

Leptomeningeal pathology systematic review protocol v.16 final 7/23/2021

Carol Palackdharry MD, MS, FACP (✉ dr.palackdharry@arcsology.org)

CEO Arcsology, ActiveHealth

2. Stephanie Wottrich BS

Case Western Reserve School of Medicine, Cleveland, OH

3. Erin Dienes PhD

Senior Director of Biostatistics, Arcsology

Christopher D. Witiw MD

Assistant Professor, Division of Neurosurgery, University of Toronto

5. Mohamad Bydon MD

Professor, Departments of Neurosurgery, Orthopedics, and Health Services Research, Assistant Dean, Education Enrichment and Innovation, Mayo Clinic School of Medicine, Rochester MN

Michael P. Steinmetz MD

William P. and Amanda C. Madar Endowed Professor and Chair, Department of Neurological Surgery, Cleveland Clinic Lerner College of Medicine Neurologic Institute, Cleveland OH

Vincent C. Traynelis MD

A. Watson Armour and Sarah Armour Presidential Professor and Vice Chair, Department of Neurosurgery, Rush University School of Medicine

Method Article

Keywords: leptomenigitis; arachnoiditis; radiculitis; leptomenigeal fibroisis; arachnoid fibrosis; adhesive arachnoiditis; arachnoid cysts; arachnoid scarring; arachnoid ossificans; arachnoidopathy; arachnopathy; Bannwarth's Syndrome; basilar meningitis; chronic meningitis; meningitis; encephalomeningoradiculopathy; familial adhesive arachnoiditis; leptomenigeal adhesions; leptomenigeal scarring; meningeal scarring; meningitis serosa; meningoradiculitis; meningitis serosa circumscripta spinalis; meningoradiculopathy; carcinomatous meningitis; neoplastiic meningitis; Pseudotumor cerebrii; rhinosurgical cerebral arachnoiditis; optociasmatic arachnoiditis; subarachnoid fibrosis; subarachnoid cysts; tuberculous meningitis; syringomyelia; ventriculomenigitis

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Abstract

This prospective PRISMA systematic review with modified e-Delphi [SR] started with a focus on harm [arachnoiditis] caused by multiple types of spinal interventions, mostly spinal surgery. Preclinical studies were included in the searches to inform future directions. Global social media groups with >15K patients with the diagnosis express disdain towards doctors for being harmed and then abandoned—disabled, with intractable neuropathic pain, and no known therapy. The protocol was amended, additional searches added when collected 63 terms for the same area of pathology, and the SR expanded to diseases of the leptomeninges. This incomparable partnership between physician-scientist-patients and multiple neurosurgeons generates answers, exposes disparities, and results in an unanticipated conclusion.

Introduction

With the increasing number of spinal surgeries and spinal procedures being performed, greater numbers of patients are reporting adverse events. Small series have reported an incidence of arachnoiditis [ARC] as high as 16% for laminectomies and 21% for spinal fusions, and an unknown but significant percent occurring with epidural steroid injections and regional anesthesia. Some pain management physicians have stated the incidence has increased over 400% in the past decade, primarily due to spine procedures, dramatically increasing the prevalence of symptomatic patients to hundreds of thousands of patients globally.

Primary question: what is known about “arachnoiditis,” specifically: [CHANGED TO LEPTOMENINGEAL PATHOLOGY 12/2019 BY 100% E-DELPHI VOTE]

1. **Variable terminology for the same disease;**
2. **Real world incidence**
3. **Pathology**
4. **Etiology [with particular attention to global differences]**
5. **Clinical course;**
6. **Evidence-based therapeutic options in humans;**
7. **What is known about prevention of long term sequelae?**
8. **Comparison of our findings to how patients are currently being treated**
9. **Proposal for consistency of diagnostic terminology in medical community**
10. **And how can this inform patient care and future research?**

Reagents

Table 1: Eligibility criteria, modifications, information sources, and different terms for same pathology. *A title search for arachnoiditis would have returned 21/63 of the terms used in the literature [appearing in bold]. All the

terms describe some form of leptomenigeal disease, with or without the involvement of the underlying CNS. Most papers had surgical descriptions and pictures, pathology, or autopsy verification of leptomenigeal disease.

