

Papers and Originals

Management of Supratentorial Intracranial Abscess: A Review of 200 Cases

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Summary: Two hundred cases of intracranial supratentorial abscess have been reviewed: 100 spanned the years 1951 to 1957, and 100 the years 1962 to 1967. The mortality rate of 40% was the same in both series, chiefly owing to continuing inaccurate localization of the abscess and inadequate use of antibiotics. The hazards of lumbar puncture are real, and this procedure is contraindicated when convulsions, signs of a hemisphere disturbance, or papilloedema are present. Of the methods for localizing intracranial abscess the site of E.N.T. sepsis, ventriculography, and brain scanning were found to be the most valuable. Penicillin in high dosage continues to be the most important antibiotic. The results of assiduously repeated burrhole aspiration compare favourably with those of later excision.

Introduction

The preliminary assessment of the results of treatment of patients with intracranial abscess in 1967 showed a disturbingly high mortality despite the use of supposedly advanced methods of management. Earlier major reviews of the management of intracranial abscess (Jooma *et al.*, 1951) have established that the use of antibiotics and particularly penicillin has lowered the mortality, but more recent publications (Gregory *et al.*, 1967) indicate that there has been little improvement in results since then, while series in which only a particular form of surgical treatment is considered have shown remarkably good results (Krayenbühl, 1967). Although many earlier papers have established certain principles in the management of intracranial abscess which are widely accepted—namely, early diagnosis, accurate location by radiography, immediate evacuation of pus, and the use of antibiotics—any failure to improve results would demand a re-examination of the principles on which treatment is based.

The purpose of the present review is to attempt to answer four questions: (1) Have the results of treatment continued to improve since the introduction of antibiotics? (2) If results have not improved, can this be ascribed to a change in the disease? (3) Which of the methods used in the management of these patients have been effective? (4) If the mortality remains high can a scheme of management be produced in order to lower this mortality?

Patients

The series consists of 200 cases of proved intracranial abscess; 100 were admitted to Atkinson Morley's Hospital or the National Hospital for Nervous Diseases, Queen Square, in

the years 1951 to 1957, these being referred to as group 1; 100 were admitted to Atkinson Morley's Hospital, the National Hospital, or the Wessex Neurological Centre in the years 1962 to 1967, these being referred to as group 2. Cases admitted to Atkinson Morley's Hospital in 1967 and to the Wessex Neurological Centre in 1965 and 1966 were observed by me; in all other cases the relevant information was obtained from the medical and nursing records.

The methods of management used in the three centres were similar. Cerebellar abscesses were not reviewed, because their management is not controversial. Subdural abscess was considered with cerebral abscess, because the problems of presentation and initial management are similar. Follow-up in about 80% of the patients was continued until 1967 either by letter or by outpatient visit.

Overall Results

In the three centres concerned there was no significant change in the incidence of intracranial abscess in relation to numbers of admissions for other conditions. Table I shows the overall

TABLE I.—Overall Results

	Group 1. 1951-7 (100 Cases)	Group 2. 1962-7 (100 Cases)
Dead	37%	42%
Severe deficit	7%	7%
Well	56%	51%

results achieved in each group. By "well" is meant that the patients had returned to their normal life, and that this had been maintained until the last follow-up. Among these patients were some who had occasional epileptic attacks, but none in whom these were disabling. "Severe deficit" indicates that the patients have been unable to return to their normal life owing to neurological or mental deficit or to epilepsy.

Factors in Disease Before Treatment.—The factors reviewed in the two groups in an attempt to determine any change in the natural history of the disease are shown in Table II. Length of history refers to the interval between the onset of the first neurological symptom—usually headache, focal deficit, or seizure—and admission to the neurosurgical department. When considering site of abscess the incidence of E.N.T. sepsis is also shown because of its relevance to methods of localization. Middle-ear infection as the source of infection was easily determined; infection of the frontal or ethmoid sinuses was accepted as the source only if there had been operative drainage of the sinuses, or frank osteomyelitis, or swelling of the forehead, or proptosis. Under source, "thoracic" indicates bacterial endocarditis, empyema, bronchiectasis, or lung abscess; "unknown" indicates that the source of infection was never established

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either in life or at necropsy. The patient's level of consciousness was graded in levels from A to D; A, fully alert and orientated; B, drowsy and disorientated but responding to commands; C, responding only to painful stimulation; and D, showing no response to stimulation.

