Neuropsychiatric Disease and Treatment

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ORIGINAL RESEARCH

Incidental intracranial pathology: a retrospective case review of structural neuroimaging results amongst young adult psychiatric patients

This article was published in the following Dove Press journal:
Neuropsychiatric Disease and Treatment

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Objective: Given that there continue to be conflicting recommendations on the inclusion of routine structural neuroimaging amongst the investigations ordered in psychiatric patients, our group aimed to add to the data on intracranial pathology amongst, specifically, the young adult psychiatric population. This is a novel study in that it includes all presentations (mania, depression, psychosis, anxiety, substance use disorders) and presents, to the authors' knowledge, the largest cohort of imaging results amongst this group.

Method: The neuroimaging (CT and MRI) reports of 224 patients admitted to the Young Adult Assessment, Evaluation and Reintegration Unit (12-A) at the Alberta Hospital Edmonton (AHE) between the years of 2012–2015 were reviewed, and all findings were classified into one of four categories (normal, abnormal/benign, abnormal and unlikely linked to symptoms, and abnormal with possible link to symptoms). This study is largely a review of CT scans, as there were only six MRI reports available in the study population.

Results: In total, 86.6% of findings were classified as normal. Amongst the scans with abnormal findings, 10.7% were deemed benign and non-specific. 1.8% of abnormal findings required an outside consultation or follow-up, but were unlikely linked to symptoms; and 0.9% were deemed possibly causally related to symptoms, though follow-up imaging deemed otherwise. The most prevalent findings were cerebral atrophy (n=6), arachnoid cysts (n=5), ventricular asymmetry (n=3), and cavum septum pellucidum (n=3).

Conclusions: This study represents the largest cohort of incidental findings in the young adult psychiatric population. These findings do not support the practice of ordering structural imaging tests in the young adult (17–26 years) psychiatric population. This suggestion agrees with recent recommendations on this question, and highlights the need for ongoing review in this area.

Keywords: computed tomography scan, magnetic resonance imaging, incidental findings, intracranial anomalies

Introduction

The question of whether psychiatric patients should be screened with structural neuroimaging remains unclear. The Canadian Clinical Practice Guidelines for the Treatment of Schizophrenia, for example, continue to recommend computed tomography or magnetic resonance imaging at illness onset and in patients with refractory illness (level B evidence).[1] The rationale cited is that patients with schizophrenia are said to have an increased prevalence of structural brain abnormalities.[1] On the other hand, the recent Choosing Wisely Canada Campaign, a partnership with the Canadian Medical Association which is aimed to "help physicians and patients engage in

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DovePress
http://doi.org/10.2147/NDT.S192200

conversations about unnecessary tests, treatments, and procedures" has suggested that clinicians do not routinely order brain neuroimaging (CT or MRI) in first episode psychoses in the absence of signs or symptoms suggestive of intracranial pathology.[2] They posit that multiple studies have found that routine neuroimaging in first episode psychoses does not yield findings which alter clinical management in a meaningful way, and that the risks of radiation exposure and delay in treatment also argue against its use.[2]

It is known that psychiatric patients do have structural brain abnormalities, particularly patients with psychotic illnesses. Gewirtz et al.[3] examined a cohort of 168 psychotic patients and found "CT findings of note" in 6.6% of patients, with cortical atrophy being the most prevalent finding, at 40% of patients. The findings were said to support the proposal that onset of psychosis be an indication for CT. Similarly, Lubman et al.[4] reviewed 340 MRI reports of first episode patients, chronic schizophrenics, and controls, and found that patients with chronic schizophrenia were most likely to have clinically significant abnormal scans. Also, in four patients, the MRI findings led to the discovery of previously unsuspected pathology.[4] Therefore, they concluded that a small proportion of patients benefited directly from MRI scanning. In a 2006 study of 435 psychiatric inpatients at a Swiss hospital, neurologic signs on exam and advanced patient age were identified as predictors of abnormal neuroimaging scan results; however, these factors were not sensitive enough to predict all significant findings.[5]

