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## Corrigendum to “Platelets and Hemostatic Proteins are Co-Localized with Chronic Neuroinflammation Surrounding Implanted Intracortical Microelectrodes” [Acta Biomaterialia. Volume 166, August 2023, Pages 278–290]

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The authors regret the oversight in which select citations contained errors that were overlooked during the review and editorial process. The authors have made the appropriate corrections. It is important to note that these corrections do not impact the data and conclusions presented in the study. The integrity and validity of the findings remain unchanged.

The manuscript version available on PubMed remains unchanged. The below correction applies to the version available on ScienceDirect.

The impacted sentences with amended in-line citations as well as the entire corrected bibliography are reproduced below.

The authors apologise for any inconvenience caused.

Although platelets’ primary function is to prevent vascular leaks and promote wound healing, under inflammatory conditions activated platelets have been suggested to promote leukocytic migration through modulating endothelial junctions [46–50,55,56].

Furthermore, fibrinogen-induced neuroinflammation has been linked to neurologic disease models such as Multiple Sclerosis, Alzheimer’s Disease, and ischemic stroke [89,107,108].

Sustained platelet presence may be influenced by a prolonged dysfunctional BBB and inflammatory chemokines released by activated endothelial and immune cells [55,71,112].

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## Corrected References Section

- [1]. Donoghue JP, Connecting cortex to machines: recent advances in brain interfaces, *Nat. Neurosci.* 5 (2002) 1085–1088. 10.1038/nn947. [PubMed: 12403992]
- [2]. Hochberg LR, Donoghue JP, Sensors for brain-computer interfaces, *IEEE Eng. Med. Biol. Mag.* 25 (2006) 32–38. 10.1109/MEMB.2006.1705745.
- [3]. Donoghue JP, Bridging the Brain to the World: A Perspective on Neural Interface Systems, *Neuron* 60 (2008) 511–521. 10.1016/j.neuron.2008.10.037. [PubMed: 18995827]
- [4]. Pancrazio JJ, Deku F, Ghazavi A, Stiller AM, Rihani R, Frewin CL, Varner VD, Gardner TJ, Cogan SF, Thinking Small: Progress on Microscale Neurostimulation Technology, *Neuromodulation Technol. Neural Interface* 20 (2017) 745–752. 10.1111/ner.12716.
- [5]. Ajiboye AB, Willett FR, Young DR, Memberg WD, Murphy BA, Miller JP, Walter BL, Sweet JA, Hoyen HA, Keith MW, Peckham PH, Simeral JD, Donoghue JP, Hochberg LR, Kirsch RF, Restoration of reaching and grasping in a person with tetraplegia through brain-controlled muscle stimulation: a proof-of-concept demonstration, *Lancet Lond. Engl.* 389 (2017) 1821–1830. 10.1016/S0140-6736(17)30601-3.
- [6]. Herreras O, Local Field Potentials: Myths and Misunderstandings, *Front. Neural Circuits* 10 (2016). <https://www.frontiersin.org/article/10.3389/fncir.2016.00101> (accessed July 1, 2022).