TABLE II

	Group 1. 1951-7			Group 2. 1962-7		
	Incidence (%)	Mortality (%)	E.N.T. Source (%)	Incidence (%)	Mortality (%)	E.N.T. Source (%)
Site:						
Subdural ..	18	28	66	20	55	85
Frontal ..	25	29	40	28	40	53
Temporal ..	34	35	91	27	22	85
Parietal ..	18	39	—	20	35	—
Multiple ..	5	100	—	5	100	—
Source:						
E.N.T. ..	54	31	—	59	37	—
Thoracic ..	16	56	—	12	66	—
Unknown ..	22	45	—	19	53	—
Others ..	8	—	—	10	—	—
Level of consciousness:						
A ..	28	18	—	29	17	—
B ..	40	32	—	32	31	—
C ..	10	60	—	13	70	—
D ..	22	64	—	26	—	—
Age:						
Under 10 ..	8	37	—	3	—	—
10-30 ..	37	30	—	35	43	—
31-50 ..	32	40	—	37	49	—
Over 51 ..	23	35	—	25	44	—
Length of history:						
Up to 1 week ..	24	37	—	23	74	—
8 days-2 weeks ..	43	33	—	37	32	—
15 days-4 weeks ..	17	35	—	26	42	—
Over 4 weeks ..	16	37	—	14	30	—

TABLE III

Organism	Group 1	Group 2	Total
Streptococci ..	55	50	105
Pneumococci ..	2	5	7
Staphylococci ..	31	9	40
Coliforms ..	12	18	30

Bacteriology.—In Table III the bacteriological findings in the intracranial pus are shown, the figures indicating the number of occasions on which the organisms were identified at the initial microscopy or culture of the pus. The available information was inadequate for a full survey of antibiotic sensitivities, but there was no report of penicillin resistance by streptococci or pneumococci. The majority of streptococci were anaerobic or microaerophilic, and often proved difficult to culture, so that identification depended on careful and immediate examination of the morphology of organisms in the pus.

Management of the Abscess Suspect

Lumbar Puncture

The clinical presentation and diagnosis of intracranial abscess has been described in many earlier reviews—for example, Webster and Gurdjian (1950)—and no attempt has been made in the present survey to repeat these observations; it is accepted that the clinical picture is a combination in varying degree of the features of raised intracranial pressure, neurological deficit, and sepsis. However, since the usual differential diagnosis in these cases includes meningitis and encephalitis the place of lumbar puncture, and particularly its potential hazards, was considered.

Lumbar puncture was performed in 140 patients during the weeks before definitive treatment of the intracranial abscess; in 41 of these there was significant deterioration in the level of consciousness during the subsequent 48 hours, 25 dying; in 98 patients there was no deterioration, and 20 died. Eleven of the patients whose level of consciousness deteriorated after lumbar puncture were either fully alert or mildly drowsy, and only two had papilloedema. Since lumbar puncture was done

usually to determine the presence or absence of purulent meningitis, the incidence of focal neurological disturbance (convulsions, hemisphere signs, papilloedema) before lumbar puncture in these 200 cases of abscess was compared with that in 50 cases of non-tuberculous meningitis. The incidence in the cases of abscess was 68%, and in the cases of meningitis 30%.

Methods of Localization of Pus

The accuracy of the different methods of localization is shown in Table IV, as judged by successful aspiration of pus through a burrhole whose position was determined by one of the methods of localization. In none of the 10 patients with multiple abscess were the lesions localized by any method. In patients with chronic otitis media the burrhole was placed immediately above the root of the pinna, while in those with frontal or ethmoid sinus infection it was placed low in the frontal region. Carotid arteriography was done by percutaneous puncture, and ventriculography through posterior parietal burrholes. In 21 patients the abscess was entered while attempting ventriculography; in eight of these the abscess was subdural. Tapping an abscess while attempting to tap a ventricle did not appear to be any more hazardous than tapping an abscess which had been localized by other methods. In five cases adequate localization of the abscess was achieved despite only the contralateral ventricle being visualized. Deterioration in the patient's condition during or immediately after ventriculography occurred in only six patients, four of whom died. Five patients had brain scans—three positive scans showing parietal abscesses accurately and two negative scans being late follow-up investigations. The mortality in patients in whom ventriculography or arteriography failed to localize the abscess was 81%.