Others still recommend against routing neuroimaging in the psychiatric population. Several prospective[6] and retrospective[7–12] analyses published in the 1980s and 1990s sought to examine the use of brain imaging in psychiatry, the results of which have been summarized elsewhere.[5] These studies aimed to determine the proportion of abnormal results and changes to diagnoses and management, identify risk factors for abnormal scans, and make recommendations on when brain imaging should be considered. While the number of abnormal scans in this group of studies was anywhere between 15% and 53% (excluding changes related to alcohol abuse), the proportion of changed diagnoses was 18% in one study and less than 7% in all other studies. Overall, these studies suggest that routine neuroimaging does not frequently alter diagnosis or management in the absence of clinical history or physical exam findings suggestive of structural intracranial pathology contributing to the symptoms.[6,10] In 2008, a NICE technology appraisal guidance was published stating structural neuroimaging techniques are not recommended as a routine part of the initial investigations for the management of first-episode psychosis.[13] Locally, a recent study was completed by Goulet et al.[14] stating routine CT or MRI scans are of little benefit and should be reserved for situations where history or examination suggests neurological causation, or possibly for people aged 50 years and older. Other groups agree that neuroimaging may not be required amongst first episode psychosis patients: Khandanpour et al[15] reviewed 112 consecutive cerebral MRI and 204 consecutive CT examinations and concluded they were unlikely to reveal disease leading to a significant change in management, while Williams et al.[16] reviewed imaging results in over 100 12–30-year-old patients with first episode psychosis, and found 0% of cases to have remarkable neurological findings related to the presentation which would require non-psychiatric treatment, a finding much lower than their expected rate of 3% based on population data.

Aside from arguments suggesting its lack of diagnostic utility or influence on management, other reasons stated to avoid structural neuroimaging in the psychiatric population are economically-based. Albon et al.[17] completed a thorough and comprehensive economic evaluation on structural neuroimaging in psychosis, and concluded that the economic impact of screening can be cost incurring, particularly with use of MRI. Adams et al[18] also state the imaging is not cost-effective in this population and has little utility.

One must also consider the potential of the screening procedure itself to be anxiety provoking to the patient (especially those prone to claustrophobia), as well as the consequence of producing apprehension after an incidental finding is identified and the patient is waiting to discuss its significance with a consultant. It is known that asymptomatic subjects themselves may have a variety of structural brain abnormalities. An oft cited 1999 study of 1,000 healthy volunteers ranging in age from 3–83 years found 18% of scans to be abnormal, and, although 15.1% required no referral, 1.8% were classified as a routine referral, and 1.1% required an urgent referral.[19] A more recent systematic review and meta-analysis on the topic of incidental findings in the general population suggested a prevalence of neoplastic findings at 0.70% and non-neoplastic findings at 2.0%.[20] The group calculated the "number of asymptomatic people needed to scan to detect any incidental brain finding" at 37 individuals. With this in mind, one would expect to find a frequency of at-least that

of the general population when imaging psychiatric patients, and these results might cause unnecessary apprehension.

Despite these conflicting findings and recommendations, most research in the literature seems focused on the first episode psychosis population, which is often poorly defined to begin with, and there is little reported data outside of this group. Our team was interested in studying the prevalence of incidental intracranial pathology amongst all presentations, not just first episode psychosis. We looked at the population admitted to the Young Adult Assessment, Evaluation, and Reintegration Unit (12-A) at The Alberta Hospital Edmonton, which has been operating since 2012 and is an 20-bed inpatient unit open to patients aged 17–26 years who meet certain inclusion and exclusion criteria. To our knowledge, this study presents the first and largest study of its kind.

Method

Ethics approval was sought and obtained for this retrospective chart review in accordance with the University of Alberta's Research Ethics Office. The study received a waiver of consent because the research involves no more than minimal risk to the subjects, the waiver or alteration will not adversely affect the rights and welfare of the subjects, and the research could not practically (feasibly) be carried out without the waiver.

We first obtained a list of all patients admitted to Unit 12-A from its inception in October 2012 through to October 2015. There were a total of 822 patients admitted during this period, and 224 of these received a non-contrast CT scan of the head at the Alberta Hospital Edmonton.

The study only included patients with first episode psychiatric admission and no associated gross neurological deficits.

We designed an abstracting form to record patient demography to capture age, gender, reason for presentation to the acute psychiatric unit, duration of symptoms, possible biological comorbidities, indication for CT scan, and findings on CT scan reported by an experienced radiologist. We reviewed charts and recorded findings on the abstracting form. CT examinations of 224 patients were reviewed for the presence or absence of hemorrhage; presence or absence of infarction; site and size of hemorrhage or infarction; evidence of arterial thrombus; effacement of cerebral gyri and/or fissures; and prominence of the cerebral ventricles, gyri, fissures, as well as the effacement of the gray–white matter interface. Patients with positive findings were compared with neuro-psychiatric presentations and diagnosis.