Inclusion for search

1. Not limited to humans. English or English translation available. Any age, sex, gender identity, race, geographic area, and co-existing illnesses were included. Grey literature prospectively defined for inclusion.

Inclusion Criteria for data synthesis

2. Humans only for the SR. [non-human studies removed by manual review and placed in a separate database]. All other factors the same as above

Exclusion Criteria for data synthesis

1. Acute meningitis without outpatient follow-up
2. Sources requiring payment for full text despite sources listed below
3. Sources with data errors unexplained after contacting authors
4. Websites claiming unpublished positive results, but data not shared for review
5. Published after 5/30/21 for discussion and 12/6/20 for data synthesis
6. Methods not sound, flawed, clearly biased, but cited as to reason for exclusion

SR Modifications

1. Added structured search for leptomenigeal, arachnoid, subarachnoid, pia fibrosis. Obscure terminologies searched separately added by hand
2. Cutoff date modifications: moved from 12/31/2018 to 12/6/20 to 5/30/21 (5/30/21: 15 new abstracts, 10 infectious CR [including SARS-CoV-2], 1 autopsy, 4 CS. Links to abstracts added to full online protocol. No data change).
3. Addition of ICD 11 terminology and proposal already submitted to WHO Proposal #2C3P
4. 7/1/21 change from 2009 to 2020 PRISMA SR chart and checklist

Databases:

PubMed/NCBI, Google Scholar, Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid Embase, Ovid Cochrane Central Register of Controlled Trials, Ovid Cochrane Database of Systematic Reviews, and Scopus.

Full Text Sources:

1. Academic Libraries: Mayo Clinic, Cleveland Clinic, Case Western Reserve, University of Chicago, Rush University

2. Apps: Zotero plug-in, Google Scholar plug-in, "Unpaywall" app

Included grey literature

1. Case reports in searched databases
2. Google: Legal settlements, class action lawsuits, government proceedings, manufacturer device adverse events [AE] tracking, investigative reporting, EU proceedings mandating recertification of medical devices to exclude those without clinical data.

Different names for this same LM pathology found in hand searching.* Bolded names [21] contain "arachnoiditis" and non-bolded [42] do not

adhesive arachnoiditis, arachnoid adhesions, arachnoid cysts, arachnoid fibrosis, arachnoid scarring, arachnoid ossificans, **arachnoiditis ossificans**, arachnoid webs, **arachnoiditis**, arachnoidopathy, arachnopathy, aseptic meningitis, Bannwarth's Syndrome, basilar fibrosis, basilar meningitis, **cerebral arachnoiditis**, **chemical arachnoiditis**, **chronic circumscribed arachnoiditis**, **chronic circumscribed cystic arachnoiditis**, chronic leptomeningitis, chronic meningitis, **chronic serous arachnoiditis**, **chronic spinal adhesive arachnoiditis**, cystic meningitis, **cystic arachnoiditis**, encephalomeningoradiculopathy, encephalomyeloradiculitis, epiduro-arachnoiditis, **familial adhesive arachnoiditis**, **focal adhesive arachnoiditis**, **hereditary arachnoiditis**, leptomeningeal adhesions, leptomeningeal fibrosis, leptomeningeal inflammation, leptomeningeal scarring, leptomeningitis, meningeal fibrosis, meningeal scarring, meningeal adhesions, meningitis, meningitis serosa, meningitis serosa circumscripta spinalis, meningoradiculitis,, meningoradiculopathy, myeloradiculitis, myeloradiculopathy, **neoplastic arachnoiditis**, **optochiasmatic arachnoiditis**, post-op radiculitis [current spine literature], postmyelographic arachnoiditis, Pseudotumor cerebrii, radiculitis, radiculomyelitis, **rhinosinusogenic cerebral arachnoiditis**, serosa circumscripta spinalis, **spinal arachnoiditis**, subarachnoid cysts, subarachnoid fibrosis, syringomyelia, Tubercular meningitis, Tuberculosis meningitis, ventriculomeningitis

