Original articles

Subdural empyema

A review of 48 patients

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Summary

The data of 48 patients with a subdural empyema, treated in the period 1946-1980, have been reviewed in order to evaluate factors that influenced the outcome. A delay in diagnosis and surgical treatment, plus a severe disturbance of consciousness at the moment of surgery, all had a negative bearing on the subsequent outcome. The mode of operation also had an influence on the outcome in this series. In those patients with a severely disturbed level of consciousness at the time of surgery, the outcome was more favourable if multiple burr-holes were performed rather than a craniotomy. In patients with a minor disturbance of consciousness, however, this difference was not apparent.

Key words: subdural empyema, prediction of outcome, treatment.

Introduction

Subdural empyema is a rare disease, comprising 22% of all intracranial bacterial infections diagnosed in two Neurosurgical Departments in The Netherlands•, an incidence, in fact, fairly similar to that noted by others[1-3].

With the introduction of antibiotics, the mortality rate decreased significantly, but still remained high (23%-43%)[4]. Recent studies, however, have shown a lower mortality rate, ranging from 14% to 28%[5-7]. In order to evaluate which factors influenced the ultimate outcome, we reviewed the charts of all patients with a subdural empyema, who had been admitted to two hospitals in the period 1946-1980.

Patients

In the period 1946-1980, 48 cases of subdural empyema were diagnosed. In one of these cases the diagnosis was established at autopsy. Of the 48 patients, 78% was male and 22% female. The age of the patients in relation to the primary source is shown in Table 1. In 67%, the source was a paranasal infection. The majority of the patients was younger than 30 years (86%). In only four cases, presenting with sinusitis, could osteomyelitis of the posterior wall of the frontal sinus be demonstrated as being the pathogenic pathway. The four miscellaneous sources included two cases with a pulmonary infection, one with an orbital infection and one with a subdural empyema after the insertion of a Spitz-Holter drain. The term "possible sinusitis" (see Table 1) refers to a very suspect history with a non-proven diagnosis.

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TABLE 1. Etiology in relation to age

Age	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40	Total
Sinusitis	0	2	5	7	5	2	0	0	3	24
Possible sinusitis	0	1	2	4	1	1	0	1	0	10
Otitis	1	0	0	0	0	2	0	0	0	3
Trauma	1	0	1	1	0	1	0	0	0	4
Operation	0	0	0	0	0	0	0	0	3	3
Miscellaneous	1	0	0	2	0	0	0	1	0	4
Total	3	3	8	14	6	6	0	2	6	48

TABLE 2a. Symptoms and signs at the first neurological examination (48 patients)

Headache	37 (77%)
Fever	46 (96%)
Vomiting	9 (18.5%)
Swelling of the forehead or orbita	15 (31.5%)
Altered consciousness levels	30 (62.5%)
Meningeal irritation	29 (60%)
Focal deficit	23 (48%)
Seizures	7 (29%)

TABLE 2b. Neurological symptoms and signs at the moment of surgery (47 patients)

Altered consciousness levels	42 (89%)
Papilledema	23 (49%)
Focal deficit	46 (97%)
– hemiparesis	34 (72%)
– falx syndrome	10 (21%)
– dysphasia	10 (21%)
– hemianopia	6 (13%)
– ataxia	1 (2%)
Seizures	22 (47%)

Symptoms and signs

Table 2a shows the symptoms and signs at the first examination. Most patients (77%) complained of severe headache at the onset, or intensified headache, as a symptom of the primary infection. All but 2 patients had pyrexia; in 22 cases, more than 40°C. Vomiting was mentioned in 18.5% of the cases. Changes in the level of consciousness were recorded in 62.5% of the patients at the first neurological examination, a focal deficit was present in 48% and meningeal irritation in 60%. In 29% of the patients, seizures were also noted.

Table 2b shows the symptoms and signs at the time of surgery in 47 patients. One patient was omitted from the table because the diagnosis had been made during autopsy. Focal deficits were present in 97% of the patients. Hemiparesis was recorded in a total of 44 cases (93%) and in 10 of them was more pronounced in the leg than in the arm ("falx syndrome"). Alteration of consciousness occurred in 89% of our patients, with simultaneous seizures in 47% of the cases. Papilledema, present in 23 patients (49%) was usually slight. The patients were graded according to a scheme modified from van Alphen[1], (see Table 3). Table 4 shows the clinical grades of the patients at the moment of the first neurlogical examination and at the moment of surgery. Table 4 also shows that at the first neurological examination a minority with no or a slight disturbance of consciousness (grade I and II) has a moderate or severe focal disturbance (26%). Yet, at the moment of operation the majority of the patients in grade I and II has a moderate or severe focal disturbance (64%).

