Cataract and cognitive impairment: a review of the literature

J M Jefferis,1,2 U P Mosimann,2,3 M P Clarke1,4

ABSTRACT
Acquired cataract and cognitive impairment are both common age-related problems, and ophthalmologists are increasingly likely to encounter patients who have both. Patients with dementia types who display early visuospatial impairment may present first to ophthalmology services. When these patients have coexisting cataract, it may be difficult to distinguish visual complaints due to cataract from those due to dementia. The interaction between visual impairment due to cataract and neurodegenerative disorders affecting the central visual pathways, is not fully understood. Visual impairment due to cataract may stress impaired attentional mechanisms and cataract extraction may improve cognitive performance in some patients with early cognitive impairment; however, the benefits of cataract surgery in established dementia are less clear. In this study, the literature on this subject was reviewed and the implications for practice were considered.

DEFINITIONS

Age-related cataract
Age-related cataract refers to acquired lens opacity with ageing. The pathophysiology and classification of acquired age-related cataract have been reviewed elsewhere (eg, references 13–15).

Mild cognitive impairment
Mild cognitive impairment is characterised by a decline in cognitive ability (memory, language, attention/executive function or visual perception), without significant impairment in occupational or social functioning. Patients with mild cognitive impairment have an increased risk of developing dementia.16–18

Dementia
Dementia is an age-related clinical syndrome that involves progressive cognitive decline for at least 6 months, sufficient to interfere with social or occupational functioning. International classifications (Diagnostic and Statistical Manual for Mental Disorders, Fourth Edition, Text Revision, and International Classification of Diseases, 10th Revision) currently state that dementia must involve memory impairment and at least one other impaired cognitive domain—for example, language, judgement or visual perception.19–22 This definition relates most closely to Alzheimer’s disease but will be revised in the near future as memory impairment is often not a prominent initial feature in dementia. Dementias that show early visuospatial impairment with less prominent memory impairment include dementia with Lewy bodies, Parkinson’s disease dementia and posterior cortical atrophy.23–25

EPIDEMIOLOGY: DO CATARACT AND DEMENTIA COEXIST IN OLDER POPULATIONS?

Epidemiology of cataract
Age-related cataract is the most common cause of reversible blindness worldwide. In the UK, a study of men 65–83 years old showed that 25% had vision 6/24 or worse attributable to cataract.26 More than 17% of Americans >40 years old have cataract.19 The prevalence of cataract increases with advancing age, with increased numbers of severe cataracts in older populations.20–28 Cataract is a frequent cause of visual impairment and blindness in older, institutionalised patients.29–31 Cataract surgery is a common procedure,32 and in the UK NHS, it is the third most frequent main hospital intervention or procedure after childbirth and upper gastrointestinal endoscopy (http://www.hesonline.nhs.uk/).
Epidemiology of dementia

There are an estimated 24.3 million patients with dementia worldwide, with 4.6 million new cases every year (one every seven).²⁷ Six to ten per cent of those >65 years old in the USA suffer from dementia, and if mild cognitive impairment is included, the prevalence doubles.²⁸ Dementia prevalence increases exponentially with advancing age, with 1% of 65-year-olds, 5% of 90-year-olds and upwards of 80% of 100-year-olds.²⁹⁻³² Alzheimer’s disease is the most common cause of dementia, followed by Dementia with Lewy bodies and vascular dementia.³³⁻³⁵

Coexistence of cataract and dementia

Cataract and dementia are both age-related (figure 1), and it follows that they will frequently coexist. Ophthalmology departments in the UK have more attendances for patients >70 years old than any other speciality (http://www.hesonline.nhs.uk/). There are more than three million ophthalmology outpatient attendances for patients >60 years old in the UK each year (http://www.hesonline.nhs.uk/) of whom approximately 5% (ie, 150 000) would be expected to have dementia.²⁷ ²⁹ ³³ This assumes no causative interaction between eye disease and dementia, and equal access to ophthalmology services for patients with dementia. The latter assumption is plausible for patients living in the community; however, it may not apply for nursing home residents, where prevalence of dementia and visual impairment are high and access to medical care may be restricted.²³ ²⁵ ³⁶

THE RELATIONSHIP BETWEEN COGNITIVE IMPAIRMENT AND VISUAL IMPAIRMENT

There is a strong association between cognitive test scores and visual acuity²⁷ with longitudinal data showing the rate of change of vision and the rate of change of cognition to be significantly correlated.³⁸ There are essentially three hypotheses for this association:

1. Decreased vision impairs a subject’s ability to see and interpret the test material. Cognitive tests are therefore biased against visually impaired subjects and give artificially poor scores for patients with low vision. This is known as the ‘cognitive resource’ theory. This first hypothesis was supported by Dickinson and Rabbitt²⁹ who showed that simulating visual impairment with lenses impaired healthy volunteers’ recall of text passages, despite being able to accurately read text at the time of presentation. The authors concluded that the additional effort required for reading under impoverished stimulus conditions consumed processing resources needed for effective memory. Kempen and Kricehevsy⁴⁰ showed that subjects with uncorrected refractive error and decreased near vision did worse than controls with corrected vision on facial recognition and visual form discrimination tasks. Both studies show that visual impairment due to uncorrected refractive errors impairs cognitive performance in cognitively intact volunteers. This emphasises the importance of testing visual acuity and correcting refractive errors before cognitive testing.

2. Cognitive test scores are low in patients with poor vision because they have a true cognitive impairment. A common factor underlies both cognitive decline and visual decline. Impaired vision is therefore a marker of cognitive impairment. This is known as the ‘common factor’ theory. The close relationship between cognitive and visual decline has been used in itself to argue that there must be common factors underlying both.³⁷ ³⁸ In further support of this second hypothesis, Lindenberger and colleagues⁴¹ showed that simulating ‘old age’ vision in middle-aged patients did not affect their performance on a variety of cognitive tasks. ‘Old age vision’ did not give subjects ‘old age cognition’, suggesting that poor vision alone did not account for decreased test scores in older patients. Droby et al⁴² showed that patients with visual impairment did worse on both visually presented tasks and aurally presented tasks. Patients with decreased vision performed poorly on cognitive tasks that did not require vision, suggesting that their low vision was accompanied by a real cognitive impairment. These observations have led to the suggestion that a common factor (which may be normal ageing) underlies both visual and cognitive decline.

3. A combined mechanism. There is still debate as to whether impaired cognitive performance in association with visual impairment is simply due to degraded stimulus representations or whether there is a common factor underlying cognitive and visual decline. The coexistence of the two problems is not proof of a common causation (although it
may be suggestive). It seems probable that both mechanisms play a role.

IS THERE A COMMON AETIOLOGY UNDERLYING CATARACT AND DEMENTIA?
Cataract and dementia are degenerative processes and have been proposed to share common aetiological mechanisms. Risk factors for cataract include advancing age, female sex, smoking and lower socioeconomic class (and associated lower educational attainment). These are also risk factors for dementia. Vascular risk factors contribute to both vascular dementia and Alzheimer’s disease. They also seem to be important for the generation of cataract. Diabetes, smoking and obesity are risk factors for age-related cataract as well as dementia. Statins may be protective for dementia and cataract. Antihypertensives are protective in dementia, and there is some association between hypertension and cataract. The ApoE4 allele, which is known to be a genetic risk factor for Alzheimer’s disease, is not associated with increased cataract risk. Given many common risk factors, dementia patients may be expected to have a higher incidence of cataract. However, a single study of self-reported previous cataract surgery found no association between cataract and cognitive impairment.

NEURODEGENERATIVE DISORDERS WITH PROMINENT VISUAL SYMPTOMS
Patients with dementia often experience visual phenomena, including visual hallucinations, visual complaints and visuo-perceptual impairments. If these symptoms appear early in the course of the disease, they may help distinguish between different causes of dementia. Many of the visual symptoms that are seen in dementia have complex terminology attributed to them. The definitions of these terms are given in table 1.

Dementia with Lewy bodies is characterised by prominent visuospatial impairment and persistent, well-formed visual hallucinations. Compared to Alzheimer’s disease, patients with dementia with Lewy bodies have less memory impairment, but more visuospatial impairment, which helps to separate dementia with Lewy bodies from other causes of dementia. There is an association between visual hallucinations and visuospatial impairment in that patients with more severe perceptual impairment are more likely to experience visual hallucinations.