- [7]. Kozai TDY, Du Z, Gugel ZV, Smith MA, Chase SM, Bodily LM, Caparosa EM, Friedlander RM, Cui XT, Comprehensive chronic laminar single-unit, multi-unit, and local field potential recording performance with planar single shank electrode arrays, *J. Neurosci. Methods* 242 (2015) 15–40. 10.1016/j.jneumeth.2014.12.010. [PubMed: 25542351]
- [8]. Bulea TC, Prasad S, Kilicarslan A, Contreras-Vidal JL, Sitting and standing intention can be decoded from scalp EEG recorded prior to movement execution, *Front. Neurosci.* 8 (2014). <https://www.frontiersin.org/article/10.3389/fnins.2014.00376> (accessed July 1, 2022).
- [9]. McFarland DJ, Sarnacki WA, Wolpaw JR, ELECTROENCEPHALOGRAPHIC (EEG) CONTROL OF THREE-DIMENSIONAL MOVEMENT, *J. Neural Eng.* 7 (2010) 036007. 10.1088/1741-2560/7/3/036007. [PubMed: 20460690]
- [10]. Soekadar SR, Witkowski M, Vitiello N, Birbaumer N, An EEG/EOG-based hybrid brain-neural computer interaction (BCI) system to control an exoskeleton for the paralyzed hand, *Biomed. Tech. (Berl.)* 60 (2015) 199–205. 10.1515/bmt-2014-0126. [PubMed: 25490027]
- [11]. Bleichner MG, Freudenburg ZV, Jansma JM, Aarnoutse EJ, Vansteensel MJ, Ramsey NF, Give me a sign: decoding four complex hand gestures based on high-density ECoG, *Brain Struct. Funct.* 221 (2016) 203–216. 10.1007/s00429-014-0902-x. [PubMed: 25273279]
- [12]. Nakanishi Y, Yanagisawa T, Shin D, Fukuma R, Chen C, Kambara H, Yoshimura N, Hirata M, Yoshimine T, Koike Y, Prediction of Three-Dimensional Arm Trajectories Based on ECoG Signals Recorded from Human Sensorimotor Cortex, *PLOS ONE* 8 (2013) e72085. 10.1371/journal.pone.0072085. [PubMed: 23991046]
- [13]. Shoffstall A, Capadona JR, Chapter 28 - Prospects for a Robust Cortical Recording Interface, in: Krames ES, Peckham PH, Rezai AR (Eds.), *Neuromodulation Second Ed.*, Academic Press, 2018: pp. 393–413. 10.1016/B978-0-12-805353-9.00028-0.
- [14]. Pancrazio JJ, Peckham PH, Neuroprosthetic devices: how far are we from recovering movement in paralyzed patients?, *Expert Rev. Neurother.* 9 (2009) 427–430. 10.1586/ern.09.12. [PubMed: 19344294]
- [15]. Bowsher K, Civillico EF, Coburn J, Collinger J, Contreras-Vidal JL, Denison T, Donoghue J, French J, Getzoff N, Hochberg LR, Hoffmann M, Judy J, Kleitman N, Knaack G, Krauthamer V, Ludwig K, Moynahan M, Pancrazio JJ, Peckham PH, Pena C, Pinto V, Ryan T, Saha D, Scharen H, Shermer S, Skodacek K, Takmakov P, Tyler D, Vasudevan S, Wachrathit K, Weber D, Welle CG, Ye M, Brain-computer interface devices for patients with paralysis and amputation: a meeting report, *J. Neural Eng.* 13 (2016) 023001. 10.1088/1741-2560/13/2/023001. [PubMed: 26924826]
- [16]. Hochberg LR, Bacher D, Jarosiewicz B, Masse NY, Simeral JD, Vogel J, Haddadin S, Liu J, Cash SS, van der Smagt P, Donoghue JP, Reach and grasp by people with tetraplegia using a neurally controlled robotic arm, *Nature* 485 (2012) 372–375. 10.1038/nature11076. [PubMed: 22596161]