TABLE 3. Clinical grade

GRADE I	A: alert, no neurological symptoms or signs.
GRADE I	B: alert, no neurological symptoms or signs, except meningeal irritation.
GRADE II	A: somnolence and/or slight focal disturbances.
GRADE II	B: somnolence and/or moderate to severe focal disturbances.
GRADE III	A: subcomatose and slight focal disturbances.
GRADE III	B: subcomatose and moderate to severe focal disturbances.
GRADE IV	A: comatose.
GRADE IV	B: comatose with disturbance of the vital functions.

TABLE 4. Clinical grade (47 patients) at the moment of the first neurological examination and operation (in parenthesis the number of patients that died).

Clinical grade	I		II		III		IV	
	A	B	A	B	A	B	A	B
At the first neurological examination	1	6(1)	25(4)	11(2)	0	2(1)	2	0
At the operation	1	1	4	22	1(1)	7(2)	7(2)	4(3)

Diagnostic procedures

Haematological studies always showed signs of infection (elevated sedimentation rate or toxic leukocytosis). A lumbar puncture was performed on 40 of our patients and on 4 occasions the CSF showed no abnormality. The usual finding was a slight pleiocytosis or moderately elevated protein level. In 20 cases, the CSF pressure was recorded and was raised in all but two. Bacterial cultures of the CSF, carried out in 13 cases, were sterile.

Of the 30 skull X-rays, 80% showed signs of sinusitis, especially frontal sinusitis. In one case, there was widening of the sutures of the skull. X-rays of the skull showed no abnormality in four cases. Angiography was performed in 28 cases and all but two showed abnormalities consistent with subdural accumulation. Figures 1a and 1b show the typical avascular area beneath the skull and along the falx, due to accumulation of material in the subdural space.

In the last four years, nine of our patients have undergone CT scanning and five of them showed hypodense areas over the hemisphere or along the falx, indicating accumulation of pus in the subdural space. Figures 2 and 3 show examples of accumulation of pus over the hemisphere and along the falx. In two cases, CT scanning showed clear signs of diffuse cerebral involvement (partial compression of the ventricle, midline shift and irregular contrast-enhancement). Figures 4a and 4b show an example of this involvement. In one of the two cases, however, CT scanning revealed no signs of subdural pus. In the first two patients who underwent CT scanning, a midline shift was recorded, but owing to the poor quality of the scans, no further information could be obtained.

EEG examinations in 25 cases, showed some degree of slowing in each case with low

Fig. 1a.
Lateral view, showing the avascular area between the skull and the cerebrum.

1b.
A.P. view, showing the avascular area along the falx.

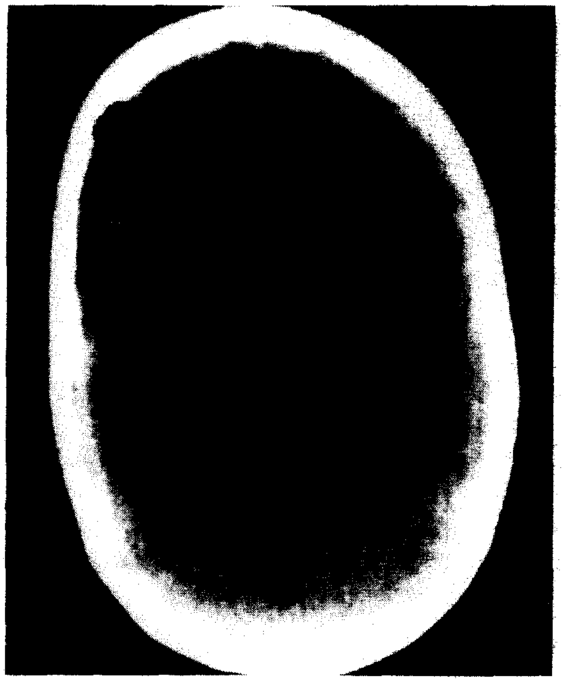

Fig. 2a.
Slight hypodense area over hemisphere with accumulation of air and slight compression of the lateral ventricle.

