

The Feasibility and Safety of Day Case Brain Tumour Biopsy: An Eight-Year Experience in the United Kingdom

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Abstract: *Purpose:* Day-case surgery for selected procedures has the potential to reduce healthcare costs and improve patient experience. In neurosurgery, brain biopsies have been performed as day-case procedures for selected patients. The purpose of this study is to demonstrate the safety and feasibility of a clinical pathway that facilitates day-case brain biopsy surgery to improve the generalisability of the evidence and inform wider adoption of this practice. *Materials and methods:* A single centre, retrospective study of patients aged ≥ 18 years requiring a brain biopsy for presumed tumour between November 2009 and December 2017 was performed. All patients received pre-admission radiology imaging +/- trajectory planning (as required), an operation on a morning theatre list and post-biopsy CT head 4-6 hours to rule out haemorrhage or other complications. Discharge was aimed at 6 hours post-biopsy if observations and CT were satisfactory. All data was collected via an institution operative database and descriptive statistical analysis was conducted. *Results:* A total of 447 brain tumour biopsies performed over the eight-year study period of which a total of n=160 (35.8%) were planned day-case. The proportion of biopsies performed as day-case increased over the study period, from four in 2009 to 33 per annum in 2017, an increase from only 10% (n=4) to 66% (n=33) of the total annual biopsies for this centre. Of the 160 planned day-cases, 135 (84.4%) were actual day-cases and successfully discharged on the same day as the operation. The mean patient age was 58 years. Twenty-five cases had at least one overnight unplanned stay, revealing a failure rate of 15.6%. *Conclusions:* This study demonstrates the safety of our day-case brain tumour biopsy service and is consistent with other centres' experiences. This represents an opportunity for neurosurgeons to confidently contribute to an increasing provision of day-case surgery across the service.

Keywords: Tumour, Biopsy, Patient Safety, Day-Case Surgery

1. Introduction

In many surgical specialties, day case surgery has been adopted for selected operations and suitable patients as it confers advantages for both the patient and the healthcare service [5, 21]. These include shorter hospital stays, improved short term outcomes and a reduced healthcare resource use [3, 4]. As well as maximising these intended benefits, day case surgery pathways must still ensure adverse outcomes are minimised. Although there are some notable examples of day case neurosurgery, the spread of adoption particularly among

cranial procedures has been limited [30, 20, 1]. This is primarily because neurosurgical patients may be at greater risk of complications, which can be life threatening and require more intensive post-operative monitoring and access to emergency intervention, as compared to other surgical patients.

There are approximately 12,000 new brain tumour diagnoses per year in the United Kingdom [9]. Despite the increasing use of pre-operative medical imaging in the diagnosis and characterisation of brain tumours, the gold standard diagnostic process remains an integrated

classification approach combining molecular information with histology. This necessitates examination of a tissue sample obtained via an image-guided biopsy or at the time of surgery for tumour debulking [14]. The inherent risks associated with invasive procedures to obtain tissue for diagnostic purposes are mitigated because this process permits a precise in-vivo assessment of the tumour allowing for accurate prognostication, treatment planning and patient counselling [14]. The growing use of image-guidance and awake anaesthetic techniques have facilitated the development of more minimally-invasive neurosurgical procedures and can reduce the related risks [22]. As a result of this, patients can be fully ambulant and medically fit for discharge within hours after surgery. Therefore, brain biopsy operations may be well suited to the possibility of same-day discharge in selected patients.

Recent evidence suggests the safety profile of such day-case services is favourable [8, 13]. However, the existing literature is limited to a small number of centres and further data are required to ensure the evidence is generalisable to a broad neurosurgical population. There are also barriers associated with implementing day-case services for brain biopsies including identifying the most suitable patients and defining the feasibility of the pathway required for prompt same day treatment, post-operative investigations, and discharge planning. Therefore, the aim of this study is to report the outcomes of day-case brain lesion biopsy in a further large UK neurosurgical centre and to assess the feasibility and clinical safety of this procedure.

2. Materials and Methods

2.1. Study Population and Setting

A single centre, retrospective study of consecutive patients aged ≥ 18 years requiring a brain biopsy for presumed tumour between November 2009 and December 2017 was performed. This observational study was deemed to be a service evaluation as no non-routine clinical data or novel interventions were utilised. All brain tumour biopsies carried out within the study period were included following identification via a locally held operation computer database. Patients aged below 18 years were excluded from this study. Planned day-case was defined as a case aiming to arrive and be discharged from hospital on the same day i.e., not spending a night in hospital. Actual day-cases were patients who achieved same-day discharge, whereas unplanned overnight patients were defined as those originally planned day-cases who required an overnight stay. Planned overnight cases were those that were expected to require at least one night in hospital and were therefore never listed for day-case surgery.

