

# Keyhole craniectomy in the surgical management of spontaneous intracerebral hematoma

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## Abstract

**Background and Objective:** Although the surgical management of spontaneous intracerebral hematoma (SICH) is a controversial issue, it can be life saving in a deteriorating patient. Surgical techniques have varied from the open large craniotomy, burr hole and aspiration to the minimally invasive techniques like stereotactic aspiration of the SICH, endoscopic evacuation and stereotactic catheter drainage. The authors report their experience with a keyhole craniectomy for the surgical evacuation of SICH. **Methods:** Ninety-six cases of SICH were treated using the keyhole craniectomy technique. A small craniectomy of 2-2.5 cm diameter was made using a vertical incision over a relatively 'silent area' of the cortex closest to the clot. Using a small cortical incision the hematoma was evacuated and decompression was achieved. Hemostasis was achieved using standard microneurosurgical techniques. **Results:** Good to excellent outcome was achieved in 55 cases. Mortality was noted in 23 patients. Blood loss was minimal during the procedure. Good evacuation of the clot was seen in all but 5 cases as judged by the postoperative CT scan. **Conclusion:** The keyhole craniectomy technique is minimally invasive, safe and can achieve good clot evacuation with excellent hemostasis. It can be combined with microscopic or endoscopic assistance to achieve the desired result.

## INTRODUCTION

Spontaneous intracerebral hematoma (SICH) is one of the most devastating forms of cerebrovascular disease accounting for about 10% of all strokes. It is associated with high morbidity and mortality.<sup>1</sup> The role of surgery in the management of these cases is controversial. It is possible that some cases will benefit from surgical evacuation. Current practice favours surgical intervention in following situations: lobar hemorrhage, clot volume between 20 to 80 ml, worsening neurological status, relatively young patients, and hemorrhage causing midline shift or raised intracranial pressure (ICP).<sup>2</sup> Surgical indications in cerebellar hematomas however are more accepted. Hematomas above 3 cm diameter and those causing hydrocephalus, generally require surgical evacuation.<sup>2,3,4</sup>

Various surgical strategies have been adopted over the years for evacuation of the intracerebral hematomas ranging from the large open craniectomies and decompression to the more minimally invasive therapies like stereotactic evacuation of hematomas, endoscopic evacuation, stereotactic endoscopic evacuation,

stereotactic fibrinolytic therapy, etc.<sup>5-9</sup> Tsementzis has advocated a method of a small trephine craniotomy 3 cm in diameter and evacuation of the hematoma through this craniotomy.<sup>5</sup> The authors present their experience with a keyhole craniectomy in the evacuation of spontaneous intracerebral hematomas.

## METHODS

Volume of the hematoma was calculated from the CT as per the formula proposed by Lisk *et al* and Kothari *et al*.<sup>10</sup> Surgery was performed under endotracheal general anesthesia. A vertical incision was made over the temporalis muscle and extended superiorly slightly. The temporalis muscle was split and a burr hole was made. The burr hole is widened into a craniectomy about 2-2.5 cm in diameter over a relatively silent area of the cortex and as near to the hematoma as possible (Figure 1A). A cruciate dural opening is made and a cortical incision is made over this relatively silent area (Figures 1B and 1C). The hematoma is then evacuated using mild suction. High-pressure suction is usually avoided as it may cause further damage to the walls of the hematoma

cavity. Clots that are adherent to the walls of the cavity especially anteriorly and medially are left alone, as evacuation of these may stir up further bleeding or may cause extensive damage to the internal capsule and thalamus. Ventricle is not opened. Hemostasis is achieved by continuous saline irrigation, pressure packing, using the bipolar cautery and standard microneurosurgical techniques. The endoscope may also be introduced into this opening to achieve hemostasis and if required for any further clot evacuation. The brain is usually lax at this stage (Figure 1D). The clot cavity is usually lined by surgical and the dura left open and covered with gel foam. The temporalis muscle and the scalp are then closed in layers. Post-operatively all the patients were electively ventilated and received appropriate antibiotics, anti-edema measures, anticonvulsants and steroids. The blood pressure was well controlled and if required analgesics and sedatives were given. Tracheostomy was done in patients who required prolonged ventilation. Low molecular weight heparins were used if the patient took

time for ambulation. Repeat CT was generally done 48-72 hours after the surgery.

