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Pathophysiology 22 (2015) 1–13

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Mobile phone and cordless phone use and the risk for glioma – Analysis of pooled case-control studies in Sweden, 1997–2003 and 2007–2009

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Received 16 April 2014; received in revised form 25 September 2014; accepted 16 October 2014

Abstract

We made a pooled analysis of two case-control studies on malignant brain tumours with patients diagnosed during 1997–2003 and 2007–2009. They were aged 20–80 years and 18–75 years, respectively, at the time of diagnosis. Only cases with histopathological verification of the tumour were included. Population-based controls, matched on age and gender, were used. Exposures were assessed by questionnaire. The whole reference group was used in the unconditional regression analysis adjusted for gender, age, year of diagnosis, and socio-economic index. In total, 1498 (89%) cases and 3530 (87%) controls participated. Mobile phone use increased the risk of glioma, OR = 1.3, 95% CI = 1.1–1.6 overall, increasing to OR = 3.0, 95% CI = 1.7–5.2 in the >25 year latency group. Use of cordless phones increased the risk to OR = 1.4, 95% CI = 1.1–1.7, with highest risk in the >15–20 years latency group yielding OR = 1.7, 95% CI = 1.1–2.5. The OR increased statistically significant both per 100 h of cumulative use, and per year of latency for mobile and cordless phone use. Highest ORs overall were found for ipsilateral mobile or cordless phone use, OR = 1.8, 95% CI = 1.4–2.2 and OR = 1.7, 95% CI = 1.3–2.1, respectively. The highest risk was found for glioma in the temporal lobe. First use of mobile or cordless phone before the age of 20 gave higher OR for glioma than in later age groups.

Keywords: Ipsilateral; 25 years latency; Time since first exposure; Glioma; Wireless phones

1. Introduction

There has been a large worldwide increase during the last decade in the use of wireless communication, with greater exposure to radiofrequency electromagnetic fields (RF-EMF). This has caused increasing concern for health risk. During use of both mobile and cordless phones, the brain is the main target of RF-EMF. The highest exposure is on the same side of the brain when the handheld phone is used (ipsilateral), whereas the contralateral side is less exposed [1]. Due to the smaller head size, thinner skull bones and higher brain conductivity, a child absorbs higher rates than adults [2–4].

Our group reported the first indication of an increased brain tumour risk associated with use of wireless phones some 15 years ago [5–7]. This was followed by additional case-control studies as reviewed in Hardell et al. [8]. A Danish cohort study on mobile phone users has been initiated [9], but poor exposure assessment makes it uninformative [10,11].

The International Agency for Research on Cancer (IARC) at WHO evaluated human cancer risks from RF-EMF exposure in May 2011. It included all sources in the frequency range of 30 kHz–300 GHz. A total of 29 invited scientists participated. The final classification as Group 2B means that RF-EMF exposure is 'possibly' a human carcinogen, a conclusion based on an overwhelming majority of the voting experts [10,12].

The evaluation on the long-term use of wireless phones, i.e. >10 years, were in the IARC classification based on our results [13–15] and the Interphone study group, also preprint studies available [16–18]. The brain tumours associated with the use of wireless phones are the malignant types, mostly

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http://dx.doi.org/10.1016/j.pathophys.2014.10.001
0928-4680/

glioma, and acoustic neuroma, a benign tumour of the 8th cranial nerve. In contrast, no consistent pattern of an association has been found for the most common benign brain tumour, meningioma [see also reviews in [8,19,20]. The Interphone results were reported only on the use of mobile phones, whereas we also included cordless phones in our assessment. The potential bias due to this different classification of exposure that distorts of the overall risk towards unity has been discussed elsewhere [8,21].

The IARC evaluation was based on fairly short latency period (time from first exposure until diagnosis), with results on at most the latency group ≥10 years. To study longer periods of use, we made a new case-control study encompassing patients diagnosed from 2007 to 2009. Data have already been published on acoustic neuroma [22], meningioma, [23] and malignant brain tumours in total [24].