2.2. Pre-Operative Management

Pre-operative imaging was performed either using computed tomography (CT) for image guidance and planning purposes, or a multi-parametric magnetic resonance imaging (MRI) protocol. Each patient was discussed at a regional

neuro-oncology neurosurgical multidisciplinary team meeting. The decision to offer day-case surgery was carried out via a pre-operative outpatient clinic consultation with a neuro-oncological neurosurgeon, in line with NICE CSG10 [19]. Patients were considered suitable for planned day-case depending on factors including patient preference, clinical comorbidities, and technical factors relating to the risk of the biopsy. The availability of transport to the nearest accident and emergency department if required post-operatively, and the availability of a responsible adult at home to provide support were also important considerations in patient selection. Each planned day-case procedure had an anticipated completion time before 13:00 hours. Routine pre-assessment tests involved biochemical and haematological investigations including coagulation profile and a group and save. Pre-operative outpatient imaging was undertaken prior to admission. The radiology imaging and pre-assessment services were essential in facilitating same day appointments for patients on this pathway. These investigations were carried out prior to admission, and this required a rapid access outpatient pathway with minimal time from clinic to admission to ensure scans are relevant.

2.3. Image-Guided Biopsy

The protocol followed is as follows:

1. Pre-admission radiology imaging +/- trajectory planning (as required)
2. Fast from 02:00h
3. Admission 07:30h
4. Operation on morning theatre list; biopsy to be complete by 13:00h
5. Post-biopsy CT 4-6h post-biopsy to rule out haemorrhage / other complication
6. Discharge ≥ 6 h post-biopsy subject to satisfactory CT scan.

Surgical procedure: Following induction of anaesthetic, standard skin prep and drape, and skin infiltration with local anaesthetic with adrenaline, a linear incision is made, and burr hole made according to the pre-operative neuronavigation plan. After dural cautery & incision, the biopsy needle is passed along the pre-planned neuronavigation trajectory to the target. Typically, eight cores of tissue are obtained, with cores from each quadrant at two locations along the same trajectory, usually one at the pre-planned target and one from 5-10mm deep or superficial from that target depending on the anatomy. Tissue samples are submitted for frozen section / smear and fixed histological preparations. Prior to removing the biopsy needle, 0.3ml of air can be injected at the biopsy site (Weerakkody *et al.*, 2009). The wound is closed in standard manner.

2.4. Post-Operative Management

Following surgery, patients are transferred to a recovery area for approximately one hour. Once stable, they are transferred back to the ward for observation. A CT brain scan is carried out 4-6-hours post-operatively.

Patients are considered fit for discharge if the CT scan was satisfactory, and if they are fully mobile, eating and drinking, have no new neurological deficit, and have a responsible adult at home. Patients receive verbal and written information about recognising possible complications and what action should be taken. They are discharged with simple analgesia such as paracetamol and dihydrocodeine.

Follow-up outpatient consultation occurs following discussion of the histopathology results and treatment plan in the neuro-oncology MDT, normally 1-2 weeks after the biopsy.

2.5. Data Collection

Data was collected and tabulated using Microsoft Excel version 16.15. The total number of brain tumour biopsies, those planned for a day-case procedure or not, and where any day-case procedures resulted in an unplanned overnight stay were recorded. In hospital and 30-day post-operative complications for all planned day-case procedures were also recorded. Descriptive statistical analysis was performed on Microsoft Excel version 16.15 to generate summaries of patient characteristics and clinical features.

3. Results

3.1. Biopsy Rate over Time

There was a total of 447 brain tumour biopsies performed over the eight-year study period of which a total of n=160

(35.8%) were planned day-case (Figure 1). The overall biopsy rate varied by a small amounts year-on-year across the study period. However, the proportion of biopsies performed as day-case increased over the study period, from four in 2009 to 33 per annum in 2017, an increase from only 10% (n=4) to 66% (n=33) of the total annual biopsies for this centre (Figure 2 and Table 1).

3.2. Biopsy Cases as Planned Day Case VS Unplanned Overnight

Of the 160 planned day-cases, 135 (84.4%) were actual day-cases and successfully discharged on the same day as the operation. Therefore, 25 cases had at least one overnight unplanned stay, revealing a failure rate of 15.6%. The demographics of the 160 planned day-cases and the incidence of complications are summarised in Table 2. The mean patient age was 58 years. Four (2.5%) cases had a readmission within 28 days of the day-case procedure, three following a seizure and one with a wound infection. There were no post-operative deaths. Of those that had an unplanned overnight stay (Table 3), the most frequently causes were post-operative haematoma reported on CT scan (managed with overnight observation, n=8; 5%) and new neurological deficit that resolved by the next day (n=6; 3.8%). The majority of these patients (n=20; 80%) required only one night in hospital and were discharged the following day, suggesting minor clinical and functional negative effects with recovery of temporary deficits.