- [17]. Hochberg LR, Serruya MD, Friehs GM, Mukand JA, Saleh M, Caplan AH, Branner A, Chen D, Penn RD, Donoghue JP, Neuronal ensemble control of prosthetic devices by a human with tetraplegia, *Nature* 442 (2006) 164–171. 10.1038/nature04970. [PubMed: 16838014]
- [18]. Colachis SC, Dunlap CF, Annetta NV, Tamrakar SM, Bockbrader MA, Friedenberg DA, Long-term intracortical microelectrode array performance in a human: a 5 year retrospective analysis, *J. Neural Eng.* 18 (2021) 0460d7. 10.1088/1741-2552/ac1add.
- [19]. Barrese JC, Rao N, Paroo K, Triebwasser C, Vargas-Irwin C, Franquemont L, Donoghue JP, Failure mode analysis of silicon-based intracortical microelectrode arrays in non-human primates, *J. Neural Eng.* 10 (2013) 0 6 6014. 10.1088/1741-2560/10/6/066014.
- [20]. Bedell HW, Hermann JK, Ravikumar M, Lin S, Rein A, Li X, Molinich E, Smith PD, Selkirk SM, Miller RH, Sidik S, Taylor DM, Capadona JR, Targeting CD14 on blood derived cells improves intracortical microelectrode performance, *Biomaterials* 163 (2018). 10.1016/j.biomaterials.2018.02.014.
- [21]. Saxena T, Karumbaiah L, Gaupp EA, Patkar R, Patil K, Betancur M, Stanley GB, Bellamkonda RV, The impact of chronic blood-brain barrier breach on intracortical electrode function, *Biomaterials* 34 (2013) 4703–4713. 10.1016/j.biomaterials.2013.03.007. [PubMed: 23562053]
- [22]. Michelson NJ, Vazquez AL, Eles JR, Salatino JW, Purcell EK, Williams JJ, Cui XT, Kozai TDY, Multi-scale, multi-modal analysis uncovers complex relationship at the brain tissue-implant neural interface: new emphasis on the biological interface, *J. Neural Eng.* 15 (2018) 033001. 10.1088/1741-2552/aa9dae. [PubMed: 29182149]
- [23]. Hermann JK, Ravikumar M, Shoffstall AJ, Ereifej ES, Kovach KM, Chang J, Soffer A, Wong C, Srivastava V, Smith P, Protasiewicz G, Jiang J, Selkirk SM, Miller RH, Sidik S, Ziats NP, Taylor DM, Capadona JR, Inhibition of the cluster of differentiation 14 innate immunity pathway with IAXO-101 improves chronic microelectrode performance, *J. Neural Eng.* 15 (2018) 025002. 10.1088/1741-2552/aaa03e. [PubMed: 29219114]
- [24]. Falcone JD, Sohal HS, Kyriakides TR, Bellamkonda RV, The impact of modulating the blood-brain barrier on the electrophysiological and histological outcomes of intracortical electrodes, *J. Neural Eng.* 16 (2019) 046005. 10.1088/1741-2552/ab1ef9. [PubMed: 31048574]