Fig. 2b.
Same picture as figure 3a, with contrast. Enhancement of the border of the hypodense area.

amplitudes in 7 patients. The localization of these abnormalities corresponded in seven cases with the localization of the empyema.

Technetium scanning of the brain performed in three cases, showed in all these patients an increased uptake along the convexity, corre-

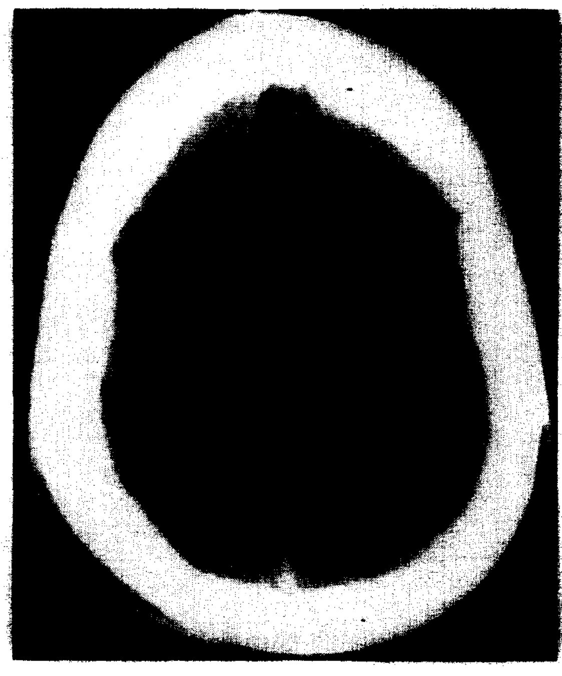

Fig. 3a.
Hypodense area along the falx.

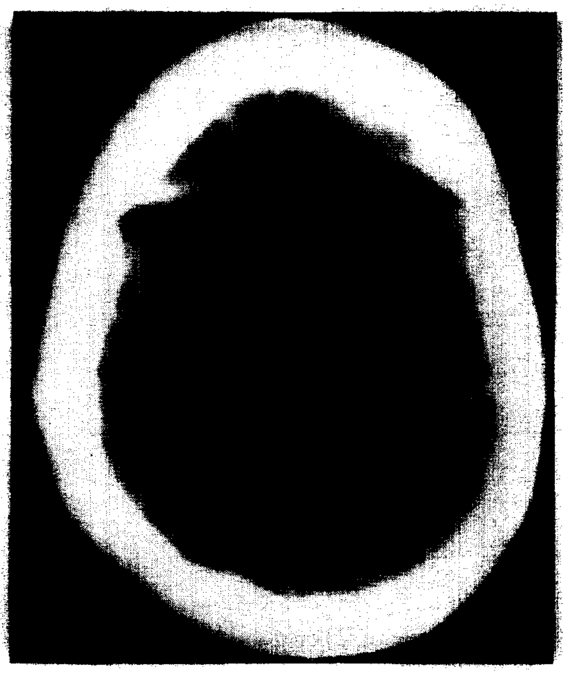

Fig. 3b.
Same picture as figure 4a, with contrast. Enhancement of the borders of the hypodense area.

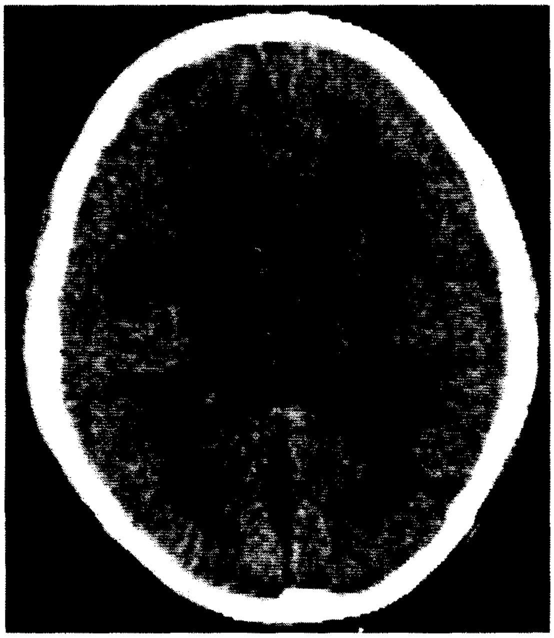

Fig. 4a.
Hypodense area along the anterior and posterior falx. Partial compression of the ventricle and midline shift.