## RESULTS

A total of 96 patients, 65 males and 31 females, varying from 3<sup>rd</sup> to 8<sup>th</sup> decade, were operated for surgical evacuation of SICH in our centers. Seventy-two patients (75%) had basal ganglionic hematomas involving the putamen and globus pallidus, 24 (25%) had lobar hematomas, and 2 (2%) had thalamic extension of the hematoma. Hypertension (58, 60%) and diabetes mellitus (25, 26%) were the commonest associated conditions. Fifty-one patients (53%) were in Glasgow Coma Scale (GCS) 6-8, 18 (19%) between 9-12 and 11 patients (12%) in GCS 13-15 and 16 patients (17%) in GCS <6 pre-operatively. The volume of the hematoma varied from 30 ml to above 70 ml. Forty seven patients (49%) were operated within 24 hours, 21 (22%) between 24 to 48 hours, 14 (15%) between 48 to 72 hours and 13 patients (14%) between 3 to 7 days. Only one patient was operated beyond 7 days after ictus.

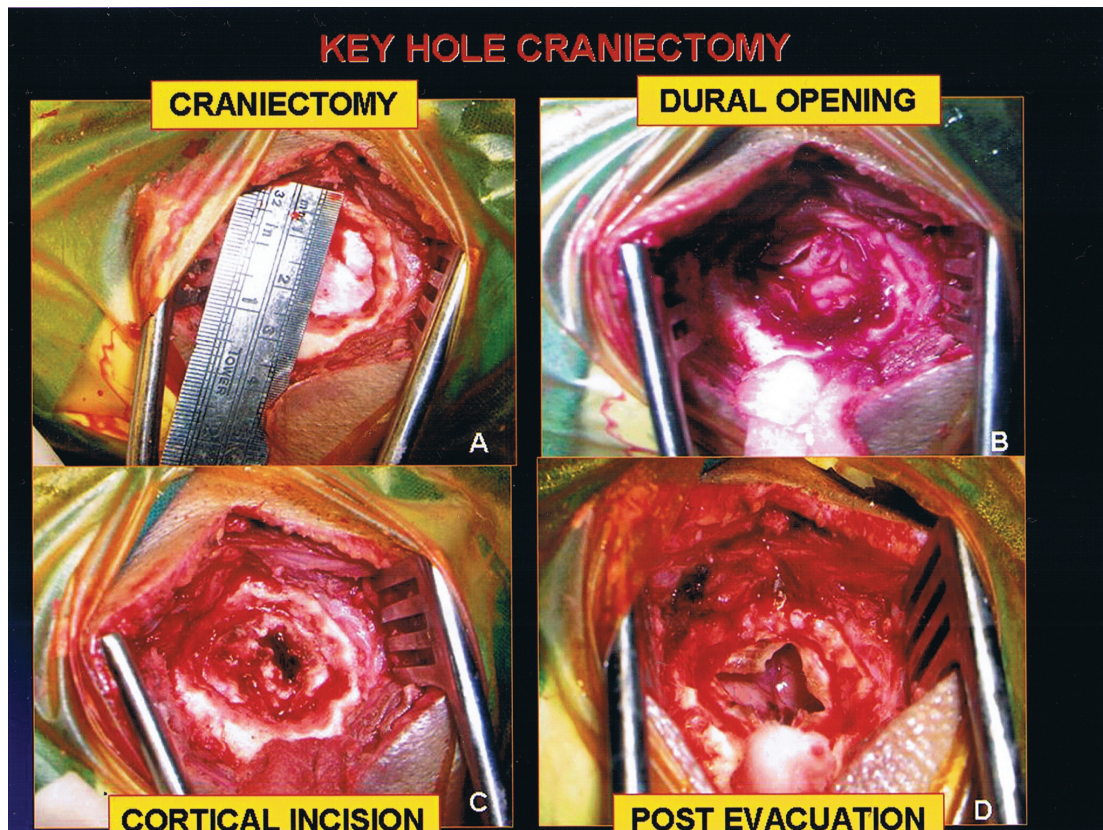


Figure 1: Intraoperative photograph depicting the various stages of the surgical procedure. (A) Key hole craniectomy; (B) Dural opening; (C) Cortical incision; (D) Lax brain after the evacuation of the Spontaneous intracerebral hematoma

