Swiss authors Steinlin et al. ( [1] ) described 2 cases of children who had neonatal Escherichia Coli meningitis who later developed spinal granulomatous adhesions causing severe spinal complication in adolescence.

One boy died after surgery for a high cord lesion, the other had severe progressive neurological deterioration with spinal and cerebella symptoms.

The authors concluded that chronic arachnoiditis could occur many years after the acute bacterial meningitis.

Rosetti et al. ( [2] ) described 2 unusual cases of eosinophilic arachnoiditis.

These tend to arise in immunocompromised patients, but in these cases, the patients were HIV-negative.

They developed

"cystic arachnoiditis over the spinal cord associated with eosinophilic meningitis".

Histology of the meningeal spinal cord lesions showed a

"vasculocentric mixed inflammatory reaction".

Lacking any other explanation, the authors suggested the cases, in drug addicted patients, were caused by:

"hyperergic reaction in the meniges (sic) toward drug-adulterants inoculated through the intravenous route."

Moling et al. ( [3] ) reported a case of cerebral aspergillosis, which tends to occur in severely immunocompromised patients.

The patient presented with 14 months of chronic meningitis, ventriculitis, choroid plexitis and lumbar arachnoiditis, complicated by acute hydrocephalus. Aspergillus, from the candida group, was isolated from CSF.

Cystercicosis is the most common parasitic disease affecting the nervous system.

It tends to arise through ingestion of contaminated water or food containing Taenia solium.

More commonly, (60-90% of cases) the brain is affected, especially at the base of the brain where cysticerci accumulate in multicast or grapelike structures.

However, in rare cases, the spinal cord is involved.

Colli et al. ( [4] ) reported on 12 cases of intradural spinal neurocysticercosis.  Of these, 9 also had hydrocephalus, and developed nerve root symptoms some months later.

In 9 cases, the lesion was in the thoracic or lumbar region, with 3 cases in the cervical region.

Presenting symptoms included muscle weakness (67%), pain (67%) and sphincter disturbance (25%).

These were in addition to symptoms corresponding to intracranial hypertension (headache, vomiting, transient visual loss, diplopia, and ataxia).

The prognosis was worse for patients with moderate to severe arachnoiditis.

Sotelo and Marin ( [5] ) looked at 92 cases of hydrocephalus secondary to cysticercotic arachnoiditis.

They found that mortality rate was around 50% within the first 2 years after shunting; and in most patients, arachnoiditis and positive immune reactions persisted for many years.

Recently, Arriada-Mendicoa et al. ( [6] ) described imaging features of sellar cysticercosis, which can cause extension through the basal cisterns and third ventricle with focal arachnoiditis arising as an inflammatory response.

Cases may present with unexplained loss of visual acuity and hormonal disturbances.

Cosan et al. ( [7] ) presented a rare case of spinal toxoplasmosis which initially manifested some 13 years before admission as a spastic paraparesis.

Investigations showed that the patient had adhesive arachnoiditis associated with osteoid formation caused by past toxoplasmosis infection.

A case of proliferative granulomatous arachnoiditis as a form of tuberculous myeloradiculopathy was described by Amorin Diaz et al. ( [8] ).

Of note, the authors remarked that autopsy revealed more extensive lesions than those imaged on serial MRI. Characteristic intramural inflammatory exudate with medullar necrosis was observed.

Poon et al. ( [9] ) in Hong Kong, recently reported a case of spinal tuberculous arachnoiditis after meningitis, with acute hydrocephalus.

The patient had weakness of both lower limbs and urinary retention.

Recently Tanriverdi et al. ( [10] ) reported 3 cases of intradural spinal tuberculosis, which involved diagnosis of intramedullary abscess in the first case and early and late phases of arachnoiditis in the other two patients.

The patients with arachnoiditis, who were treated by shunting or simple decompression, had a

"relatively less favorable clinical outcome."

De at al. ( [11] ) published an article in the Journal of Indian Medicine in 2002, dealing with tuberculous meningitis (TBM) in children.

The incidence of TB remains high in India, especially within slum areas, despite a routine vaccination programme.

TBM has been considered as primarily a disease of young children (and the elderly).

They described a 76% incidence of hydrocephalus with their study population (compared with 78% in Paginini and Gonzalez).

The authors recommended use of CT scan to diagnose the disease, "The triad of CT features (thalamic infarction, basal cisterns enhancement and hydrocephalus) is diagnostic of TBM." Other common features include enhancement of basal cisterns, periventricular lucency, tuberculoma and tuberculous abscess.

Boukobza et al. ( [12] ) described MRI features of CNS TB. These included: tuberculomas leptomeningitis, infarction, abscesses, hydrocephalus, and pachymeningitis.