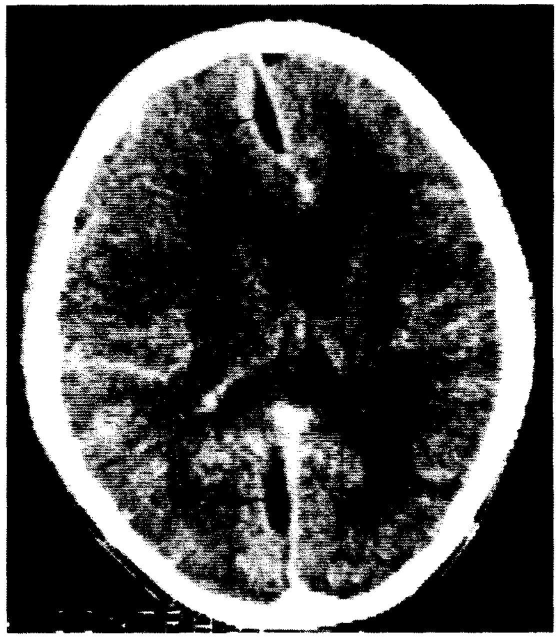

Fig. 4b.
Same picture as figure 5a, with contrast. Irregular enhancement in the hemisphere.

sponding to the localization of the pus.

Bacterial cultures of pus, obtained during surgery, were performed in 37 cases (see Table 5), of which 18 were sterile. In 10 cases, species of streptococcus were found (7 were aerobic and 3 were anaerobic), and in another 6 cases, staphylococcus aureus was present. Proteus mirabilis, haemophilus influenzae and candida albicans were found in one case each.

TABLE 5. Results of bacterial cultures of pus obtained during surgery (37 patients)

Streptococcal species	10
Staphylococcus aureus	6
Miscellaneous	3
Sterile	18

TABLE 6. Modes of primary therapy in 47 patients. (the number of patients who required secondary therapy is also shown. The percentage of patients who died is shown in parentheses).

Primary therapy	total	Secondary therapy burr-holes	Secondary therapy craniotomy
Burr-holes	20 (15%)	0	9
Craniotomy	27 (18.5%)	2	6

Treatment

Table 6 shows the different modes of surgical treatment. Twenty patients were treated with one or more burr-holes and 27 with a craniotomy. The pus was localized over the frontal lobe in 31 cases. In 12 cases pus was found along the falx, and in 4 of these cases it was the sole localization. In 4 patients more widespread localization of the pus was evident – in 3 cases over the whole hemisphere and in one case bilateral and subtentorial.

Table 6 also shows the number of patients who required a second operation. Of the 20 cases who had been treated initially with burr-holess, 9 required a craniotomy later on. In the group of 27 who had been treated initially with a craniotomy, 6 patients underwent a second craniotomy and two patients were treated by burr-hole surgery as a second operation. All patients were treated with systemic antibiotics after surgery, guided where possible by the results of the cultures. Repeated local instillations of antibiotics were used in only 2 cases.

Associated intracranial infections

In 7 cases an epidural empyema was found and in all but one of these, the epidural accumulation was related to the site of the subdural pus. In 6 cases a cerebral abscess was found, all of them having been diagnosed following the first operation. In one case, the site of the cerebral abscess was related to a Spitz-Holter drain. The other 5 abscesses occurred in patients in whom surgery was delayed for some time (an average of 25.4 days following the first examination, in contrast to the 10.5 days in the whole group). The presence of a cerebral abscess had a considerable influence on the final outcome; 4 of the patients died and one patient survived with a severe hemiparesis.

Conspicuous thrombophlebitis of the superior sagittal sinus was recorded in only one patient during autopsy.