Equipment

[bmj.n71](#)

Procedure

1. Define Question: Entire group [final written protocol approved 12/16/18, unanimous]
2. Create test search strings: Palackdharry and Säynäjoki
 - (1) Perform test searches: Palackdharry and Säynäjoki
 - (2) Hand searching major articles for additional terminology for arachnoiditis: Palackdharry
3. Zotero purchased as reference manager [unlimited storage, private group]
4. Recreate search strings with additional terminology

- (1) Run searches #1 with initial cutoff date of 1/1/2019 through PubMed, Mayo Library [Embase, Cochrane, Scopus], and Google Scholar
5. Abstract Review Team [20 trained reviewers] reviews all abstracts for inclusion or exclusion
6. Abstract Review Team hand searches articles prior to internet availability for additional articles
7. 4/1/19: Oversight committee votes to add additional searches because of critical new terminology discovery [arachnoid fibrosis, leptomenigeal fibrosis]
- (1) Run searches string #2 through PubMed, Embase, Cochrane, Scopus, Google Scholar, cutoff date 1/1/2019
- (2) Abstract review Team reviews search string 2 for inclusion and exclusion
8. Full text obtained by Palackdharry [public, unpaywall, Google Scholar], Wottrich & Wooster [Case Western and Cleveland Clinic Library], Witiw [University of Chicago Library] and Goyal [Mayo Clinic Library]
9. 5/1/2019 to 12/1/2020 Arcsology runs patient donation drive to fund the SR costs [purchase of Covidence, payment of any publication costs, etc]
10. Rerun of search string 1 and 2 in PubMed and Mayo: Start date 1/1/2019 and cutoff date of 3/2/2020
- (1) Additional abstracts reviewed for inclusion/exclusion
- (2) Full text for additional articles obtained as specified in #8 above
11. Any abstract selected for inclusion without full text available from our stated resources were excluded from inclusion in full SR review
12. Deduplication run in Zotero
13. Zotero "included" file exported and then imported into Covidence 1.0
14. Additional deduplication performed by Covidence
15. Zotero "included" files were sorted: treatment, autopsy & pathology, causes, brain involvement, diagnosis and imaging, differential diagnosis, ethics of harm, FBSS, non-classified articles, not extracted [post deadline], outcomes and complications.
16. Full text review in Covidence performed by 2 different reviewers
17. Data extraction performed twice on each included article and errors corrected/consensus reached. Completion date: 9/16/2020
- (1) Created baseline characteristic templates for Covidence: Palackdharry
- (2) Different characteristic tables created for different Zotero categories
- (3) Created data tables for Covidence: Palackdharry

- (4) Same data tables used for all articles
18. Covidence unable to export final data [9/16/20 – 10/7/20] due to large file and platform stability issues.
19. As of 10/7/20: attempting to download data extraction from Covidence without success. Covidence to do back-end work around
20. 10/8/2020 Data extraction downloaded from Covidence team in both csv and xlxs formats
21. Dienes has started to analyze data and prepare findings
22. Special notes added 12/22/2020: Pubmed auto-update of the 59 search strings has 3 critical new articles to include, including 1 on treatment with thalidomide in TB chronic arcs published 12/2020 and a NEJM review on sensory ganglionopathy for reference published 11/20. Both will be included in the discussion by unanimous approval.
23. Dienes Re-extracted every article due to last column missing data not extracting in R. This was completed 1/2021
24. Draft recommendations [completed 2/1/2021]
25. Present recommendations to involved academic and ARCSOLOGY committee members [committee members include patient representatives as well as additional clinicians not involves in SR, but with knowledge of disease therapy] [completed 2/1/2021]
26. Consensus round 1: review of results [completed 2/1/2021]
27. Individual ratings of each recommendation sent to Palackdharry [completed 2/1/2021]
28. 75% must either agree or strongly agree [5 point scale] to support conclusion [completed 2/1/2021]
29. if 75% not reached for a statement, statement is re-drafted and sent for voting again not needed
30. once statement is approved, only changes made to content of recommendation are sent for redrafting
31. Consensus round 2 [completed 2/15/21]
32. All consensus recommendations are sent to committee members, including new and all previous versions of statements [completed 2/15/21]
33. Ratings and comments compiled [completed 4/17/21]
34. Evaluation of consensus [completed 4/17/21]