- [25]. Bennett C, Samikkannu M, Mohammed F, Dietrich WD, Rajguru SM, Prasad A, Blood brain barrier (BBB)-disruption in intracortical silicon microelectrode implants, *Biomaterials* 164 (2018) 1–10. 10.1016/j.biomaterials.2018.02.036. [PubMed: 29477707]
- [26]. Bennett C, Mohammed F, Alvarez-Ciara A, Nguyen MA, Dietrich WD, Rajguru SM, Streit WJ, Prasad A, Neuroinflammation, oxidative stress, and blood-brain barrier (BBB) disruption in acute Utah electrode array implants and the effect of deferoxamine as an iron chelator on acute foreign body response, *Biomaterials* 188 (2019) 144–159. 10.1016/j.biomaterials.2018.09.040. [PubMed: 30343257]
- [27]. Bjornsson CS, Oh SJ, Al-Kofahi YA, Lim YJ, Smith KL, Turner JN, De S, Roysam B, Shain W, Kim SJ, Effects of insertion conditions on tissue strain and vascular damage during neuroprosthetic device insertion, *J. Neural Eng.* 3 (2006) 196. 10.1088/1741-2560/3/3/002. [PubMed: 16921203]
- [28]. Johnson MD, Kao OE, Kipke DR, Spatiotemporal pH dynamics following insertion of neural microelectrode arrays, *J. Neurosci. Methods* 160 (2007) 276–287. 10.1016/j.jneumeth.2006.09.023. [PubMed: 17084461]
- [29]. Hoeferlin GF, Menendez DM, Krebs OK, Capadona JR, Shoffstall AJ, Assessment of Thermal Damage from Robot-Drilled Craniotomy for Cranial Window Surgery in Mice, *J. Vis. Exp.* (2022). 10.3791/64188.
- [30]. Shoffstall AJ, Paiz JE, Miller DM, Rial GM, Willis MT, Menendez DM, Hostler SR, Capadona JR, Potential for thermal damage to the blood-brain barrier during craniotomy: implications for intracortical recording microelectrodes, *J Neural Eng* 15 (2018) 034001. [PubMed: 29205169]
- [31]. Ravikumar M, Sunil S, Black J, Barkauskas DS, Haung AY, Miller RH, Selkirk SM, Capadona JR, The roles of blood-derived macrophages and resident microglia in the neuroinflammatory response to implanted Intracortical microelectrodes, *Biomaterials* 35 (2014) 8049–8064. 10.1016/j.biomaterials.2014.05.084. [PubMed: 24973296]
- [32]. Davalos D, Kyu Ryu J, Merlini M, Baeten KM, Le Moan N, Petersen MA, Deerinck TJ, Smirnoff DS, Bedard C, Hakozaki H, Gonias Murray S, Ling JB, Lassmann H, Degen JL, Ellisman