Patients with idiopathic Parkinson’s disease are at increased risk of developing dementia, with the 4-year prevalence being nearly three times higher than in non-Parkinson’s subjects. Parkinson’s disease dementia shows considerable overlap with dementia with Lewy bodies, both having prominent visuospatial impairment at the onset of the disease. Fluctuations in visual attention and extrapyramidal motor features. Visual symptoms, such as visual hallucinations, can be an indication of the progression from Parkinson’s disease to Parkinson’s disease dementia.

Posterior cortical atrophy is also known as visual variant Alzheimer’s disease. It affects the occipital and parietal cortex, and visual symptoms are present from the onset of the disease. Patients with posterior cortical atrophy often present to eye care providers with visual complaints before the diagnosis is established. Other features include simultanagnosia (the patient only perceives one element of a picture or object at a time and is unable to absorb the whole), hemispatial neglect and hemianopia. Posterior cortical atrophy is one of the causes of Balint’s syndrome (see table 1). Unlike typical Alzheimer’s disease, day-to-day memory, language skills and affect remain relatively intact (reviewed in references).

In typical Alzheimer’s disease, perceptual and visuospatial abilities tend to be relatively spared at the onset of disease, compared to dementia with Lewy bodies and Parkinson’s disease dementia, and memory impairment is the most prominent feature. Visual hallucinations and visuospatial impairment are less common in typical early-stage Alzheimer’s dementia and, if present, suggest comorbidity (eg, delirium) or another diagnosis. There are reports of complex visual disturbances in Alzheimer’s disease; however, most of these studies were done before the dementia with Lewy body consensus criteria were established in 1996 and the Parkinson’s disease dementia consensus criteria in 2005. It is therefore likely that some of these early studies included other causes of dementia in their Alzheimer’s disease samples or assessed advanced disease. Visual hallucinations can occur in established Alzheimer’s disease and may be exacerbated by ocular pathology such as cataract or other causes of age-related eye disease. Visual field defects have been reported in Alzheimer’s disease, most frequently inferior arcuate field defects. This creates potential diagnostic confusion with normal tension glaucoma, which has been observed to be more frequent in patients with Alzheimer’s disease.

The rare Heidenhain variant of sporadic Creutzfeldt–Jakob disease (sCJD) is characterised by visual symptoms predominating at presentation. These include decreased vision, blurred vision and visual distortions.

Table 1 Some visual symptoms described in neurodegenerative diseases and their definitions

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual agnosia</td>
<td>An inability to recognise familiar objects by sight</td>
</tr>
<tr>
<td>Proposagnosia</td>
<td>A specific form of visual agnosia, an inability to recognise faces</td>
</tr>
<tr>
<td>Optic ataxia</td>
<td>An inability to reach for objects in the visual environment</td>
</tr>
<tr>
<td>Simultanagnosia</td>
<td>The patient only perceives one element of a scene at a time and is unable to absorb the whole</td>
</tr>
<tr>
<td>Palinopsia</td>
<td>Images persist to some extent even after their corresponding stimulus has left</td>
</tr>
<tr>
<td>Oculomotor apraxia</td>
<td>An inability to explore a scene and to shift gaze from one area to another</td>
</tr>
<tr>
<td>Balint’s syndrome</td>
<td>A combination of simultanagnosia, optic ataxia and oculomotor apraxia</td>
</tr>
</tbody>
</table>

THE EFFECT OF CATARACT SURGERY ON COGNITIVE PERFORMANCE AND NEUROPSYCHIATRIC FEATURES
Cognitive decline and visual decline are associated and may be related, and it therefore follows that reversal of visual impairment (as in cataract surgery) may improve cognitive function or visual hallucinations.

A number of studies have tested the hypothesis that cataract surgery can improve cognitive function with varying results: these are summarised in table 2. The evidence from Gray and colleagues and similar results from Ishii et al support the hypothesis. However, the modest improvement (of just two points or less) on the mini-mental state examination (MMSE) score demonstrated in both studies may not be clinically significant, and may reflect a learning effect, particularly as in the Gray study participants performed better at 6 months postoperatively than 2 months postoperatively. In a small prospective study of patients with known cognitive
Review

Does cataract surgery improve cognitive performance?

