. Dane, Akar, Hacibeyoglu, and Varoglu (2001), Akar, Sivrikaya, Canikli, and Varoglu (2002) and Gumustekin, Akar,

Dane, Yildirim, Seven, and Varoglu (2004) reported that hand preference may be related to the right-left asymmetry in femoral bone mineral density[47,48,49].
In a resent study, the bone mineral densities of both right and left proximal femur regions except Ward's region were higher in right-handed subjects compared to left-handed ones[50]. It can be stated that right-handed subjects have decreased risk of bone fracture than left-handed subjects.
The decreased bone mineral densities in left-handed participants compared to right-handers may be associated with the increased risk of bone breaks and fractures in left-handers[21, 22] (Stellman, et al., 1997; Coren & Previc, 1996) because the decreased bone mineral density is a good marker of bone fractures. Also, it can be stated that left-handed wictims will have more severe consequences during accident.
The decreased bone mineral density in left-handers may also associated with higher injury risk of smaller traumas. The measured bone mineral densities were within normal ranges in all subjects. The effect sizes of sex and handedness are similar. Therefore, left-handedness and female sex can be considered possible risk factors for bone fractures.
In above mentioned study, the bone mineral densities of both right and left all proximal femur regions were higher in men than in women[50]. The rate of left-handedness was elevated for men diagnosed with bone fractures when compared with all other male patients in a case-control study of 8.801 hospitalized patients with cancer and those with other conditions, but this relation was absent in women patients[21] (Stellman, et al., 1997). Aggleton, Kentridge, and Neave (1993) and Aggleton, Bland, Kentridge, and Neave (1994) reported that the left-handed men, but not the left-handed women, were more likely to die prematurely in accidents or in warfare[5,6]. Also, Dagistan, et al. (2009) reported that left-handed boxer men had higher dental trauma risk than right-handed boxers[20].
Coren and Previc (1996) reported the results of two studies[22]. On study 1 retrospective responses were used from medical history checklists completed by 1064 males on active duty with the United States Air Force. The left-handers were at significantly higher risk for knee problems, elbow and shoulder problems, and also swollen and painful joints, although there was no difference in the incidence of broken bones. On study 2 an expanded handedness scale and retrospective reports of both bone breaks and fractures for a predominantly university sample of 1.716 (975 women, 741 men) whose median age was 20 years, indicated that non right-handers were at greater risk for bone breaks and fractures.
In another study[51], ambidextrous men had slightly elevated risk of traffic and home injury, whereas ambidextrous women had slightly elevated risk of work injury compared with right-handers (Pekkarinen, Salminen & Järvelin, 2003).
Boote, Hayes, Abahussin, and Meek (2006) reported that fibrillar collagen in the human cornea and limbus is arranged anisotropically, and left and right corneas are structurally distinct[52]. Also, Dane, Aslankurt, and Yazici (2007) reported the cataracts formed earlier in the dominant eye for both right- and left-eye dominant patients[53]. This difference by handedness may also be associated with asymmetry in collagen content or structure of the lens by handedness in patients.
As a consequence, the higher susceptibility of the left-handed subjects for accident-related injuries such as bone fractures may be associated with lower bone mineral density in the left-handed participants than in the right-handed. Also, sex related differences in accident-related injuries may be explained by differences in bone mineral density by handedness in women.

5. Asymmetry in carotid artery

Arterisclerosis is a chronic disease of the arterial system characterized by abnormal thickening and hardening of the wessel walls. In arterosclerosis, the tunica intima undergoes a series of changes that decrease the artery's ability to change lumen size. Smooth moscle cells and collagen fibers migrate into the tunica intima, causing it to stiffen and thicken. This process gradually narrows the arterial lume. Common carotid intima-media thickness (CCA-IMT) has been shown to be associated with atherosclerosis and stroke[54,55,56,57,58,59,60,61,62]. Increased CCA-IMT determined by B-mode ultrasonography has been shown to be directly associated with an increased risk of myocardial infarction and stroke in older adults without a previous history of cardiovascular disease[62,63].

It has been reported that left-handed, not right-sided, brain infarction was associated with increased risk of sudden death and left-handed or ambidextrous patients have a lower risk of sudden death than right-handed patients[64].