Scans were classified into one of four categories, as used and described elsewhere in the literature: (1) normal; (2) abnormal, with no clinical impact (benign or non-specific findings with no implication on diagnosis, management, or treatment); (3) abnormal, with implication on management or treatment, but an unlikely causal link to psychotic symptoms; and (4) abnormal, with implication on management or treatment, and a possible causal link to psychotic symptoms.

Results

We identified a total of 224 scans that met our inclusion criteria; these were comprised of 164 male patients and 60 females. The mean age in our sample was 20.97 years. The diagnostic category occurring with the greatest frequency was major depressive disorder (n=40), followed by unspecified schizophrenia spectrum and other psychotic disorder (n=38), and schizophrenia (n=35).

Of all scans analyzed, 194 were described as normal (first category; 86.6%) and 30 were noted to have findings of interest (second, third, and fourth categories; 13.4%). Of these, 24 (10.7%) fell into the second category (ie, abnormal, with no clinical impact) and four (1.8%) fell into the third category (abnormal, with an implication on management or treatment, but an unlikely causal link to psychiatric symptoms), with two (0.9%) in the final category (abnormal, with an implication on management or treatment, and a possible causal link to psychiatric symptoms; see Table 1).

The findings in the second category included benign cysts, a prominent arachnoid granulation, cerebral atrophy, mega cisterna magna, asymmetric ventricles, cavum septum pellucidum, prominent extra axial space/dehydration, and possible artifacts. Third category findings included moderate-to-large arachnoid cysts in the cerebellum and middle cranial fossa. Finally, the fourth category contained one patient with sulcal effacement and an asymmetric prominence of the cortex in the left frontal lobe laterally (differential diagnosis included encephalitis; follow-up MRI revealed normally appearing left frontal lobe), and another with dense calcification in the genu of internal capsule (differential diagnosis included ? Fahr's disease or Cockayne disease, TORCH infection, prior ischemic insult or metabolic abnormality; follow-up MRI revealed calcification was actually in the globus pallidus and likely physiologic).

Table 1 Intracranial abnormalities found in various disorders. The abnormalities are classed into how they affect management decisions

Population characteristic	Psychiatric diagnosis (n)	Imaging modality	Normal	Abnormal, benign, non-specific	Abnormal, may modify management and treatment, but unlikely causal link to symptoms	Abnormal, may modify management and treatment, possible causal link to symptoms
inpatients scanned, n=224, mean age =20.97 years, sex ratio M:W =164:60	(21) Adjustment disorder (3) Alcohol use disorder (20) Bipolar I (3) Bipolar II (1) Borderline personality disorder (1) Cannabis induced depressive disorder (7) Cannabis induced psychotic disorder (3) Cannabis use disorder (1) Cluster A traits (2) Delusional disorder (2) Dysthymic disorder (40) Major depressive disorder (2) Malingering (2) OCD (2) Opioid use disorder (4) Polysubstance dependence (12) Schizoaffective disorder (35) Schizophrenia (1) Schizotypal personality disorder (2) Still in hospital (1) Stimulant induced depressive disorder (2) Stimulant induced psychotic disorder (2) Stimulant use disorder (1) Substance/medication-induced depressive disorder (10) Substance/medication-induced psychotic disorder (38) Unspecified schizophrenia spectrum and other psychotic disorder (1) Generalized anxiety disorder (1) Unspecified depressive disorder (1) Post-traumatic stress disorder (1) Intermittent explosive disorder (2) Attention deficit hyperactivity disorder	(224) CT (6) MRI (done off-site as follow-up)	n=194 (86.6%)	(3) benign cysts (1) prominent arachnoid granulation (6) cerebral atrophy (2) mega cisterna magna (3) asymmetric ventricles (3) cavum septum pellucidum (1) prominent extra axial space/dehydration (3) possible artifact (2) small hypodense lesions in perivascular space, n=24 (10.7%)	(2) moderate-to-large arachnoid cysts (1) Rathke cleft cyst (follow-up MRI showed unchanged over several years) (1) localized raduidensity in sella turcica (follow-up MRI showed superior convexity of pituitary with no intraglandular signal/commonly seen as normal variant), n=4 (1.8%)	(1) sulcal effacement with asymmetric prominence cortex of left frontal lobe laterally, ? encephalitis (follow-up MRI revealed normally appearing left frontal lobe) (1) dense calcification in genu of internal capsule ?Fahr's disease or Cockayne disease, TORCH infection, prior ischemic insult, or metabolic abnormality (follow-up MRI revealed calcification was actually in the globus pallidus and likely physiologic), n=2 (0.9%)

Abbreviations: OCD, Obsessive Compulsive Disorder; CT, Computerized Tomograpghy; MRI, Magnetic Resonance Imaging; TORCH, Toxoplasmosis, Other agents (parvovirus B19, syphilis, varicella), Rubella, Cytomegalovirus.