Outcome

Table 7 shows the outcome in 46 cases in relation to the clinical picture at the moment of surgery. Two patients were excluded because in one the diagnosis was established during autopsy and in the other because of complications due to an associated pinealoblastoma. Table 7 also shows that all the patients who died (17.5%), were suffering from a severe disturbance of consciousness (clinical grade III or IV) at the moment of surgery. One patient died during the operation, following acute deterioration some hours after a suboccipital puncture. Two patients had a very acute clinical course and in another 5 patients surgery was delayed for a considerable time. In these 5 cases, the mean interval between the first neurological examination and surgery was 26.7 days, as against 10.5 days in the whole group. In 4 of the 7 autopsies, bilateral cerebral involvement was found (diffuse cerebritis as well as abscesses).

In 13 of the 38 survivors, the follow-up lasted for only one year. The mean duration of follow-up in the other 25 cases was 5.9 years, with a range of 1-23 years. Six patients survived but were severely disabled. Four of them were left with mental deterioration, seizures and focal deficits, one with seizures and severe focal deficits and one with a severe focal deficit. Severe disability in this series is not related to the clinical grade at the moment of surgery, in contrast to mortality. Possible causes of severe disability are: 1. a very acute clinical course (2 cases), 2. enlargement of residual subdural pus, requiring more than two operations (2 cases) and 3. hydrocephalus requiring drainage (2 cases).

Of the 38 survivors, 19 (50%) experienced seizures during the follow-up period. In most cases, however, they were easily managed (outcome C and D in Table 7). The percentage is probably too low because of limited follow-up procedures. One patient suffered his first seizure 7 years after surgery.

Only 5 patients, excluding the 6 severely disabled cases, had slight focal deficits at follow-up. This low incidence is surprising in view of the high frequence of focal deficits before treatment.

If one relates the length of time between the first neurological examination and surgery, and the clinical grade at the moment of surgery to

TABLE 7. Relationship between outcome and clinical grade at surgery (46 patients). The percentages are indicated in parentheses.

Outcome		total	clinical grade I	II	III	IV
No sequalae	A	15 (32.5%)	2	10	2	1
Slight focal deficit	B	3 (6.5%)	0	2	1	0
Seizures	C	12 (28.5%)	0	7	1	4
Seizures and slight focal deficit	D	2 (4.5%)	0	2	0	0
Severely disabled	E	6 (13.0%)	0	4	1	1
Death	F	8 (17.5%)	0	0	3	5

the final outcome figures, it appears that patients who undergo surgery within five days and without severe disturbance of consciousness at that moment, enjoy the most favourable prognosis (Table 8).

The importance of the clinical grade at the time of surgery can also be demonstrated by comparing the outcome figures for those patients treated in the period 1946-1965 (25 cases) with those in the period 1965-1980 (21 cases); all 8 patients who died, were treated in the first period. This difference in mortality can partially be explained by the difference in the percentage of patients in grades III or IV at the moment of surgery (52% in the first group and 29% in the second group). This improved result is probably also related to the difference in the length of time between the first examination and surgical treatment (12.3 days in the first group and 7.4 days in the second group). The number of severely disabled patients is the same in both groups.

Table 9 shows the relation between the clinical grade at the moment of treatment, the mode of operation and the outcome. The outcome does not differ in the clinical grades I and II patients treated with burr-holes (12 patients) nor in the craniotomy patients (15 cases). Seven of the 12 patients who initially underwent burr-hole surgery, however, required a second operation, as against only 4 of the 15 craniotomy patients. Patients in clinical grades III or IV who were treated with burr-holes, made a slightly better recovery than those patients on whom a craniotomy was performed.

TABLE 8. Recovery related to clinical grade at surgery and the time interval (46 patients). The number of patients in each category is indicated in parentheses. Outcome-score: see Table 7.

Interval	Clinical grade	Outcome A	B	C	D	E	F
< 5 days	Grade I & II (17)	9	1	5	1	1	0
	Grade III & IV (10)	2	0	4	0	1	3
>5 days	Grade I & II (10)	3	1	2	1	3	0
	Grade III & IV (9)	1	1	1	0	1	5

TABLE 9. Relationship between clinical grade at surgery, mode of operation and outcome (46 patient). The number of patients in each category is indicated in parentheses

Clinical grade	Surgical method	Outcome: Severely disabled	Dead
I & II	Burr-holes (12)	2	0
	Craniotomy (15)	2	0
III & IV	Burr-holes (8)	0	3
	Craniotomy (11)	2	5

Discussion

The purpose of this study was to look for factors that had influenced the outcome in patients with a subdural empyema. Factors that appeared to have been important in this series are the moment of diagnosis, the moment at which surgery is performed and the patient's clinical grade at that point, and finally, the actual mode of operation.