Rodriguez-Hernandez et al. (2003) compared left and right common carotid artery intima-media thickness as measured by B-mode ultrasonography and reported that the difference between both sides was significant (left, 0.75 ± 0.11 mm, right, 0.71 ± 0.11 mm)[65]. Also, they reported that the incidence of nonlacunar cerebrovascular stroke was significantly higher at the left side and suggested a predilection for cerebrovascular disease at the left side, which may be related to greater hemodynamic stres and intimal damage in the left carotid artery. Also, Denairo et al. (2000) have reported that CCA-IMT was lower on the right side than on the left side in both sexes[66].

Bogren et al. (1994) have reported that all right-handed subjects in their study had higher flow rates in the left internal carotid artery than in the right, and all left-handed subjects had higher flow rates in the right internal carotid artery than in the left[67].

In the study performed by Onbas et al. (2007), there was a difference between ıntima media thicknesses of the left and right common carotid artery, with higher values on the left side[68]. In some earlier studies, CCA-IMT was also higher on left side than on right side[65,66,69,70].

Rodriguez-Hernandez et al. (2003) reported that the incidence of nonlacunar cerebrovascular stroke was significantly higher at the left side[65]. Algra et al. (2003) reported that left-sided, not right-sided, brain infarction was associated with increased risk of sudden death[64]. In the light of these studies, it can be speculated that there is a predilection for cerebrovascular disease at the left side, which may be related to greater hemodynamic stress and intimal damage in the left carotid artery.

But, a common pathophysiological mechanism associated with the higher IMT in the left CCA and the more frequent occurrence of stroke in the left hemisphere is unclear. The higher IMT in the left CCA may result from the fact that the cell-mediated (T cell-dependent) hypersensitivity was higher in the left side of the body than the right side[71,72,73].

Because atherosclerosis is a chronic inflammatory disease[74,75], its pathogenesis involves disturbed lipoprotein metabolism, the formation of proinflammatory lipid peroxidation products, and the host's immune responses[76,77]. Oxidized LDL is present in atherosclerotic lesions and contains a wide variety of lipid peroxidation products, which in turn can form neo-self determinants recognized by specific innate and adaptive immune responses[78,79]. During atherogenesis, LDL is oxidized, generating various oxidation-specific neopeptides, such as malondialdehyde-modified LDL or the phosphorylcholine head group of oxidized phospholipids. These epitopes are recognized by both adaptive T cell-dependent and innate T cell-independent type 2 immune responses[80,81].

In the study performed by Onbas et al. (2007), the difference in CCA-IMT between right and left sides was statistically significant in the left handers, but not in the right-handers[82]. The greater difference in the left-handers may be due to a more active and effective immune system in the left-handers than in the right-handers[39, 43, 44, 45, 46].
Also, in the study performed by Onbas et al. (2007), handedness related differences in CCA-IMT demonstrated. Both right and left CCA-IMTs were lower in the left-handers than in the right-handers. They speculated that a lower risk of sudden death in the left-handed or ambidextrous patients than the right-handed patients in brain infarction[64], may be associated with the lower IMT in the left-handers. The lower CCA-IMT on both sides for the left-handers may result from the handedness related differences in carotid artery blood flow in healthy subjects measured with MR velocity mapping[67].

6. References

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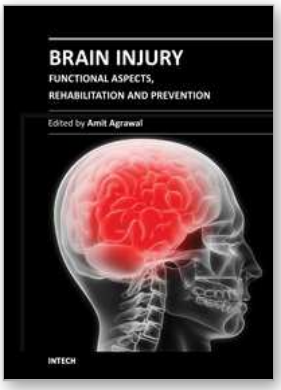

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The present two volume book "Brain Injury" is distinctive in its presentation and includes a wealth of updated information on many aspects in the field of brain injury. The Book is devoted to the pathogenesis of brain injury, concepts in cerebral blood flow and metabolism, investigative approaches and monitoring of brain injured, different protective mechanisms and recovery and management approach to these individuals, functional and endocrine aspects of brain injuries, approaches to rehabilitation of brain injured and preventive aspects of traumatic brain injuries. The collective contribution from experts in brain injury research area would be successfully conveyed to the readers and readers will find this book to be a valuable guide to further develop their understanding about brain injury.

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