35. Acceptance of ratings if consensus achieved [completed 4/17/21]
36. Statement of which areas consensus could not be achieved [completed 4/17/21]
37. Revisions to wording or style [completed 4/17/21]
38. Submission for publication [in process as of 7/23/2021]

Troubleshooting

1. LENGTH OF TIME TO CREATE, TEST, AND VERIFY SEARCH STRINGS, WAS DIFFICULT WHEN THE 62 ADDITIONAL NAMES FOR THE DISEASES WERE IDENTIFIED.
2. DUE TO VOLUME OF RETURN ANALYSIS OF ABSTRACTS TOOK FAR LONGER THAN PREDICTED
3. DUE TO TIME TAKEN TO ANALYZE DATA, SEARCH WAS 5 MONTHS OUT OF DATE, SO FINAL SEARCH PERFORMED AT START OF WRITING PUBLICATION TO DETERMINE IF CONCLUSION-CHANGING STUDIES HAD BEEN PUBLISHED, WHICH HAD NOT. THEREFORE WE DID NOT HAVE TO REDO THE ENTIRE DATA ANALYSIS, BUT DO PRESENT LINKS TO THE ADDITIONAL CASE REPORTS PUBLISHED [THOUGH NONE PROVIDE NEW INFORMATION OR DATA]

below is the process and troubleshooting to obtain all sources:

METHODS 3: DEVELOPMENT OF FINAL SEARCH STRINGS

PILOT SEARCH: DONE INDEPENDENTLY BY PALACKDHARRY AND SÄYNÄJOKI ON 12/16/18

- a. "Arachnoiditis" in pubmed: 2104 articles. Searched 12/16/18
- b. "Chronic meningitis" in pubmed: approx. 3973 articles 12/16/18
 - i. chronic; meningitis
- c. Arachnoiditis under clinical queries : 615 studies, 2 systematic reviews, 5 genetics
- d. Arachnoiditis or "chronic meningitis" 2513
- e. pachymeningitis AND hasabstract[text] 12/16/18 with abstracts in English: 37039
- f. MeSH Terms: syndrome; laminectomy; meningitis; arachnoiditis epidural fibrosis; chronic; meningitis; laminectomy; post; syndrome; pachymeningitis; arachnoiditis; radiculomyelitis; failed back surgery syndrome =
- g. (((("arachnoiditis"[MeSH Terms] OR "arachnoiditis"[All Fields]) OR "chronic meningitis"[All Fields]) OR radiculomyelitis[All Fields]) OR "epidural fibrosis"[All Fields]) = 3024 articles 12/16/18

2. Full search strings will use e, g, h AND each term listed in the "specific area" list

Search string table for pub med with primary search string finalized 1/13/19

1/30/19 Search string for pubmed changed to primary search string only due to problems with pubmed databases returning faulty results depending on search order.

1/26/19 ARACHNOIDITIS SEARCH STRING 1 PUBMED #1

PRIMARY STRING RETURN 1/13/19 3366 ARTICLES

((("arachnoiditis"[MeSH Terms] OR "arachnoiditis"[All Fields]) OR "chronic meningitis"[All Fields]) OR "Radiculomyelitis"[All Fields] OR "radiculitis"[All Fields]) OR (((("meningitis"[MeSH Terms] OR "meningitis"[All Fields] OR "pachymeningitis"[All Fields]) AND hasabstract[text]) AND (((("arachnoiditis"[MeSH Terms] OR "arachnoiditis"[All Fields]) OR "chronic meningitis"[All Fields]) OR radiculomyelitis[All Fields]) AND hasabstract[text])