Discussion

Our study represents the largest cohort of incidental findings in the young adult psychiatric population. In total, 86.6% of the findings were interpreted as normal; the findings on the remainder of the scans were either classified as benign, not causal towards symptoms, or possibly causal initially with follow-up scans determining otherwise. Overall, these findings do not support the practice of ordering structural imaging tests in the young adult (17–25 years) psychiatric population. Given the economic and patient burden of routine neuroimaging, these findings highlight the need for ongoing review in this area.

Our findings suggest that, in this cohort of young adult psychiatric patients, the use of neuroimaging did not significantly alter clinical management. The majority of scans did not identify any intracranial pathology. The identified abnormalities were deemed either benign, or warranted further investigation. In patients with scans that were abnormal and were initially thought to have a possible relationship to symptoms or management, follow-up MRI imaging showed normal variants and non-pathologic changes. Taken together, these results suggest that, in this cohort, the results of brain imaging studies did not reveal clinically significant abnormalities or lead to substantial changes in diagnosis or management. There is inconsistency in recommendations on routine brain imaging in psychiatric patients and the published literature on the usefulness of this practice. The results from our cohort are similar to studies that did not reveal significant abnormalities in brain imaging, and support recommendations that call into question the usefulness of routine scans in this population.[2] Given that age[5] and neurological deficits on examination[5,6] are often identified in the literature as predictors of abnormal brain imaging results, perhaps neuroimaging in the young adult population could be reserved for those with a clinical history or examination suggestive of an alternative structural diagnosis. A recent study looking at the benefits of using MRI as a routine radiological test in patients with First Episode Psychosis (FEP) reports that the majority of the positive radiological findings did not require further medical intervention and most importantly the findings did not change the course of the management.[21] This further increase to the unending debate about what constitutes a routine biological investigation in patients with FEP.

Limitations of this study include the fact that the scans evaluated were those of a patient cohort already admitted to a psychiatric unit. Therefore, it is possible that patients who underwent neuroimaging upon presentation to the emergency department and had abnormal scans were admitted elsewhere and, thus, excluded from the study population. Therefore, further research is needed to investigate neuroimaging findings in all patients presenting with psychiatric symptoms to the emergency department rather than those who were admitted to a psychiatric unit. Furthermore, the present study evaluates patients admitted to the young adult unit at the Alberta Hospital Edmonton, which is a psychiatric hospital. It is possible, therefore, that this study could be excluding more medically complex patients who may have been admitted to psychiatric units at other acute care facilities for closer medical monitoring. Finally, this represents a retrospective analysis of scan reports, and it is not known whether there was further clinical history of physical examination findings that prompted ordering of neuroimaging in any of the patients.

The use of neuroimaging in psychiatric conditions has been an evolving area of research. There is emerging literature on development of neuroimaging-based biomarkers to aid in diagnosis, prognostication, and prediction of treatment response in psychiatry.[22] Previous studies have shown that MRI brain abnormalities were reportedly higher in individuals with high risk psychosis than control.[23] These findings strongly suggest the possibilities the radiological biomarkers in patients with high risk psychosis. It is foreseeable that in the future, integration of multimodal imaging techniques, genetic markers, and clinical history may be used to diagnose rather than "rule out" other pathologies in a psychiatric presentation. However, at present, these methods remain in the research realm and have yet to be validated and translated into routine clinical practice.

In conclusion, the findings of the present retrospective study, to our knowledge, represent the largest analyzed cohort of brain imaging studies in the young adult psychiatric population. The results of this study do not support the practice of routine neuroimaging in psychiatric patients. Further research is needed to identify risk factors to predict significant abnormal brain imaging findings, and the ordering of brain imaging tests should be guided by clinical history and physical exam findings. Otherwise, patients would unnecessarily be exposed to a high dose radiation and more so, adding high cost of hospital bills from an expensive radiological investigation. It remains to be determined whether evolving neuroimaging techniques can provide clinically useful biomarkers to aid in diagnosis and guide treatment decision-making in psychiatry.

Ethics Statement

The study was conducted in full compliance with the principles of the "Declaration of Helsinki" and within the laws of the information act of Alberta.

Disclosure

The authors report no conflicts of interest in this work.

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