TABLE IV.—Site of Abscess

Method of Localization	Subdural		Frontal		Temporal		Parietal		All
	No.	% Accurate	No.	% Accurate	No.	% Accurate	No.	% Accurate	% Accurate
	Site of E.N.T. sepsis ..	16	100	13	87	28	100	1	—
Carotid arteriogram ..	15	68	22	65	16	100	18	67	73
Ventriculogram ..	17	83	21	81	14	71	25	96	84

The reports and where possible the records of E.E.G.s done in 53 patients were reviewed. These at the time were interpreted by one of three specialists, all of whom had wide experience in their fields. Localization was accurate in 51% and an accurate guide to the likely pathology was provided in 36% of patients. A review of the records showed that areas of phase reversal and electrical silence when present were more important than the areas of high-voltage slow-wave activity in terms of localization.

Surgery of Intracranial Pus

All patients in this series with intracerebral abscess, apart from the few who were thought to have a tumour rather than an abscess, were treated initially by burrhole aspiration; in some this was followed later by excision at craniotomy. In Table V the mortality for burrhole aspiration is compared with that for excision of intracerebral abscess, firstly, in all the patients,

TABLE V

	Aspiration		Excision	
	No.	Mortality	No.	Mortality
All patients ..	96	37%	46	20%
Patients alive at 11 days ..	74	19%	31	10%

and, secondly, in those who were still alive 11 days after admission.

Thirty-seven patients treated by repeated aspiration died, 20 of them in the first five days after admission; of the 46 patients treated by excision, 10 had a craniotomy in the first five days, and four died; 31 had a craniotomy after the tenth day, and five died.

Antibiotics

Antibiotics were given systemically and into the abscess cavity at each aspiration in dosages of 10,000 or 20,000 units of intrathecal penicillin with 25 or 50 mg. of intrathecal streptomycin. Adequate records of systemic antibiotic dosage were available in 128 patients. In 35 patients, of whom 17 died, the antibiotics were given in low dosage or were inappropriate for the organisms isolated; three of the survivors were left with severe neurological deficits and in two of the survivors the abscess recurred. In nine patients, of whom one died, the levels of antibiotic dosage approached those used in the treatment of bacterial endocarditis. In 84 patients, of whom 18 died, antibiotic dosages were considered adequate at the time, the average maximum daily dosages being penicillin 4 mega units, streptomycin 1.4 g., sulphonamides 3.7 g., chloramphenicol 2 g., ampicillin 2 g., cloxacillin or methicillin sodium 3.5 g.

Mastoid Surgery

No attempt has been made to assess the type or efficacy of mastoid surgery, but the timing of mastoid surgery in relation to the mortality of temporal or subdural abscess has been reviewed. Forty-two patients had mastoid surgery and eight died; 18 patients with middle ear disease as the source of infection did not have mastoid surgery, and 12 of these died, nine during the first week. Twenty patients had mastoid surgery before admission to the neurosurgical departments and five died; 10 had mastoid surgery during the first week, two dying; and 12, of whom one died, had mastoid surgery after the first week, in half of them this being later than the fourth week.

Discussion

The overall results in Table I show that the results of treatment of supratentorial intracranial abscess in two groups of 100 patients separated by exactly 10 years have not improved; in 1967 20 patients were admitted and 10 died. In the face of apparent advances in methods of management of acute neurosurgical problems it is tempting to ascribe this failure to improve results to changes in the natural history and presentation of the disease. The figures in Table II show that there has been no significant change in site of abscess, aetiology, level of consciousness on admission, age, or length of neurological history. The continuing high incidence of E.N.T. sepsis as the source of infection is striking and is at variance with the findings of Krayenbühl (1967) and of Gregory *et al.* (1967), but is little different from those of Pennybacker (1951). The continuing importance of E.N.T. sepsis in the genesis of temporal and subdural abscess is of particular significance when methods of localization are considered. It is well known that the lower the level of consciousness the poorer the prognosis, and it is disturbing to find that the mortality for level of consciousness D has increased significantly in group 2 to 80%.