Table 2

<table>
<thead>
<tr>
<th>Authors</th>
<th>Study design</th>
<th>Sample and control group (if any)</th>
<th>Cognitive assessments</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray et al.</td>
<td>Prospective, observational (without control group)</td>
<td>32 cognitive normal patients (mean age 78.1 (6.5 SD)) undergoing either first eye second eye surgery or sequential cataract surgery</td>
<td>MMSE score before and 2 months after cataract surgery</td>
<td>No improvement in cognitive scores for either intervention or control group. No difference in the cognitive scores between 2 groups.</td>
</tr>
<tr>
<td>Tamura et al.</td>
<td>Prospective, observational (with control group)</td>
<td>20 patients (mean age 82.1 (6.0 SD)) undergoing either first eye second eye surgery</td>
<td>MMSE score before and 2 and 6 months after surgery and postoperatively</td>
<td>Improvement in MMSE scores at 6 months postoperatively (although not 2 months post-op)</td>
</tr>
<tr>
<td>Ishii et al.</td>
<td>Prospective, observational (without control group)</td>
<td>81 Prospective, observational (without control group) 102 cognitively normal patients (mean age 75.3 (8.2 SD)) undergoing cataract surgery</td>
<td>Multivariate Organic Mental Syndrome Examination (MMSE) scores at baseline and 1 year postoperatively</td>
<td>Significant improvement in MMSE scores after cataract surgery</td>
</tr>
<tr>
<td>Mattson et al.</td>
<td>Randomised control study</td>
<td>56 cognitively normal patients with bilateral cataract randomised to either cataract surgery (mean age 73.4 (5.9 SD)) or control group (mean age 76.5 (8.45 SD))</td>
<td>MMSE score before and 2 months after cataract surgery</td>
<td>Improvement in MMSE score postoperatively. Significant improvement in MMSE scores compared to control group.</td>
</tr>
<tr>
<td>Grodstein et al.</td>
<td>Cross-sectional epidemiological study</td>
<td>16 197 women in the community aged 70 to 79 years. 3597 women (mean age 75.1) self-reported previous cataract surgery, 12 600 (mean age 73.9) reported no previous surgery</td>
<td>MMSE score before and 2 months after cataract surgery</td>
<td>Significant improvement in MMSE scores after cataract surgery. Significant improvement in MMSE scores postoperatively.</td>
</tr>
</tbody>
</table>

Review of the literature showing evidence both for and against improved cognition after cataract surgery. MMSE, mini-mental state examination.

CONSENT FOR CATARACT SURGERY IN PATIENTS WITH DEMENTIA

Patients with established dementia may lack the capacity to consent according to the requirements for consent laid out in the Mental Capacity Act 2005. In these patients it is up to the clinician to decide whether surgery is in the patient’s best interests taking into account the wishes and beliefs of the patient when competent, their current wishes and general well-being. Deciding whether cataract surgery is in an individual patient’s best wishes is also likely to involve discussion with people close to them. Some of the legal, ethical and moral issues surrounding informed consent for cataract surgery in patients with dementia have been reviewed previously.

HOW DOES COGNITIVE DECLINE INFLUENCE OUTCOMES FROM CATARACT SURGERY?

Postoperative visual acuities after cataract surgery decline with advancing age, even when recognisable ocular pathologies are taken into account. Older patients may also have difficulty converting improved vision to improved functioning after cataract surgery. Other age-related pathology, such as macular degeneration and glaucoma, may contribute to visual impairment in older patients; however, there is increasing evidence that decline in cerebral function is partly responsible for age-related visual deterioration.

Given that cerebral changes may be partly responsible for decreasing postoperative visual acuities after cataract surgery in older patients, it follows that cognitively impaired older patients may have worse postoperative visual acuities than non-cognitively impaired patients. Patients may also have visual symptoms that are due to cognitive impairment but which they perceive as being due to eye pathology and so expect to improve after cataract surgery.

SYMPTOM COMPLEXES IN CATARACT AND DEMENTIA: DO THEY OVERLAP?

Visual symptoms in cataract

Patients with cataract may experience deterioration in visual acuity, loss of contrast sensitivity, difficulty reading, recognising...
faces, watching television, glare and altered colour recognition. Crabtree et al. explored the subjective symptoms of patients >65 years old with cataract. They excluded patients with MMSE scores <25. They found that the symptoms that patients complain of can be grouped into sight-related mobility, recognition and perception, and hand–eye coordination. Table 2 shows some of the subjective symptoms elicited by semistructured interviews that led to the development of the Cataract Symptom Scale.