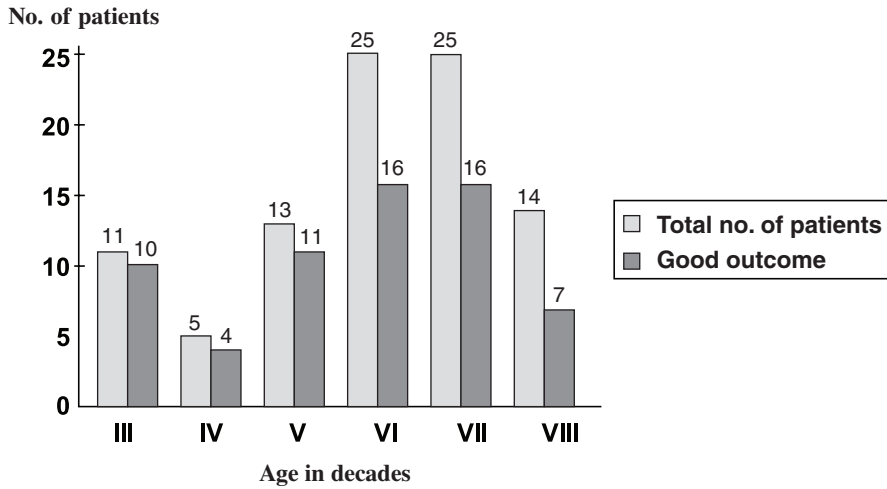


Figure 2: The outcome of patients according to age

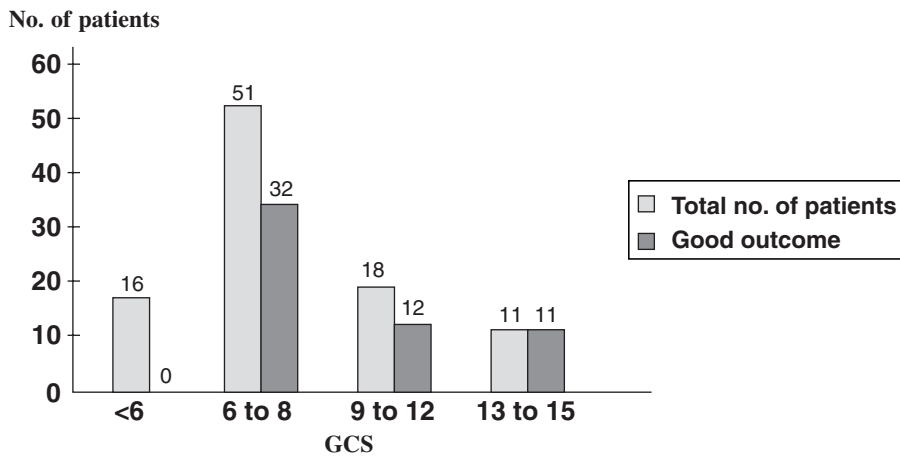


Figure 3: The outcome according to preoperative Glasgow Coma Scale (GCS)