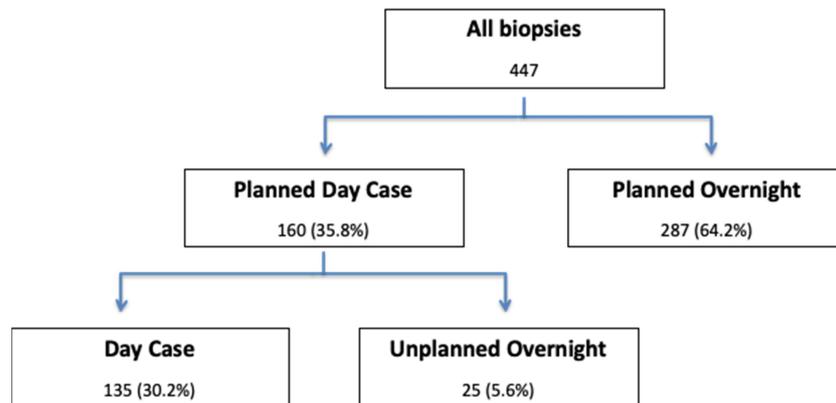


Figure 1. Breakdown of all biopsy groups across the study period.

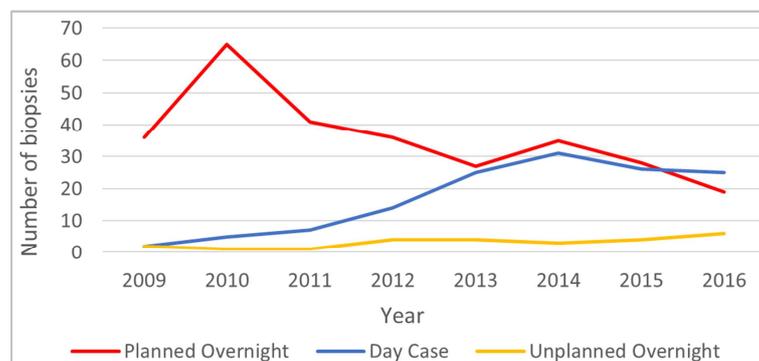


Figure 2. Proportion of day-case biopsies by year across the study period.

Table 1. Change in biopsy category over the study period.

Year	Total Biopsies	Planned Day Case	Planned Overnight	Proportion of Day Case (% of total)
2016-17	50	33	17	66%
2015-16	58	29	29	50%
2014-15	69	34	35	49%
2013-14	56	30	26	54%
2012-13	54	16	38	30%
2011-12	49	9	40	18%
2010-11	71	6	65	8%
2009-10	40	4	36	10%

Table 2. Demographics and complications for planned day case procedures.

Variable	Day case (Actual) n=135 (84.4%)	Day case (Unplanned overnight) n=25 (15.6%)	Total n=160
Mean Age (Years)	58.7	57.0	57.7
Supratentorial / Infratentorial	122/13	25/0	147/13
High grade & Lymphoma & Mets	98	24	122
Low Grade Glioma	25	1	26
Non-tumour	12	0	12
Readmission <28 days	3	1	4
Wound infection	1	0	1
Haematoma requiring evacuation	0	0	0
New neurological deficit	0	6	6
Mortality	0	0	0

Table 3. Reasons for day case procedures requiring unplanned overnight stay.

Post-operative Complication	Number of patients with outcome n; (%)	Mean length of stay (days)
Haematoma reported on CTH*	8 (5%)	1
New neurological deficit**	6 (3.8%)	1
Seizure/functional	1 (0.6%)	13
Delayed imaging	4 (2.5%)	1
Unknown	2 (1.3%)	1
Non-neurological		
Cardiac	2 (0.3%)	3
Social	1 (0.6%)	3

*Either not associated with a neurological deficit, requiring a period of observation or the deficit resolved by the next day.
**Resolving by the next day.

4. Discussion

The adoption of day-case brain biopsy at our centre has increased over time. Our results suggest that the proportion of biopsies performed as a day-case increases with experience. The feasibility of day-case brain biopsy is increased by selecting patients with few comorbidities and social issues, and those who have a responsible adult at their place of discharge. The day-case biopsy pathway is facilitated by optimising patient selection, pre-operative investigations, and proactively aiming to acquire CT brain scans at 4-6 hours post-operatively. The safety profile in our patient population was favourable with an acceptable unplanned overnight stay rate, low rate of procedure related morbidity, and no mortality. Our results contribute to the literature in this area by confirming the generalisability of evidence to guide the implementation and adoption of day-case brain biopsy.