**Visual symptoms in dementia**

Visual symptoms may be the presenting symptom in idiopathic, dementing disease. Visual symptoms complained of by patients with dementia include difficulty reading, visuospatial difficulties, blurred vision and visual hallucinations. Glare has also been reported as an early symptom in a patient presenting with Alzheimer's disease. Visual symptoms that may be present in dementia are shown in table 3, divided into the same groups as the cataract groups for ease of comparison.

Symptoms reported in dementia in the older patients show a large degree of overlap with those described in children with cerebral visual impairment. As in children, a structured history taken from a close friend or relative, for evidence of cognitive and visual perceptual visual dysfunction, may reveal visual difficulties that the patient is unable to describe. This is particularly important in patients with dementia because anosognosia (unawareness of symptoms) is not uncommon.

Visual symptoms seen in cataract and dementia have a large degree of overlap (see table 3). This creates diagnostic difficulties in distinguishing which symptoms are due to cataract and which are due to cognitive impairment, particularly in the older population where most patients will have some degree of lens opacity on examination (see figure 1).

**Figure 2** A proposed model for older patients presenting for cataract surgery. This gives advice on which patients would require further assessment by a multidisciplinary team (MDT) including ophthalmologists, neurologists and old-age psychiatrists.

| Table 3 Visual symptoms in cataract (from reference 93) and visual symptoms in dementia (from references 69 72 73 97) |
|----------------|----------------|----------------|
| **Visual symptoms in cataract** | **Visual symptoms in dementia** |
| Sight-related mobility | Sight-related mobility |
| Getting off the pavement | Finding way in familiar surroundings |
| Going downstairs | Bumping into objects |
| Crossing the road | |
| Recognition and perception | Recognition and perception |
| Blurred vision | Blurred vision |
| Reading small print and newspapers | Recognition of objects |
| Seeing television subtitles/teletext | Recognising faces |
| Seeing numbers on a bus | Reading |
| Needing a bright to read | |
| Hand–eye coordination | Hand–eye coordination |
| Pouring hot drinks | Reaching for objects |
| Seeing to write | Playing golf |
| Reading | Playing tennis |
| Other | Other |
| Glare while driving | Glare while driving |
| Visual field defects | Visual hallucinations |

**CAN VISUAL SYMPTOMS ASSOCIATED WITH COGNITIVE IMPAIRMENT BE CONFUSED WITH SYMPTOMS DUE TO CATARACT?**

A retrospective review of 22 patients with the Heidenhain variant of sCJD, in which visual symptoms predominate at presentation, showed that 17 (77%) of these patients initially presented to ophthalmology services. Two patients had their symptoms attributed to cataract and underwent cataract extraction before a diagnosis of sCJD was made. sCJD is a devastatingly rapid, progressive form of dementia with decline.
to death typically within 6 months. Removing a cataract for symptoms due to sCJD would become rapidly apparent as an error; however, removing a cataract, or a lens with a normal degree of age-related opacity, for symptoms due to a more gradual, progressive dementia would be more difficult to detect. It is likely, on statistical grounds and given the absence of routine cognitive testing before cataract surgery, that some patients have cataract surgery for symptoms due to early forms of dementia, but the extent to which this occurs is not yet clear.

**IMPLICATIONS FOR PRACTICE**

The symptoms of cataract and dementia overlap, and there is therefore a risk that without thorough preoperative clinical assessment, inappropriate cataract surgery could be performed on patients with cognitive impairment. In patients with visual symptoms due to both cataract and cognitive impairment, a lack of awareness of the cognitive component of the symptomatology will lead to unrealistic expectations of the improvement in symptoms that would follow cataract surgery. Furthermore, persistent visual symptoms after cataract surgery may be incorrectly attributed to other pathology, such as cystoid macula oedema or age-related macular degeneration, leading to inappropriate management. Given the large numbers of older patients presenting to ophthalmology services, many patients are likely to be encountered with visual symptoms and dementia. Eye care services may be more accessible to older patients with perceptual disturbances than old-age psychiatry services, and ophthalmic assessment may be more acceptable than cognitive assessments. This highlights the need for awareness by ophthalmologists of the potential for cognitive impairment to cause visual symptoms and a multidisciplinary approach in managing such patients with good lines of communication between ophthalmology, neurology and old-age psychiatry services. Figure 2 gives a model of how such a multidisciplinary team may be accessed and what it may involve.

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