Methods of Localization

The figures in Table IV show that methods of localization did not always provide the accuracy that is necessary for successful aspiration of an abscess, and this was one of the major

factors contributing to the failure to improve overall results. However, when the decision to place a temporal or frontal burrhole for aspiration of the abscess was made purely on the site of E.N.T. sepsis the results show a degree of accuracy unrivalled by any other method of localization, a fact to which there are no references in the literature. The accuracy of localization of the subdural abscess, often very difficult by the usual radiological methods, is striking. The accuracy of the E.E.G. in localization is no different from that found in other large series, and its limitations are considerable.

Carotid arteriography has been used extensively in the localization of intracranial abscess in many series. Pennybacker (1951), in reviewing 110 cases of cerebral abscess, wrote that "arteriography usually reveals supratentorial space occupying lesions with great accuracy," but Schurr (1951), in reviewing the same series of cases, stated that only 30 patients had arteriograms and in 12 of them the abscess was temporal. Krayenbühl (1967) stated that in 57 of 77 patients who had angiograms there was "only vascular displacement and a more or less huge avascular area"; he does not indicate whether these features led to accurate localization of the abscess. Bligh and Rack (1962) reported three cases in which carotid arteriography was seriously misleading, while Gregory *et al.* (1967) recorded accurate localization by arteriography in only 7 out of 13 cases.

Our own figures for arteriography show that every temporal abscess was accurately localized. For the frontal, parietal, and subdural abscesses accurate localization was achieved in only 36 (65%) out of 55 patients. Of the 19 patients whose arteriograms failed to localize the abscess, 14 died; in three the abscess was later accurately localized on the basis of E.N.T. sepsis, in two by brain scan and in one by ventriculogram. The following cases serve to illustrate the difficulties of carotid arteriography in intracranial abscess.

Case 1.—1962. A 35-year-old man with a two-week history of increasing headache and vomiting was drowsy on admission with mild papilloedema and a left hemiparesis. The ultrasound showed a midline shift to the left, a ventriculogram showed a shift from right to left, but the right ventricle was not filled, and a right carotid arteriogram showed the anterior cerebral artery displaced to the left and Sylvian vessels stretched and displaced medially. A burrhole in the region of the operculum did not enter an abscess. He was treated with antibiotics and osmotic diuretics but died after 48 hours, a large frontal abscess being found at necropsy.

Case 2.—1967. A 47-year-old woman with a month's history of headache was drowsy and aphasic on admission with bilateral papilloedema and a right hemiparesis. A left carotid arteriogram showed the anterior cerebral arteries shifted to the right with stretching of the middle cerebral vessels, these being interpreted as showing a posterior frontal or opercular mass. Needling through a burrhole on the coronal suture obtained only necrotic tissue with abundant polymorphs, and further needling still failed to enter a frontal abscess 4 cm. in diameter found when the patient died on the fifth day.

Case 3.—1964. A 56-year-old woman had undergone a mastoidectomy on the day of admission when she was drowsy, with a severe left hemiparesis. A right carotid arteriogram showed only 3 mm. displacement of the anterior cerebral arteries and the deep veins to the left. She was treated with antibiotics but became unconscious within hours of admission, and died on the fourth day. Necropsy revealed a large subdural abscess over the right parietal and temporal lobes.

Case 4.—1964. A 34-year-old man with a week's history of a progressive right hemiparesis, dysphasia, and seizures was alert and dysphasic with a right hemiplegia on admission. A left carotid arteriogram showed minimal displacement of the distal part of the pericallosal artery. A brain scan showed a localized high parietal lesion from which 40 ml. of pus was obtained by needle aspiration.

Cases 1 and 2 illustrate the problems of localization of the frontal abscess by arteriography, the oedema behind the abscess presumably being responsible for the displacement of the middle cerebral vessels which was so misleading; this error has been made repeatedly over the years, and on more than one occasion in 1967. Case 3 illustrates the difficulty of demonstrating a subdural abscess by arteriography, and also the danger

of disregarding the E.N.T. septic focus as a guide to localization.

It would therefore seem that carotid arteriography, though a relatively safe and valuable method of investigation, cannot be relied on to demonstrate abscesses accurately unless they are within the temporal lobe; and that unless the arteriographic localization is unequivocal other methods of localization must be used.