"A tuberculomas-leptomeningitis association was found in 4 patients. Patients with leptomeningitis showed thick meningeal contrast enhancement involving all basal cisterns, expanding to the sylvian fissures level, and causing narrowing of the sylvian arteries... In three out of five patients, leptomeningitis was the initial presentation."

Spanish authors Vega et al. ( [13] ) reported on 2 cases of tuberculous meningitis in patients with HIV, in which arachnoiditis (?radiculomyelitis') arose as a complication. Clinical presentation involved subacute paraplegia, radicular pain, sensitive level and neurogenic bladder.

Lyme disease: French authors Mantienne et al. ( [14] ) reported on a case of Lyme disease of the spinal cord, presenting as conus medullaris syndrome. They suggested that vasculitis was the likely mechanism for meningitis:

"Leptomeningitis may be the first stage of spinal infection in Lyme disease, preceding parenchymal infection leading to myelitis".

MRI findings were non-specific, showing contrast enhancement on the pial surface in the lower thoracic cord and conus medullaris.

Diagnosis was achieved via analysis of CSF which showed raised immunoglobulins against the organism Borrelia burgdorferi.

Coccidioides immitis is a fungus that primarily causes meningitis, typically widespread, especially involving the basal meninges.

This chronic inflammatory response, a combination of suppurative and granulomatous inflammation, leads to thickening of meninges, hydrocephalus, arteritis, cranial nerve palsies and infarction.

Other fungi (Blastomyces, histoplasma) may also cause meningitis.

Relapsing bacterial meningitis is a rare problem, mostly seen in neurosurgical patients. ( [15] ) Tang and Chen found that

"Gram-negative bacilli, especially Klebsiella species, were the commonest micro-organisms identified for both the initial episode and the relapse of infection."

Nardone et al. ( [16] ) recently reported a case of symptomatic syringomyelia, which appeared six years after Listeria meningoencephalitis. They remarked:

"Chronic spinal arachnoiditis, as shown by standard MRI and dynamic phase contrast (PC) cine-MRI, may occur after spinal infection and is likely the cause of syringomyelia."

Cases of iatrogenic infection have been reported after myelography, epidural injection, lumbar puncture and spinal surgery. Schneeberger et al. ( [17] ) noted:

"Iatrogenic meningitis following lumbar puncture is a rare complication of myelography, spinal anesthesia, intrathecal chemotherapy, and epidural anesthesia."

Worthington et al, ( [18] ) described 2 cases of bacterial meningitis due to streptococcal infection after Iophendylate (Pantopaque) myelography.  They suggested that it is difficult to differentiate from the "more common" aseptic meningitis arising after myelography.

Schelkun et al. reported another similar case. ( [19] )

Gelfand and Abolnik ( [20] ) suggested,

"Bacterial meningitis is a rare complication of myelography".

Again, it was noted that a distinction between chemical and bacterial meningitis might be difficult.

They described three patients with streptococcal meningitis following myelography performed using the water-based contrast medium iopamidol.

More recently, Schlegel et al. in France ( [21] ) reported a case of iatrogenic meningitis due to the organism Abiotrophia defectiva after myelography.

Koka and Potti ( [22] ), reporting a case of abscess after epidural steroid injection, wrote that

"Although spinal epidural abscess is uncommon, its incidence is likely to rise with increasing use of epidural injections for the control of lower back pain."

There have also been reports of chemical meningitis ( [23]  [24] )

Kaiser et al. ( [25] ) reported a case of meningitis after spinal anaesthesia for hysteroscopy.

Whilst they conjectured that this might have arisen as a result of a bacteraemia, they also suggested that

"Contamination from the patient's skin and from the upper airway's flora of the operator seems to be a more plausible cause."

They also noted that spinal anaesthesia is contra-indicated in the febrile patient and concluded:

"Asepsis is essential during spinal puncture".

Swedish author, Moen, ( [26] ) reported on 9 cases of iatrogenic meningitis, 8 after spinal anaesthesia and one after myelography. Alpha-haemolytic streptococci were cultured in seven cases, the remaining two cases being culture-negative. This organism is usually commensal, but has been implicated in cases of iatrogenic meningitis.

It lives in the upper respiratory tract, which has lead several authors to recommend good hygiene and use of face masks as preventive measures during invasive spinal procedures. Indeed, Moen, remarking on a

"widespread habit of omitting face masks when performing dural puncture",

stresses,

"The use of face masks should be mandatory whenever any kind of lumbar puncture is performed."

Trautmann et al., a German team, described 3 cases of bacterial meningitis ( [27] ) after spinal or epidural anaesthesia and noted that the organisms involved were likely to have come from the anaesthetist as a source of infection.