4/5/19 ARACHNOID FIBROSIS ADDED TO SEARCH: PUBMED #2

((((((("arachnoid"[MeSH Terms] OR "arachnoid"[All Fields]) OR "arachnoid mater"[All Fields]) OR sub-arachnoid[All Fields]) OR subarachnoid[All Fields]) OR meningeal[All Fields]) OR leptomeningeal[All Fields]) OR pia[All Fields]) OR "pia mater"[All Fields]) AND (((((((("fibrosis"[MeSH Terms] OR "fibrosis"[All Fields]) OR ("cicatrix"[MeSH Terms] OR "cicatrix"[All Fields] OR "scarring"[All Fields])) OR adhesions[All Fields]) OR blockage[All Fields]) OR destruction[All Fields]) OR ("J Adhes"[Journal] OR "adhesion"[All Fields])) AND ("humans"[MeSH Terms] OR "animals"[MeSH Terms:noexp])

1. 1725 reviewed from Pub Med only
2. 582 animals
3. 1244 humans
4. 1025 humans/abstracts

FINAL COUNTS AFTER DEDUPLICATE

1. 221 human chosen to include in SR
2. 88 animal studies will be pulled for additional discussion of future directions

MAYO #1 [WITHOUT ARACHNOID FIBROSIS]

DATA SOURCES AND SEARCH STRATEGIES

A comprehensive search of several databases from 1946 to March 15, 2019, limited to English language only, was conducted. The databases included Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid Embase, Ovid Cochrane Central Register of Controlled Trials, Ovid Cochrane Database of Systematic Reviews, and Scopus.

The search strategy was designed and conducted by an experienced librarian with input from the study's principle investigator. Controlled vocabulary supplemented with keywords was used to search for studies on arachnoiditis. The full search strategy is available in Appendix 1.

Database(s): **Embase** 1988 to 2019 Week 10, **Ovid MEDLINE(R) 1946 to Present and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) Daily, EBM Reviews - Cochrane Central Register of Controlled Trials** February 2019, **EBM Reviews - Cochrane Database of Systematic Reviews** 2005 to March 13, 2019

Search Strategy:

#

Searches

Results

1

arachnoiditis/ or (arachnoiditis or "chronic meningitis" or radiculomyelitis or radiculitis).ti,ab,hw,kw.

6608

2

limit 1 to English language [Limit not valid in CDSR; records were retained]

4755

3

remove duplicates from 2

3501

SCOPUS

1 TITLE-ABS-KEY ((arachnoiditis OR "chronic meningitis" OR radiculomyelitis OR radiculitis))

2 INDEX (embase) OR INDEX (medline) OR PMID (0* OR 1* OR 2* OR 3* OR 4* OR 5* OR 6* OR 7* OR 8* OR 9*)

3 #1 and not #2

4 DOCTYPE(ed) OR DOCTYPE(bk) OR DOCTYPE(er) OR DOCTYPE(no) OR DOCTYPE(sh) OR DOCTYPE(ch)

5 #3 and not #4

6 LANGUAGE(English)

MAYO #2. ADDING ARCS FIBROSIS

DATA SOURCES AND SEARCH STRATEGIES

A comprehensive search of several databases from 1946 to April 15, 2019, limited to English language only, and excluding animal studies, was conducted. The databases included Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid Embase, Ovid Cochrane Central Register of Controlled Trials, Ovid Cochrane Database of Systematic Reviews, and Scopus.

The search strategy was designed and conducted by an experienced librarian with input from the study's principle investigator. Controlled vocabulary supplemented with keywords was used to search for studies on arachnoid fibrosis. The full search strategy is available in Appendix 1.

Database(s): **Embase** 1988 to 2019 Week 15, **Ovid MEDLINE(R) 1946 to Present and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) Daily, EBM Reviews - Cochrane Central Register of Controlled Trials** March 2019, **EBM Reviews - Cochrane Database of Systematic Reviews** 2005 to April 10, 2019

Search Strategy:

#

Searches

Results

1

exp Arachnoid/

10851

2

(arachnoid or subarachnoid or sub-arachnoid).ti,ab,hw,kw.