Although ventriculography has acquired a somewhat evil reputation in the localization of intracranial abscesses, the evidence for this in the literature is both inadequate and conflicting. Thus Pennybacker (1951) wrote that ventriculography "often precipitates a crisis," but Kerr *et al.* (1958) stated that it was "the more reliable means of localization." Kraysenbühl (1967), in reviewing 130 cases of intracranial abscesses, made no mention of ventriculography, despite the fact that 13 of his cases had infratentorial abscesses, and only 77 had arteriography. Our own results show that ventriculography has a high degree of accuracy in the localization of intracranial abscess in general and of parietal abscess in particular, and that though the procedure can never be called desirable precipitation of crisis is relatively rare.

There is insufficient evidence in our results on which to base conclusions about brain scanning for abscess. However, numerous authors have reported success with this method of localization, among them Sweet *et al.* (1961) with 10 positive scans out of 10, Overton *et al.* (1965) with four out of five, Van Eck (1966) with seven out of seven, Gregory *et al.* (1967) with two out of two, and Planiol (1966) with 23 out of 24. Some limitation on the use of brain scanning in the urgent case has been imposed by the time required for the investigation, but the use of technetium and more recently of indium by Burrows *et al.* (1968) suggests that brain scanning will supersede all other neuroradiological methods in the localization of intracranial abscess. During 1968 subdural or intracerebral abscesses have been accurately localized by technetium scan in six patients at Atkinson Morley's Hospital.

Surgical Treatment of Intracranial Pus

Macewen (1893) reported results which bear favourable comparison with any other series; his patients included 10 with temperosphenoidal abscesses, eight of whom survived; all had mastoid operations, two had cerebral abscess evacuated through the mastoid approach and six through a temporal trephine disc. The length of neurological history varied from one week to one month and therefore chronicity cannot be the sole explanation of his success. Moreover, six of his patients had level of consciousness D on admission. Le Beau (1946) was the protagonist of early excision whatever the length of history. He reported excision in 17 patients, of whom only three died; however, only three of his patients were not alert on admission, in 12 of them the abscesses were undoubtedly chronic, and there is no comparison with treatment by burrhole aspiration. Pennybacker (1945) recorded excision in 26 patients with only two deaths, but without details of the timing of operation or the levels of consciousness, and in 1961 he gave details of the regimen for aspiration before excision, which with its delay of the second and later aspirations cannot be regarded as definitive treatment by aspiration. Jooma *et al.* (1951) noted that mortality rates for the different methods of surgical treatment in their large series of 295 cases were not comparable. Kraysenbühl (1967) advised excision but had only 14 patients treated solely by aspiration, of whom three died.

Our own results comparing aspiration with excision take into account the time of death of those patients treated by aspiration, and the time of operation in those treated by excision, and show that in patients who were alive 11 days after admission there is little difference in the results of the two methods. The mortality for excision compares not unfavourably with

Kraysenbühl's figure of 3 out of 39, but unfortunately bears little relation to the problems of management as seen in neurosurgical departments admitting patients in all stages of the disease, the majority being acute. Even if it were accepted that all other factors in the management of these patients had been satisfactory—and it has already been shown that they were not—the figures do not show any clear advantage of excision over repeated aspiration at any stage, and particularly in the first five days. This is not to deny that on occasions an abscess with a tough capsule which does not appear to shrink satisfactorily should be excised, but such a stage will rarely be reached if the early treatment by daily aspiration with local and systemic antibiotics has been assiduous. Many patients in this series had a residual cavity outlined by Thorotrast for up to 10 years without either recrudescence or epilepsy.

Misuse of Antibiotics

In present-day treatment of serious infective disease such as bacterial endocarditis and bronchitis antibiotic dosages are high, 12 million units or more of penicillin being given daily (Jones and Fletcher, 1967). Although the place of antibiotics and particularly penicillin is well established in the treatment of intracranial abscess (Jooma *et al.*, 1951; Kraysenbühl, 1967), only Gregory *et al.* (1967) have drawn attention to the necessity for very high dosage in an effort to reduce the mortality. Viewed in the light of modern antibiotic therapy, our own figures show that, apart from nine cases, antibiotic dosages were inadequate, even in the 84 patients whose dosage was thought to be adequate at the time. Penicillin was used in 46 of these patients, and the average maximum total daily dosage was clearly inadequate despite the continuing high incidence of penicillin-sensitive organisms (Table III). In 29 patients, all of whom had inadequate systemic antibiotics, the organism was either grown late or recurred up to one month after starting treatment, and 19 of these patients died. Recrudescence occurred particularly with streptococcal infections and could always be traced to inadequate penicillin treatment, which sufficed to subdue the infection but was inadequate to eradicate it. This misuse of antibiotics was one of the main causes of the continuing high mortality, and would support Gregory *et al.* (1967) in their recommendation of massive doses of penicillin on admission without waiting for bacteriological confirmation.