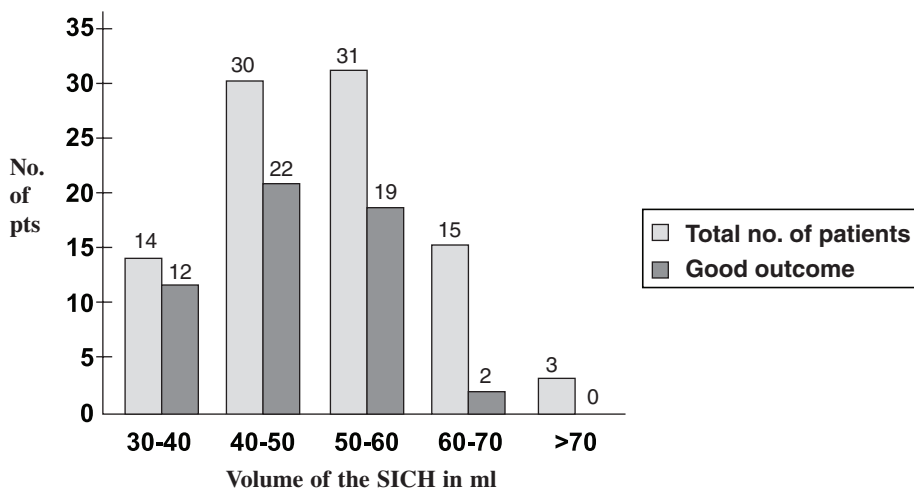


Figure 4: The outcome according to volume of spontaneous intracerebral hematoma (SICH)

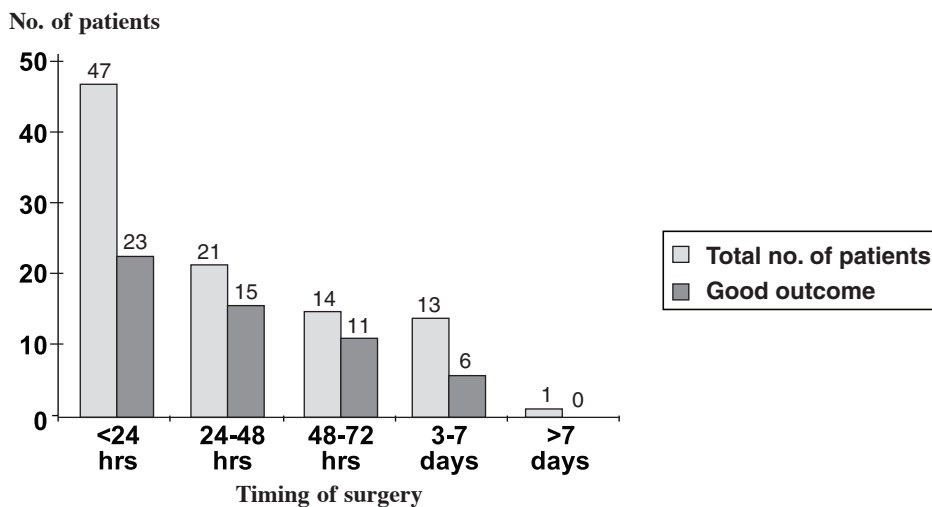


Figure 5: The outcome according to timing of surgery

The surgical outcome was assessed according to the Glasgow Outcome Scale (GOS).<sup>11</sup> They were: 5: Mild to nil disability, excellent (4 patients, 4%); 4: Moderate disability, disabled but independent, good (51 patients, 53%); 3: Severe disability, conscious but disabled and dependent, fair (11 patients, 12%); 2: Persistent vegetative state, poor (7 patients, 7%); 1: Death (23 patients, 24%).

Outcome of the patients in the various age groups is shown in Figure 2. As shown, better results were obtained in the younger age group than patients with advanced age. As for the outcome according to the sites of SICH, good and excellent outcome was seen in 36/72 patients (50%) with basal ganglia hematoma, 19/24 patients (79%) with cerebral lobes (lobar) hematoma, and none of the 2 patients with thalamus extension. Figure 3 shows the outcome according to the presenting Glasgow coma scale. Good results were achieved in all patients with a GCS 13 to 15 (100%), 12 patients (67%) with GCS 9 to 12 and 32 patients (59%) with GCS 6 to 8. All 16 patients with a GCS of less than 6 had a poor outcome. Volume of the SICH was a fair indicator of the outcome (Figure 4). Good outcome was noted in 12 of 14 patients (86%) with a volume 30 to 40 ml, 22 of 30 patients (73%) with a volume 40 to 50ml, 19 of 31 patients (61%) with a volume of 50 to 60ml, 2 of 15 patients (13%) with a volume of 60 to 70ml and in none of the 3 patients with a volume above 70ml. The outcome according to timing of surgery is shown in Figure 5.