To enlarge the study group, we have now pooled our results on malignant brain tumours for 1997–2003 and 2007–2009, because the same methods were used for both periods. We present in the following results for the most common type of malignant brain tumour, glioma. It is of importance to present separate results on glioma to compare our results with Interphone [16]. Also, separate analysis of other malignant brain tumour types is presented. The ethics committee approved these studies.

2. Materials and methods

Detailed information on materials and methods has been given previously [13,24]. In short, six administrative regions with oncology centres covering Sweden registered new cancer cases. For 1997–2003, cases and controls covered central Sweden [13], whereas the 2007–2009 study included the whole country [24]. The oncology centres reported new cases with histopathologically verified brain tumour, either benign or malignant, to us during these periods, although the actual reporting interval varied for centre to centre. Both men and women were included aged 20–80 years (1997–2003) and 18–75 years (2007–2009) at the time of diagnosis. Only living cases were included, each patient giving permission to the responsible physician before inclusion in the study. Tumour localisation in the brain was based on reports to the cancer registries and medical records, which were obtained after informed consent from the patients.

Controls were ascertained from the Swedish Population Registry, covering the whole country and being continuously updated, such that each person was traced by a unique ID number. The registry also records the address to each person. For each case, one control subject of the same gender in the same 5-year group was drawn at random from this registry. They were assigned the same year for cut-off of all exposure as the diagnosis of the each case. All these controls were used in the analysis of risk of glioma.

Exposure was assessed using a mailed questionnaire sent to each person. Regarding use of a mobile phone, the time of average use (min per day) was estimated. The technology has changed since the first introduction of mobile phones. The first generation was analogue phones with an output power of 1 W at about 900 MHz followed by the 2nd generation GSM phones (2G) with either 900 or 1800 MHz frequency and with a pulsed output power. The mean output power was of the order of tens of mW. In the 3rd generation phones (3G) the output is more to be characterised as amplitude modulated than pulsed and the output power is of the order of tens of μW. The type of mobile phone was recorded and checked by the prefix for the phone number; 010 for analogue phones and 07 for digital phones (2G, 3G).

Some special questions covered the extent of use in a car with an external antenna, and use of a hands-free device, both regarded as non-exposure to RF-EMF. The ear mostly used during phone calls, or equally both ears, was also noted.

Use of cordless desktop phones was covered by similar questions; years, average daily use, use of a hands-free device, and preferred ear. The procedure was conducted without knowledge of case/control status. Use of the wireless phone was referred to as ipsilateral (≥50% of the time) or contralateral (<50% of the time) in relation to tumour side. The same method was also applied for the control group; the subjects were assigned the same 'tumour' side as the respective case to the matched control.

The questionnaire also contained a number of questions relating to the overall working history, exposure to different chemicals and other agents, smoking habits, X-ray investigations of the head and neck, and heredity traits for cancer. These other exposure factors will be published separately for the whole study period. When questionnaire answers were unclear, they were resolved by phone using trained interviewers. Thereby, a written protocol was used for clarification of each question. The interviewer supplemented the whole questionnaire during the phone call. Each questionnaire had received a unique ID number that did not disclose whether it was a case or a control; i.e. the interviewer was unaware of the status during further data processing. All information was coded and entered into a database. Case or control status was not disclosed until statistical analyses were undertaken.

We made in addition a separate case-control study on deceased cases during for 1997–2003, using deceased persons as reference entities by interviewing the next of kin [25], see discussion below. These cases and controls are not included in the present study.

2.1. Statistical methods

StataSE 12.1 (Stata/SE 12.1 for Windows; StataCorp., College Station TX) was used for the analyses. Odds ratios (OR) and 95% confidence intervals (CI) were calculated using unconditional logistic regression including the whole control sample (i.e. matched to both malignant and benign cases) to increase the power of the study.

Latency (time from first use) was defined as the year of first use of a wireless phone to the year of diagnosis (the