The clinical picture of subdural empyema has been extensively described in the literature and follows a fairly characteristic pattern[9-11] Probably because of its low incidence in the population, 'the presence of a subdural empyema often remains unsuspected for a long time. Acute and subacute progressive deterioration in the level of consciousness, progressive focal deficits and seizures in a patient with signs of infection, are highly suspect of a subdural empyema, especially if the patient is younger than 30 years with a recent history of sinusitis.

As soon as the diagnosis is suspected, further diagnostic procedures must be carried out immediately. Haematological studies will nearly always show toxic leucocytosis or a raised sedimentation rate,[4,11] and X-ray studies of the skull can reveal the source of the causative infection. Since its introduction a few years ago, the CT scan has become the most important procedure. It facilitates the diagnosis of subdural empyema and determines the localization of the subdural pus. The empyema is manifested by a hypodense area over the hemisphere (sometimes crescent-shaped) or along the falx. Enhancement of the margins around the empyema can occur after contrast-infusion. The cerebral involvement in the infection can also be demonstrated by means of CT scanning (small hypodense areas in the cortex, oedema of the white matter, compression of the lateral ventricles, midline shift and irregular enhancement of the cerebrum after contrast infusion). In some cases, CT scanning will show fully encapsulated cerebral abscesses. It is possible, especially in the early phase, that the CT scan will reveal signs of cerebral involvement without pointing to an accumulation of subdural pus, or will reveal no abnormalities at all.[14-17] If subdural pus is not evident from CT scan or angiography, a technetium scan should be performed if there are serious clinical reasons for suspecting a subdural empyema.

Lumbar puncture as a diagnostic procedure is contra-indicated because of the risk of herniation[4,14]. EEG will nearly always show abnormalities, but these are not specific[4,14].

As soon as the diagnosis is established or is seriously suspected, immediate operative treatment is imperative,[4,11] a fact that as been clearly demonstrated in our current series. The patients operated upon within 5 days of the first neurological examination, experienced a more favourable recovery rate than those patients operated upon after a longer delay. The importance of early surgery is also suggested by dividing the patients into two groups – the group treated before 1965 shows a mortality rate of 32%, in comparison to 0% in the group treated after 1965. Surgical treatment was delayed for nearly twice as long in the first group of patients. This decreased mortality rate was also illustrated in another recent study and was again attributed to prompter surgery[18]. It is important to note that this lower mortality figure in the current series is not associated with a greater number of patients left severely disabled. Other factors are probably also responsible for this decline in mortality, e.g. improved antibiotic treatment.

The clinical grade at the moment of surgery was one of the most important factors influencing the outcome in this series. Death occurred in 42% of the patients with a severely disturbed level of consciousness immediately prior to surgery. None of the patients with no, or only slight, disturbance of consciousness, died. The significance of the clinical grade at the moment surgery is performed, has also been demonstrated by other authors[1,5].

According to a recent review of the literature, primary craniotomy is the best mode of operation[5]. Our findings suggest that in patients with little or no disturbance of consciousness, the most preferable surgical method is craniotomy, whilst that in patients with more severe disturbances of consciousness, multiple burr-holes are probably to be preferred. In these seriously-ill patients, a bilateral spread of the pus is a real possibility. In 4 of the 7 autopsies, in fact, bilateral spread of the infection was clearly evident.

The second mainstay of the treatment is intravenous antibiotics for several weeks, at least, guided where possible by the results of the subdural pus cultures[4,14]. Repeated local instillations of antibiotics are not recommended[7,15].

Conclusions

We have demonstrated the extreme importance of early recognition of the presence of subdural empyema. The introduction of the CT scan has greatly facilitated the establishment of such a diagnosis, although the procedure also has its limitations, especially in the early phase. Both a severe disturbance of consciousness at the moment of surgery and a delay in onset of surgical treatment, have a negative bearing on the patient's ultimate recovery. Primary craniotomy is indicated in patients with little or no disturbance of consciousness, and multiple burr-holes are probable to be preferred in patients with a more severe disturbance of consciousness. If treatment is started as soon as the diagnosis has been made, the patient has a very reasonable chance of survival, without any, or only slight, deficits.

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