Good outcome was seen in 23/47 patients (49%) operated upon within 24 hours of the ictus, 15/21 patients (71%) between 24 to 48 hours of ictus, 11/14 patients (79%) between 48 to 72

hours and in 6 of the 13 patients (46%) between 3 to 7 days. Only one patient was operated after 7 days who did not survive.

All patients underwent repeat CT scan post operatively after 48 to 72 hours. Subtotal to near total evacuation were seen in 91 patients (95%) (Figures 6 and 7). Repeat CT scan showed an increase in the size of haematomas in the remaining 5 patients indicating a re-bleed after the surgery resulting in their subsequent demise.

## DISCUSSION

SICH forms 10% of all strokes and carries a high morbidity and mortality.<sup>4</sup> Typically the intracerebral hematomas secondary to hypertension are found in the basal ganglia, putamen and globus pallidus; thalamus; cerebral lobes; cerebellum and brain stem.<sup>1,5</sup> The role of surgical treatment in the management of these hematomas is controversial. Clear-cut indications and guidelines for surgical treatment are not available. However it is considered by most, that surgery may be indicated in patients where the hematoma is large in the basal ganglia; lobar; where there is secondary neurological worsening; in young patients; in those with hydrocephalus and in those whom a secondary cause is suspected.<sup>1,4,5,12</sup> There is little to be gained by direct surgery in patients with thalamic and pontine hemorrhage.<sup>1</sup> However, the indications for surgery are more frequent for cerebellar hematomas as the risk of brainstem compression and hydrocephalus from ventricular obstruction are important.<sup>4</sup>

Many surgical techniques have been advocated over the past years in the treatment of surgical evacuation of SICH. Burr hole aspiration of



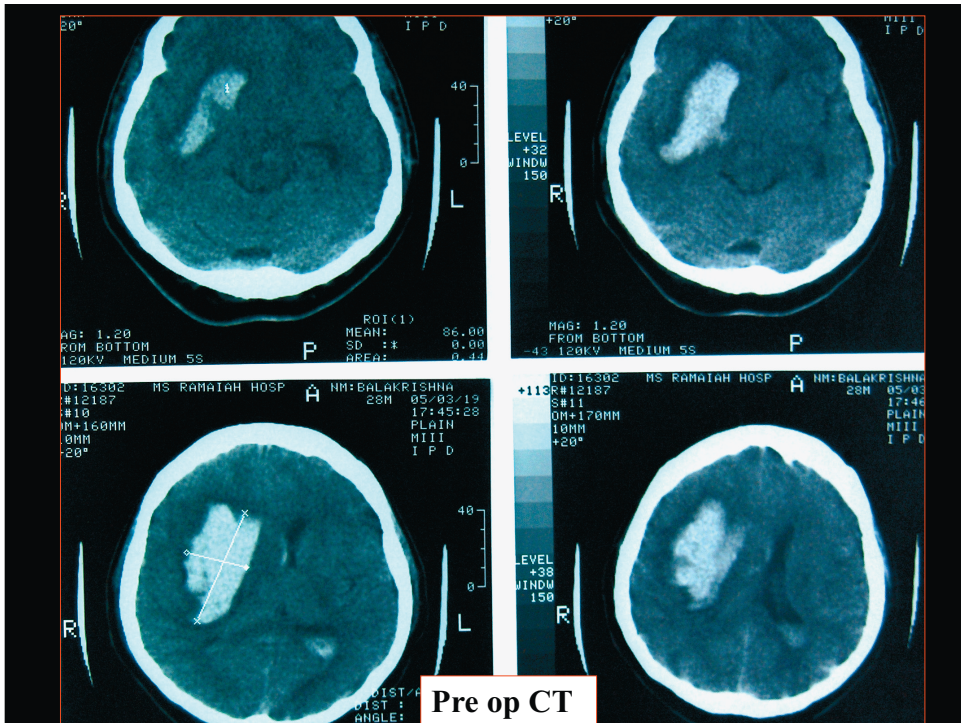


Figure 6: Preoperative CT scan of a patient with spontaneous intracerebral hematoma