106560

3

exp menix/ or exp meninges/ or (meninge* or leptomenix or leptomeningeal or "pia mater").ti,ab,hw,kw.

114042

4

or/1-3

200773

5

exp adhesion/ or tissue adhesion/ or fibrosis/

158577

6

(fibrosis or adhesion* or blockage* or destruction or scarring or cicatrice).ti,ab,hw,kw.

1360888

7

or/5-6

1370658

8

4 and 7

5098

9

limit 8 to english language [Limit not valid in CDSR; records were retained]

4522

10

remove duplicates from 9

3330

SCOPUS

1 TITLE-ABS-KEY (arachnoid OR subarachnoid OR sub-arachnoid OR meninge* OR leptomenix OR leptomeningeal OR "pia mater")

2 TITLE-ABS-KEY (fibrosis OR adhesion* OR blockage* OR destruction OR scarring OR cicatrice)

3 #1 and #2

4 INDEX (embase) OR INDEX (medline) OR PMID (0* OR 1* OR 2* OR 3* OR 4* OR 5* OR 6* OR 7* OR 8* OR 9*)

5 #3 and not #4

PUB MED 3/2/20 REVIEW BY PALACKDHARRY WITH PRIMARY SEARCH STRING, ONLY INCLUDED NEW ITEMS SINCE 4/1/2019 ORIGINAL SEARCH STRING #3

1. 367 new articles added from pub med
2. 52 ok for inclusion in SR
3. 22 reviews
4. 6 animal studies
5. 315 excluded

11733 return total for PRISMA [all to date]

10066 excluded for PRISMA given this data [all to date, not including hand]

ARC FIB 3/2/20 PALACKDHARRY PUBMED #4

- Arachnoid fibrosis string run on 1/3/20 in Pub med
- English and humans 448 total
- Only 1 since April 2019 that was not already included in weekly updates
- 0 included as it relates to dural fibrosis

Totals

- 13302 ID in PRISMA
- 11734 post deduplication
- 11734 screened
- 10067 excluded

MAYO #3 TO 4/1/19-3/2/20 [PUBMED UPDATED TO MATCH PUBMED PULL DATE]

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials January 2020, EBM Reviews - Cochrane Database of Systematic Reviews 2005 to February 27, 2020, Embase 1974 to 2020 March 02

Search Strategy:

#

Searches

Results

1

exp arachnoiditis/

2126

2

(arachnoiditis or "chronic meningitis" or radiculitis or Radiculomyelitis).ti,ab,hw,kw.

4623

3

((meningitis or pachymeningitis) and (arachnoiditis or "chronic meningitis" or radiculitis)).ti,ab,hw,kw.

1443

4

1 or 2 or 3

4623

5

limit 4 to yr="2019"

150

6

limit 5 to (conference abstract or editorial or erratum or note or addresses or autobiography or bibliography or biography or blogs or comment or dictionary or directory or interactive tutorial or interview or lectures or legal cases or legislation or news or newspaper article or overall or patient education handout or periodical index or portraits or published erratum or video-audio media or webcasts) [Limit not valid in CCTR,CDSR,Embase; records were retained]

39

7

5 not 6

111

8

remove duplicates from 7

109

MAYO#4 UPDATE MAYO PULL TO FINAL DATE TO INCLUDE "ARACHNOID OR LM FIBROSIS" TO FINAL DATE OF 3/03/2020

- by unanimous email vote
- Bydon sent Mayo results. Palackdharry loaded into Covidence.
- Numbers below are accurate to include final "fibrosis pull" and hand searching of new articles for any missed related articles
- Palackdharry 9/2/20

PUBMED/NCBI SEARCH 5/30/21

The following sources were published since 12/6/2020:

SEARCH STRING 1

Sent On: Sun May 30 15:05:34 2021

Search: (((("arachnoiditis"[MeSH Terms] OR "arachnoiditis"[All Fields]) OR "chronic meningitis"[All Fields]) OR "Radiculomyelitis"[All Fields]) OR "radiculitis"[All Fields]) OR (((("meningitis"[MeSH Terms] OR "meningitis"[All Fields]) OR "pachymeningitis"[All Fields]) AND hasabstract[text]) AND (((("arachnoiditis"[MeSH Terms] OR "arachnoiditis"[All Fields]) OR "chronic meningitis"[All Fields]) OR radiculomyelitis[All Fields]) AND hasabstract[text])

12 selected items

PubMed Results

Items 1-12 of 12 ([Display the 12 citations in PubMed](#))

1.