Again, they emphasised the need for hygiene measures.

Recently, Couzigou et al. ( [28] ) once more stressed the need for "standard precautions" to avoid iatrogenic streptococcal meningitis after spinal anaesthesia.

Lovstad et al. ( [29] ) looked at intraspinal infections (meningitis and epidural abscess) as a complication of epidural analgesia. They described 3 well documented cases of meningitis and one with epidural abscess; of particular note is the delayed diagnosis in the patient with abscess because of 3 negative MRI scans.

Infective organisms were from skin (Staphylococcus) or were opportunistic (Pseudomonas, Enterococcus, Micrococcus sp.). 2 patients were noted as being at risk

"because of probable immunosuppression and chronic infections".

The authors concluded:

"Because of the danger of infection related to epidural analgesia, all patients have to be properly monitored as long as they have epidural catheters and also after the removal of catheters. Some epidural abscesses spread longitudinally and may present as a diffuse process on MR without mechanical compression of the medulla, and may be interpreted as negative findings. Myelography with CT scan is an alternative method of investigation in such cases."

Epidural catheters are a source of infection:  Shintani et al. ( [30] ) reported a case of acute epidural abscess and septic meningitis due to a contaminated catheter used in epidural

anaesthesia. Methicillin-resistant Staphylococcus aureus (MRSA) was cultured.

MR imaging showed a low intensity mass lesion compressing the thecal sac; this was likely to be pus with some gas component.

Holt et al. ( [31] ) studied 78 patients with culture-positive epidural catheters at Odense University Hospital in Denmark. 59 had symptoms of exit site infection and 11 had meningitis (2 also had epidural abscess), corresponding to an incidence of over 4% for local infection and 0.7% for central nervous system infection.

The Gram-negative bacilli and Staphylococcus aureus caused serious infections more frequently than the others.

Use of the intrathecal pump for infusion of baclofen has also been associated with Staphylococcal meningitis. ( [32] )

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[1] Steinlin M, Knecht B, Konu D, Martin E, Boltshauser E *Eur J Pediatr* 1999 Dec; 158(12):968-70 Neonatal Escherichia coli meningitis: spinal adhesions as a late complication
[2] Rossetti AO, Meagher-Villemure K, Vingerhoets F, Maeder P, Bogousslavsky J. *J Neurol* 20 02 Jul;249(7):884-7 Eosinophilic aseptic arachnoiditis. A neurological complication in HIV-negative drug-addicts.
[3] Moling O, Lass-Floerl C, Verweij PE, Porte M, Boiron P, Prugger M, Gebert U, Corradini R, Vedovelli C, Rimenti G, Mian P. *Mycoses* 2002 Dec;45(11-12):504-11 Case Reports. Chronic and acute Aspergillus meningitis.
[4] Colli BO, Valen?a MM, Carlotti CG, Machado HR, Assirati JA *Neurosurg Focus* 2002; 12(6) Spinal Cord cysticercosis : neurosurgical aspects
[5] Sotelo J, Marin C *J Neurosurg* 1987 May; 66(5): 686-9 Hydrocephalus secondary to cysticercotic arachnoiditis. A long-term follow-up review of 92 cases.
[6] Arriada-Mendicoa N, Celis-Lopez MA, Higuera-Calleja J, Corona-Vazquez T. Imaging features of sellar cysticercosis. AJNR *Am J Neuroradiol*. 2003 Aug; 24(7):1386-9.
[7] Cosan TE, Kabukcuoglu S, Arslantas A, Atasoy MA, Dogan N, Ozgunes I, Kebabci M, Tel E *Spine* 2001 Aug 1; 26 (15): 1726-8 Spinal toxoplasmosic arachnoiditis associated with osteoid formation: a rare presentation of toxoplasmosis.
[8] Amorin Diaz M, Calleja Puerta S, Jimenez-Blanco L, Astudillo A, Fernandez JM, Lahoz CH *Neurologia*