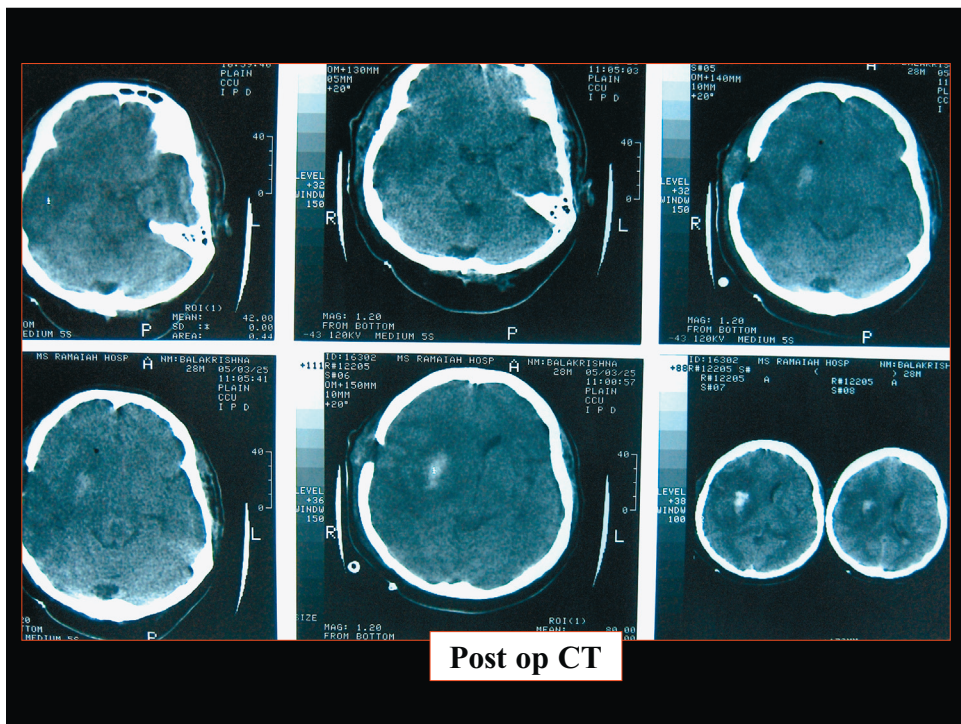


Figure 7: Postoperative CT scan of the same patient after surgery

the hematoma, craniotomy – formal large craniotomy and decompression, craniectomy and evacuation have been practiced over the years. Some authors have used minimally invasive techniques in the evacuation of these hematomas and improving patient outcome and survival. Stereotactic aspiration, endoscopic evacuation, stereotactic endoscopic evacuation and stereotactic fibrinolysis, have all been tried by various authors to improve the patient outcome and survival.

The authors advocate a keyhole craniectomy which is a minimally invasive technique by which significant evacuation of the hematoma (near total and subtotal evacuation) can be achieved with excellent hemostasis. The formal large craniotomy or decompressive large craniectomy and dural enlargement subsequent to hematoma evacuation, have proved to be very useful in a group of severely compromised patients with SICH. The evacuation of hematoma and hemostasis has been found to be excellent with this modality. However, associated morbidity of the craniotomy, prolonged operative time and blood loss has been noted as some of the disadvantages of this approach. The ‘edge effect’ resulting in compression of the brain and the cortical veins along the edges of craniectomy has also been cited as one of the disadvantages. In the minimally invasive procedures, the morbidity of extensive craniotomy can be obviated, but the evacuation of hematoma and subsequent perfect hemostasis may be technically difficult. The keyhole craniectomy is a less invasive method requiring less operating time and blood loss. Perfect hemostasis can be achieved using the standard micro-neurosurgical techniques. The ‘edge effect’ of a large craniectomy is obviated. Endoscopic usage is also possible through the same approach. The keyhole craniectomy can also be extended into a formal craniotomy if a secondary lesion such as an aneurysm or an arterio-venous malformation or a tumour is encountered. This was however not required in our series, as a diagnostic cerebral angiogram was always performed whenever an underlying vascular pathology was suspected. This surgical procedure can be performed at all neurosurgical centres with basic neurosurgical infrastructure, without any expensive instruments such as the stereotaxic apparatus or the endoscope.