Dangers of Lumbar Puncture

Pennybacker (1961), in discussing the intracranial complications of otogenic origin, said: "The dangers of L.P. are well known but I think they have probably been overstressed and the value of this information which may be gained outweighs the risks. L.P. is only dangerous in advanced cases of increased intracranial pressure when there is violent headache, stupor or coma, and in such there is often papilloedema as well." Gregory *et al.* (1967) noted that "unfortunately the usual clinical criteria of headache, nausea, vomiting and papilloedema were unreliable in assessing elevated intracranial pressure." Our own figures suggest that lumbar puncture in patients with intracranial abscess is hazardous, and that overt signs of raised intracranial pressure were the exception in those patients who deteriorated after the procedure. Because it is undesirable to subject every patient who may have meningitis rather than intracranial abscess to neurosurgical investigation we have sought for criteria which might help to resolve this differential diagnosis, and the considerably higher incidence of convulsions, hemisphere signs, or papilloedema in patients with intracranial abscess suggests that the presence of these signs is a contraindication to lumbar puncture and an indication for urgent neurosurgical investigation.

The failure to improve results from 1957 to 1967 can be ascribed to two major factors: inaccurate localization and misuse of antibiotics. A third factor which has become more noticeable in recent years is failure to tap the abscess daily. The overall mortality of 40% is disturbingly high, but unless methods of management of the acute case are revised it is unlikely to be lowered. In the light of the observations made in this paper the following scheme of initial management is suggested.

As soon as the diagnosis of supratentorial abscess is suspected no further lumbar puncture is done and the patient is transferred immediately to a neurosurgical unit, where after clinical assessment: (1) all patients unless known to be hypersensitive are started on penicillin 4 mega units six-hourly; (2) plain x-ray films of the skull and chest are taken; (3) E.N.T. territory is examined to determine whether there is overt middle ear or frontal sinus infection; and (4) E.E.G. and ultrasound are done, but should not be allowed to delay unduly the next steps.

After these preliminary steps the management will depend on the level of consciousness.

A patients who are fully alert should continue on high-dosage penicillin and have a brain scan within 48 hours. If the scan is negative, the patient should be treated expectantly with high-dosage antibiotics.

B patients who are drowsy should be given mannitol and high-dosage penicillin, and scanned within 24 hours. If this is not possible then those who have an unequivocal focus of E.N.T. sepsis should have the appropriate burrhole made; in all other cases ventriculography is indicated. Carotid angiography can only be relied on in these cases to exclude a temporal intracerebral abscess.

C patients who are unconscious should be given mannitol at once, the high-dosage penicillin should be continued, and if they have mastoid or frontal infection the appropriate burrhole should be made; in all other cases if indium or technetium is available for scanning and mannitol has lightened the level of consciousness then a delay of up to three hours for scanning is justifiable; otherwise ventriculography is indicated.

The further management will obviously depend on the results of these first steps, which have been suggested in an effort to lower the mortality of intracranial abscess that appears to be so closely related to the initial decisions in management.

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Placental Transfusion as an Intrauterine Phenomenon in Deliveries Complicated by Foetal Distress

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Summary: The details of the deliveries of 10 infants whose cords were clamped before the onset of respiration and within one minute of delivery of the chin but whose residual placental volumes were unexpectedly low are compared with 20 control infants whose cords were clamped under similar conditions but who had the expected residual placental volumes. The only statistically significant difference between these groups was in the high number of patients with foetal distress and low Apgar scores in the former group. It is concluded that placental transfusion occurred before delivery in these patients and that foetal asphyxia facilitated this transfusion, which may be the underlying mechanism of neonatal erythrocythaemia or transient tachypnoea of the newborn.

Introduction

The resurgence of interest in the potential pathological effects of a postnatal placental transfusion has rekindled interest in the physiology of this phenomenon in man. Lind and co-workers (see Moss and Monset-Couchard, 1967) have done much to further our understanding of the physiological consequences of this postnatal transfer, but little progress has been made in delineating those factors which facilitate or prevent its occurrence. Several factors influence the transfer of blood from

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