- MH, Akassoglou K, Fibrinogen-induced perivascular microglial clustering is required for the development of axonal damage in neuroinflammation, *Nat. Commun.* 3 (2012) 1227. 10.1038/ncomms2230. [PubMed: 23187627]
- [33]. Potter KA, Buck AC, Self WK, Callanan ME, Sunil S, Capadona JR, The effect of resveratrol on neurodegeneration and blood brain barrier stability surrounding intracortical microelectrodes, *Biomaterials* 34 (2013) 7001–7015. [PubMed: 23791503]
- [34]. Potter KA, Buck AC, Self WK, Capadona JR, Stab injury and device implantation within the brain results in inversely multiphasic neuroinflammatory and neurodegenerative responses, *J. Neural Eng.* 9 (2012) 046020. 10.1088/1741-2560/9/4/046020. [PubMed: 22832283]
- [35]. Wellman SM, Li L, Yaxiaer Y, McNamara I, Kozai TDY, Revealing Spatial and Temporal Patterns of Cell Death, Glial Proliferation, and Blood-Brain Barrier Dysfunction Around Implanted Intracortical Neural Interfaces, *Front. Neurosci.* 13 (2019) 493. 10.3389/fnins.2019.00493. [PubMed: 31191216]
- [36]. Bedell HW, Schaub NJ, Capadona JR, Ereifej ES, Differential expression of genes involved in the acute innate immune response to intracortical microelectrodes, *Acta Biomater.* 102 (2020). 10.1016/j.actbio.2019.11.017.
- [37]. Potter-Baker KA, Nguyen JK, Kovach KM, Gitomer MM, Srail TW, Skousen JL, Capadona JR, Development of Superoxide Dismutase Mimetic Surfaces to Mitigate Reactive Oxygen Species-Mediated Intracortical Microelectrode Failure, *J. Mater. Chem. B* 2 (2014) 2248–2258. 10.1039/C4TB00125G.
- [38]. Kozai TD, Li X, Bodily LM, Caparosa EM, Zenenos GA, Carlisle DL, Friedlander RM, Cui XT, Effects of caspase-1 knockout on chronic neural recording quality and longevity: insight into cellular and molecular mechanisms of the reactive tissue response, *Biomaterials* 35 (2014) 9620–34. [PubMed: 25176060]
- [39]. Mercanzini A, Colin P, Bensadoun JC, Bertsch A, Renaud P, In vivo electrical impedance spectroscopy of tissue reaction to microelectrode arrays, *IEEE Trans Biomed Eng* 56 (2009) 1909–18. [PubMed: 19362904]
- [40]. Prasad A, Sanchez JC, Quantifying long-term microelectrode array functionality using chronic in vivo impedance testing, *J Neural Eng* 9 (2012) 026028. [PubMed: 22442134]
- [41]. Jorfi M, Skousen JL, Weder C, Capadona JR, Progress Towards Biocompatible Intracortical Microelectrodes for Neural Interfacing Applications, *J. Neural Eng.* 12 (2015) 011001. 10.1088/1741-2560/12/1/011001. [PubMed: 25460808]
- [42]. Golabchi A, Woepel KM, Li X, Lagenauf CF, Cui XT, Neuroadhesive protein coating improves the chronic performance of neuroelectronics in mouse brain, *Biosens. Bioelectron.* 155 (2020) 112096. 10.1016/j.bios.2020.112096. [PubMed: 32090868]
- [43]. Golabchi A, Wu B, Cao B, Bettinger CJ, Cui XT, Zwitterionic polymer/polydopamine coating reduce acute inflammatory tissue responses to neural implants, *Biomaterials* 225 (2019) 119519. 10.1016/j.biomaterials.2019.119519. [PubMed: 31600673]
- [44]. Seymour JP, Kipke DR, Neural probe design for reduced tissue encapsulation in CNS, *Biomaterials* 28 (2007) 3594–3607. 10.1016/j.biomaterials.2007.03.024. [PubMed: 17517431]
- [45]. Beura SK, Panigrahi AR, Yadav P, Agrawal S, Singh SK, Role of Neurons and Glia Cells in Wound Healing as a Novel Perspective Considering Platelet as a Conventional Player, *Mol. Neurobiol.* 59 (2022) 137–160. 10.1007/s12035-021-02587-4. [PubMed: 34633653]
- [46]. Flick MJ, Du X, Witte DP, Jiroušková M, Soloviev DA, Busuttil SJ, Plow EF, Degen JL, Leukocyte engagement of fibrin(ogen) via the integrin receptor  $\alpha$ M  $\beta$ 2/Mac-1 is critical for host inflammatory response in vivo, *J. Clin. Invest.* 113 (2004) 1596–1606. 10.1172/JCI20741. [PubMed: 15173886]
- [47]. Kawecki C, Lenting PJ, Denis CV, von Willebrand factor J Thromb. Haemost. JTH 15 (2017) 1285–1294. 10.1111/jth.13696.
- [48]. Ryu JK, Petersen MA, Murray SG, Baeten KM, Meyer-Franke A, Chan JP, Vagena E, Bedard C, Machado MR, Coronado PER, Prod'homme T, Charo IF, Lassmann H, Degen JL, Zamvil SS, Akassoglou K, Blood coagulation protein fibrinogen promotes autoimmunity and demyelination via chemokine release and antigen presentation, *Nat. Commun.* 6 (2015) 8164. 10.1038/ncomms9164. [PubMed: 26353940]