[Two cases of myelin oligodendrocyte glycoprotein antibody-associated disease presenting with Cauda Equina Syndrome without conus myelitis.](#)

Kang MS, Kim MK, Kim YE, Kim JH, Kim BJ, Lee HL.

Mult Scler Relat Disord. 2021 May 8;52:103017. doi: 10.1016/j.msard.2021.103017. Online ahead of print.

PMID: 34023773

2.

[A Case of Elsberg Syndrome in the Setting of Asymptomatic SARS-CoV-2 Infection.](#)

Abrams RMC, Desland F, Lehrer H, Yeung A, Tse W, Young JJ, Mendu DR, Vickrey BG, Shin SC.

J Clin Neuromuscul Dis. 2021 Jun 1;22(4):228-231. doi: 10.1097/CND.0000000000000369.

PMID: 34019009

3.

[Post-operative radiculitis following one or two level anterior lumbar surgery with or without posterior instrumentation.](#)

Griffith MS, Shaw KA, Burke BK, Jackson KL, Gloystein DM.

J Orthop. 2021 Apr 2;25:45-52. doi: 10.1016/j.jor.2021.03.023. eCollection 2021 May-Jun.

PMID: 33927508

4.

[A Unique Case of Bannwarth Syndrome in Early Disseminated Lyme Disease.](#)

Omotosho YB, Sherchan R, Ying GW, Shayuk M.

Cureus. 2021 Apr 25;13(4):e14680. doi: 10.7759/cureus.14680.

PMID: 33912367 **Free PMC article.**

5.

[Assessment of main complications of regional anesthesia recorded in an acute pain unit in a tertiary care university hospital: a retrospective cohort.](#)

Campos MG, Peixoto AR, Fonseca S, Santos F, Pinho C, Leite D.

Braz J Anesthesiol. 2021 Apr 19:S0104-0014(21)00141-X. doi: 10.1016/j.bjane.2021.03.011. Online ahead of print.

PMID: 33887339

6.

[Hydrocephalus in Mexican children with Coccidioidal Meningitis: Clinical, serological, and neuroimaging findings.](#)

De la Cerda-Vargas MF, Sandoval-Bonilla BA, McCarty JM, De León FC, Candelas-Rangel JA, Rodríguez-Rodríguez JD, Navarro-Domínguez P, Muñoz-Hernández MA, Meza-Mata E, Fernández-González EM, Sámano-Aviña MG.

Surg Neurol Int. 2021 Mar 24;12:119. doi: 10.25259/SNI_895_2020. eCollection 2021.

PMID: 33880224 **Free PMC article.**

7.

[MRI characteristics of syringomyelia associated with foramen magnum arachnoiditis: differentiation from Chiari malformation.](#)

Hatano K, Ohashi H, Kawamura D, Isoshima A, Nagashima H, Tochigi S, Ohashi S, Takei J, Teshigawara A, Tani S, Murayama Y, Abe T.

Acta Neurochir (Wien). 2021 Jun;163(6):1593-1601. doi: 10.1007/s00701-021-04845-9. Epub 2021 Apr 21.

PMID: 33881607

8.

[Management of syringomyelia associated with tuberculous meningitis: A case report and systematic review of the literature.](#)

Kannapadi NV, Alomari SO, Caturegli G, Bydon A, Cho SM.

J Clin Neurosci. 2021 May;87:20-25. doi: 10.1016/j.jocn.2021.01.052. Epub 2021 Mar 5.

PMID: 33863527

9.