Although the purpose of the study was to highlight the surgical technique and its advantages, the authors have also studied the outcome of these patients and the factors influencing their outcome. As in all the previous studies and literature

discussing the surgical and medical management of SICH, the factors affecting the outcome were no different. Patients with advanced age were found to have poorer outcome (Figure 2). Patients with lobar hematomas had a better outcome when compared to the basal ganglionic hematomas while those with hematoma extending into the thalamus carried almost 100% mortality. The pre-operative Glasgow Coma Scale also correlated well with the surgical outcome. Patients with a GCS less than 6 carried a consistently bad prognosis while those between 13-15 had a good outcome. When the volume of the hematoma was >60 ml, the prognosis was bad while those with <60 ml had a favourable outcome. Interestingly it was noted in our study, that best outcome was obtained when the surgery was performed between 48 to 72 hours of the ictus. Good outcome was also noted when surgery was done between 24 to 48 hours of the ictus. Evacuation of the hematoma and achieving hemostasis is technically easier in these patients. However, when surgery was performed within 24 hours or after 7 days, higher mortality was noted. Hence, the authors advocate a policy of performing the surgery after 24 to 48 hours of the ictus whenever possible.

In conclusion, the authors feel that keyhole craniectomy for the surgical evacuation of SICH is a less invasive and effective surgical modality. Good evacuation of the clot can be achieved with perfect hemostasis. The authors have obtained good results with this procedure in young patients with lobar or large basal ganglionic hematomas with worsening neurological status. Surgery is not a preferred modality of treatment in patients with deep-seated (thalamic and brainstem) hematomas. Poor results may be expected in patients with advanced age, hematoma volume of more than 60ml, and GCS of less than 6.

## REFERENCES

1. Ojemann RG, Heros RC. Spontaneous brain hemorrhage. *Stroke* 1983; 14(4): 468-75.
2. Siddique MS, Mendelow AD. Surgical treatment of intracerebral hemorrhage. *Br Med Bull* 2000; 56(2): 444-56.
3. Escosa Bage M, Sola RG. Surgical indications in non traumatic intracerebral hemorrhage. *Rev Neurol* 2001; 32(11): 1060-2.
4. Lejeune JP, Thines L. Neurosurgical management of spontaneous cerebral hemorrhage. *J Neuroradiol* 2003; 30(5): 332-5.
5. Tsementzis SA. Surgical management of intracerebral hematomas. *Neurosurgery* 1985; 16(4): 562-72.
6. Zucarello M, Andaluz N, Wagner KR. Minimally invasive therapy for intracerebral hematomas.

- Neurosurg Clin N Am* 2002; 13(3): 349-54.
7. Peresdov VV. Strategy, technology and techniques of surgical treatment of supratentorial intracerebral hematomas. *Comput Aided Surg* 1999; 4(1): 51-63.
  8. Teernstra OPM, Evers SMAA, Lodder J, Leffers P, Franke CL, Blaauw G. Stereotactic treatment of intracerebral hematoma by means of a plasminogen activator. A multicenter randomized controlled trial (SICHPA). *Stroke* 2003; 34(4): 968-74.
  9. Myung-Hyun K, Jun-Hyeok S, Sung-Hak K, Dong-Bin P, Kyu-Man S. A new trend in operative technique for intracerebral hemorrhage: a comparative study of stereotactic endoscopic removal and stereotactic catheter drainage. *Journal of Korean Medical Science* 1998; 13(5): 533-40.
  10. Panicoli AM, Broderick JP. Prehospital and emergency department care of the patient with acute stroke. In: Mohr JP, Weir B, Choi DW, Wolf PA, Grotta JC, eds: *Stroke- Pathophysiology, diagnosis and management*. 4<sup>th</sup> edition. New York: Churchill Livingstone, 2004: 905-18.
  11. Turner DA. Neurological evaluation of a patient with head trauma: coma scales. In: Wilkins RH, Rengachari S, eds: *Neurosurgery*. 2<sup>nd</sup> edition. New York: Mc Graw Hill, 1996: 2667-73.
  12. Maria G, Anile C, Colosimo C, Rossi GF. Surgical treatment of primary supratentorial intracerebral hemorrhage in stuporose and comatose patients. *Neurol Res* 2002; 24(1): 54-60.