2001 Jan;16(1):46-9 [Proliferative granulomatous arachnoiditis: an infrequent form of tuberculous myeloradiculopathy]
[9] Poon TL, Ho WS, Pang KY, Wong CK *Hong Kong Med J* 2003 Feb;9(1):59-61 Tuberculous meningitis with spinal tuberculous arachnoiditis
[10] Tanriverdi T, Kizilkilic O, Hanci M, Kaynar MY, Unalan H, Oz B. *Spinal Cord*. 2003 Jul;41(7):403-9.
Atypical intradural spinal tuberculosis: report of three cases.
[11] De JK , Bagchi S, Bhadra U K, Chatterjee S N, Dutta Munshi AK *JIMA* 2002, Aug 100(8) Computerised Tomographic Study of Tuberculous Meningitis in Children
[12] Boukobza M, Tamer I, Guichard JP, Brunereau L, Polivka M, Leibinger F, Reizine D, Merland JJ. *J Neuroradiol* 1999 Oct; 26(3):172-81 [Tuberculosis of the central nervous system. MRI features and clinical course in 12 cases]
[13] Eroles Vega G, Castro Vilanova MD, Mendivil Ferrer M, Gomez Rodrigo J, Lacambra Calvet C, Ruiz-Capillas JJ, Quinones D. *Rev Clin Esp* 2001 Oct;201(10):575-8 [Arachnoiditis and intraspinal lesion. Complications of tuberculous meningitis in 2 patients with human immunodeficiency virus infection]
[14] Mantienne C, Albucher JF, Catalaa I, Sevely A, Cognard C, Manelfe C. *Neuroradiology* 20 01 Jun;43(6):485-8 MRI in Lyme disease of the spinal cord.
[15] Tang LM, Chen ST. *QJM* 1994 Aug; 87(8):511-8 Relapsing bacterial meningitis in adults.
[16] Nardone R, Alessandrini F, Tezzon F. *Neurol Sci.* 2003 Apr;24(1):40-3 Syringomyelia following Listeria meningoencephalitis: report of a case.
[17] Schneeberger PM, Janssen M, Voss A. *Infection* 1996 Jan-Feb; 24(1):29-33 Alpha-hemolytic streptococci: a major pathogen of iatrogenic meningitis following lumbar puncture. Case reports and a review of the literature.
[18] Worthington M, Hills J, Tally F, Flynn R. *Surg Neurol* 1980 Oct; 14(4):318-20 Bacterial meningitis after myelography.
[19] Schelkun SR, Wagner KF, Blanks JA, Reinert CM. *Orthopedics* 1985 Jan; 8(1):73-6 Bacterial meningitis following Pantopaque myelography. A case report and literature review.
[20] Gelfand MS, Abolnik IZ. *Clin Infect Dis* 1995 Mar; 20(3):582-7 Streptococcal meningitis complicating diagnostic myelography: three cases and review.
[21] Schlegel L, Merlet C, Laroche JM, Fremaux A, Geslin P. *Clin Infect Dis* 1999 Jan;28(1):155-6 Iatrogenic meningitis due to Abiotrophia defectiva after myelography.
[22] Koka VK, Potti A. *South Med J* 2002 Jul; 95(7):772-4 Spinal epidural abscess after corticosteroid injections.
[23] Presse Med 1993 Jan 23 22(2):86
[24] Am J Med 1987 Mar 82(3) 570
[25] Kaiser E, Suppini A, de Jaureguiberry JP, Paris JF, Quinot JF. *Ann Fr Anesth Reanim* 199 7;16(1):47-9 [Acute Streptococcus salivarius meningitis after spinal anesthesia]
[26] Moen V. *Lakartidningen* 1998 Feb 11; 95(7):628, 631-2, 635 [Meningitis is a rare complication of spinal anesthesia. Good hygiene and face masks are simple preventive measures]
[27] Trautmann M, Lepper PM, Schmitz FJ. *Eur J Clin Microbiol Infect Dis* 2002 Jan; 21(1):43-5 Three cases of bacterial meningitis after spinal and epidural anesthesia.
[28] Couzigou C, Vuong TK, Botherel AH, Aggoune M, Astagneau P. *J Hosp Infect* 2003 Apr;53(4):313-4 Iatrogenic Streptococcus salivarius meningitis after spinal anaesthesia: need for strict application of standard precautions

[29] Lovstad RZ, Berntsen AG, Berild D, Stiris M. *Tidsskr Nor Laegeforen* 2000 Aug 30;120(20):2403-6 [Intraspinal infections in patients treated with epidural analgesia]
[30] Shintani S, Tanaka H, Irifune A, Mitoh Y, Udono H, Kaneda A, Shiigai T. *Clin Neurol Neurosurg* 1992; 94(3):253-5 Iatrogenic acute spinal epidural abscess with septic meningitis: MR findings.
[31] Holt HM, Gahrn-Hansen B, Andersen SS, Andersen O, Siboni K. *Ugeskr Laeger* 1996 Jul 29;158(31):4403-5 [Infections in connection with epidural catheterization]
[32] Zed PJ, Stiver HG, Devonshire V, Jewesson PJ, Marra F. *J Neurosurg* 2000 Feb; 92(2):347-9 Continuous intrathecal pump infusion of baclofen with antibiotic drugs for treatment of pump-associated meningitis. Case report.