[Managing intrathecal administration of nusinersen in adolescents and adults with 5q-spinal muscular atrophy and previous spinal surgery.](#)

Mendonça RH, Fernandes HDS, Pinto RBS, Matsui Júnior C, Polido GJ, Silva AMSD, Grossklauss LF, Reed UC, Zanoteli E.

Arq Neuropsiquiatr. 2021 Feb;79(2):127-132. doi: 10.1590/0004-282X-ANP-2020-0200.

PMID: 33759979

10.

[\[Arachnoiditis following spinal anesthesia-Case report and review of the literature\].](#)

Brandt L, Albert S, Artmeier-Brandt U.

Anaesthesist. 2021 Mar 15. doi: 10.1007/s00101-021-00938-3. Online ahead of print.

PMID: 33721039 German.

11.

[Sporothrix brasiliensis meningitis in an immunocompetent patient.](#)

Lima MA, Vallier R, Silva MM.

Pract Neurol. 2021 Jun;21(3):241-242. doi: 10.1136/practneurol-2020-002915. Epub 2021 Feb 24.

PMID: 33627490

12.

[Arachnoiditis, a complication of epidural blood patch for the treatment of low-pressure headache: A case report and systematic review.](#)

Villani LA, Digre KB, Cortez MM, Bokar C, Rassner UA, Ozudogru SN.

Headache. 2021 Feb;61(2):244-252. doi: 10.1111/head.14076. Epub 2021 Feb 13.

PMID: 33583044 Review.

Search string 1 results: 10 case reports of various infections causing LMP [will not change outcome of study]. Orthopedic study showing very high rate of radiculitis due to hrBMP is consistent with our findings and will not change outcome.

SEARCH STRING 2

Sent On: Sun May 30 15:15:30 2021

Search: (((((((("arachnoid"[MeSH Terms] OR "arachnoid"[All Fields]) OR "arachnoid mater"[All Fields]) OR sub-arachnoid[All Fields]) OR subarachnoid[All Fields]) OR meningeal[All Fields]) OR leptomeningeal[All Fields]) OR pia[All Fields]) OR "pia mater"[All Fields]) AND (((((((("fibrosis"[MeSH Terms] OR "fibrosis"[All Fields]) OR ("cicatrix"[MeSH Terms] OR "cicatrix"[All Fields] OR "scarring"[All Fields])) OR adhesions[All Fields]) OR blockage[All Fields]) OR destruction[All Fields]) OR ("J Adhes"[Journal] OR "adhesion"[All Fields])) AND ("humans"[MeSH Terms] OR "animals"[MeSH Terms:noexp])

3 selected items

PubMed Results

Items 1-3 of 3 ([Display the 3 citations in PubMed](#))

1.

[Blood-cerebrospinal fluid \(CSF\) barrier dysfunction means reduced CSF flow not barrier leakage - conclusions from CSF protein data.](#)

Reiber H.

Arq Neuropsiquiatr. 2021 Jan;79(1):56-67. doi: 10.1590/0004-282X-anp-2020-0094.

PMID: 33656113

2.

Effect of Microscopic Third Ventriculostomy (Lamina Terminalis Fenestration) on Shunt-needed Hydrocephalus in Patients with Aneurysmal Subarachnoid Hemorrhage.

Tabibkhouei A, Azar M, Taheri M, Ghalaenovi H, Fattahi A, Kheradmand H.

Prague Med Rep. 2021;122(1):14-24. doi: 10.14712/23362936.2021.2.

PMID: 33646938

3.

An immunohistochemical study of lymphatic elements in the human brain.

Mezey É, Szalayova I, Hogden CT, Brady A, Dósa Á, Sótónyi P, Palkovits M.

Proc Natl Acad Sci U S A. 2021 Jan 19;118(3):e2002574118. doi: 10.1073/pnas.2002574118.

PMID: 33446503 **Free PMC article.**

Time Taken

This review took >40,000 hours in total and took 27 months to complete and start the publication writing.

Anticipated Results

We have identified that the leptomeninges are a new and critical organ

References

877 articles were included for the SR:

eReferences 1

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