Neurosurgery is often a high-risk intervention, requiring intense post-operative monitoring as well as access to early re-intervention where necessary. This well-established practice has conceivably hindered the earlier adoption of day-case procedures in neurosurgery. In the past two decades there has been a growing evidence base suggesting the safety

of day-case brain tumour biopsy is favourable, with combined morbidity and mortality rates of 1.2 – 6.3% [16, 24, 12, 7]. There is growing evidence that more invasive neurosurgery such as craniotomy for tumour resection and certain spinal procedures can be done safely as day-case procedures [26-28]. Day-case biopsy has the potential to help address the pressures on inpatient beds and waiting lists, through careful patient selection and implementation of efficient perioperative day-case neurosurgery pathways.

There are strong health economics and patient quality of life arguments to adopt day case biopsies where safe and feasible. The main factors include NHS resource utilisation and the lack of beds, and that patients are facilitated back into their own homes quicker. Further exploring patient experiences on day-case pathways is critical to understand the potential effect on quality of life. There are growing political drivers to increase the provision of day-case surgery across the NHS [11, 2, 6]. Where bespoke day-case pathways have been developed, converting more brain tumour biopsies into day-cases would contribute to this effort. Although a formal health economic evaluation of day-case brain biopsy within the NHS is lacking, other studies suggest the procedure could be more cost-effective than planned overnight procedures in select patients [15]. The cost of a post-operative CT scan has

dramatically decreased in recent decades and this is far outweighed by the cost of overnight hospital stays and prolonged clinical monitoring [15]. Day-case surgery also increases patient throughput, thereby reducing waiting times for other procedures. This may increase the efficiency of the service more widely and in turn would strengthen the economic argument.

Not all patients may be suitable for day-case procedures [6]. For our study, and for much of the existing literature, patient selection for consideration of a planned day-case procedure was a critical step in the operative pathway [8, 13]. With the increasing age and comorbid status of many surgical patients, the widespread application of complex day-case neurosurgery may therefore be limited to younger patients and those with less comorbidities [10].

It is important to investigate potential causes of unplanned overnight stays and re-admissions [23]. While the re-admission and complication rates were low in our study, the most common reason for an unplanned overnight stay was haematoma identified on post-operative CT. Most clinically significant haematomas will reveal themselves within six hours of biopsy, and even if they occur beyond this timepoint they are very rarely catastrophic [25]. Where a haematoma was identified on the post-operative CT scan, patients only required overnight monitoring, but none required further surgery. In all instances the patient was clinically well, and if they developed a neurological deficit, it was transient, and were therefore discharged the following day.

Three readmissions were for seizures. Epileptic seizures are well recognised in brain tumour patients especially following craniotomy where more cortex may be transgressed, but evidence to support prophylactic anticonvulsant use is limited [18]. A small proportion of patients will be at risk of new post-operative seizures, even in minimally invasive procedures such as biopsy. We therefore recognise this as an important cause of re-admission which should be mitigated with patient education about the risks associated with a seizure out of hospital, including providing written information regarding how to seek help, and the impact on driving and work.

We have demonstrated that day-case brain tumour biopsy is feasible. Our clinical pathway functions well and has a low failure rate in carefully selected patients with appropriate tumour targets, low comorbidity rates and appropriate home / family support. There are several strengths of this study. The exploration of experience over an eight-year period that permits a comparatively large sample size, and our results align with existing literature and therefore increase the generalisability of the evidence base to more centres in the UK and similar healthcare systems. Alongside this, we recognise the limitations. Although a well-maintained operative database was used to collect data, the study design was retrospective. The clinical pathway incorporated close post-operative surveillance and prompt delivery of care, but a formal evaluation of patient experience within the day-case neurosurgery pathway was not conducted. This could be remedied by incorporating patient satisfaction surveys into future studies [17].

5. Conclusion

The current study demonstrates the feasibility and safety of brain tumour biopsy as a day-case service and is consistent with other centres' experiences. In our study population, no patient suffered a complication related to the unique aspect of same-day discharge. This represents an opportunity for neurosurgeons to confidently contribute to an increasing provision of day-case surgery across the service. Future research should now consider whether more complex procedures could be safely undertaken on a day-case basis, whilst conducting health economics evaluations and assessing patient experience.

Disclosures

The authors declare no conflicts of interest.

Contributions

GS, RAC, JG. PC and ST conceptualised the idea for the study and maintained the database. WSB, FS, SPS extracted the data and WSB and FS performed statistical analysis. WSB wrote the initial draft of the manuscript, and all authors reviewed the final version prior to submission.

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