- [49]. Wilson CJ, Clegg RE, Leavesley DI, Pearcy MJ, Mediation of biomaterial-cell interactions by adsorbed proteins: a review, *Tissue Eng.* 11 (2005) 1–18. 10.1089/ten.2005.11.1. [PubMed: 15738657]
- [50]. Jenney CR, Anderson JM, Adsorbed serum proteins responsible for surface dependent human macrophage behavior, *J. Biomed. Mater. Res.* 49 (2000) 435–447. 10.1002/(sici)1097-4636(20000315)49:4. [PubMed: 10602077]
- [51]. Aronowski J, Zhao X, Molecular pathophysiology of cerebral hemorrhage: secondary brain injury, *Stroke* 42 (2011) 1781–1786. 10.1161/STROKEAHA.110.596718. [PubMed: 21527759]
- [52]. Tator CH, Koyanagi I, Vascular mechanisms in the pathophysiology of human spinal cord injury, *J. Neurosurg.* 86 (1997) 4 83–4 92. 10.3171/jns.1997.86.3.0483.
- [53]. Park E, Vellumian AA, Fehlings MG, The role of excitotoxicity in secondary mechanisms of spinal cord injury: a review with an emphasis on the implications for white matter degeneration, *J. Neurotrauma* 21 (2004) 754–774. 10.1089/0897715041269641. [PubMed: 15253803]
- [54]. Sawyer AJ, Kyriakides TR, Nanoparticle-based evaluation of blood–brain barrier leakage during the foreign body response, *J. Neural Eng.* 10 (2013) 016013. 10.1088/1741-2560/10/1/016013. [PubMed: 23337399]
- [55]. Mehta D, Malik AB, Signaling Mechanisms Regulating Endothelial Permeability, *Physiol. Rev.* 86 (2006) 279–367. 10.1152/physrev.00012.2005. [PubMed: 16371600]
- [56]. Petri B, Broermann A, Li H, Khandoga AG, Zarbock A, Krombach F, Goerge T, Schneider SW, Jones C, Nieswandt B, Wild MK, Vestweber D, von Willebrand factor promotes leukocyte extravasation, *Blood* 116 (2010) 4712–4719. 10.1182/blood-2010-03-276311. [PubMed: 20716766]
- [57]. Blair P, Flaumenhaft R, Platelet α-granules: Basic biology and clinical correlates, *Blood Rev.* 23 (2009) 177–189. 10.1016/j.blre.2009.04.001. [PubMed: 19450911]
- [58]. Alard JE, Ortega-Gomez A, Wichapong K, Bongiovanni D, Horckmans M, Megens RTA, Leoni G, Ferraro B, Rossaint J, Paulin N, Ng J, Ippel H, Suylen D, Hinkel R, Blanchet X, Gaillard F, D'Amico M, Von Hundelshausen P, Zarbock A, Scheiermann C, Hackeng TM, Steffens S, Kupatt C, Nicolaes GAF, Weber C, Soehnlein O, Recruitment of classical monocytes can be inhibited by disturbing heteromers of neutrophil HNP1 and platelet CCL5, *Sci. Transl. Med.* 7 (2015) 317ra196–317ra196. 10.1126/scitranslmed.aad5330.
- [59]. Bhat SA, Goel R, Shukla R, Hanif K, Platelet CD40L induces activation of astrocytes and microglia in hypertension, *Brain. Behav. Immun.* 59 (2017) 173–189. 10.1016/j.bbi.2016.09.021. [PubMed: 27658543]
- [60]. Cui X, Hetke JF, Wiler JA, Anderson DJ, Martin DC, Electrochemical deposition and characterization of conducting polymer polypyrrole/PSS on multichannel neural probes, *Sens. Actuators Phys.* 93 (2001) 8–18. 10.1016/S0924-4247(01)00637-9.
- [61]. Goss-Varley M, Dona KR, McMahon JA, Shoffstall AJ, Ereifej ES, Lindner SC, Capadona JR, Microelectrode implantation in motor cortex causes fine motor deficit: Implications on potential considerations to Brain Computer Interfacing and Human Augmentation, *Sci. Rep.* 7 (2017) 15254. 10.1038/s41598-017-15623-y. [PubMed: 29127346]
- [62]. Shoffstall AJ, Ecker M, Danda V, Joshi-Imre A, Stiller A, Yu M, Paiz JE, Mancuso E, Bedell HW, Voit WE, Pancrazio JJ, Capadona JR, Characterization of the Neuroinflammatory Response to Thiol-ene Shape Memory Polymer Coated Intracortical Microelectrodes, *Micromachines* 9 (2018) 486. 10.3390/mi9100486. [PubMed: 30424419]
- [63]. Goss-Varley M, Shoffstall AJ, Dona KR, McMahon JA, Lindner SC, Ereifej ES, Capadona JR, Rodent Behavioral Testing to Assess Functional Deficits Caused by Microelectrode Implantation in the Rat Motor Cortex, *J. Vis. Exp. JoVE* (2018). 10.3791/57829.
- [64]. Lindner SC, Yu M, Capadona JR, Shoffstall AJ, A graphical user interface to assess the neuroinflammatory response to intracortical microelectrodes, *J. Neurosci. Methods* 317 (2019) 141–148. 10.1016/j.jneumeth.2019.01.003. [PubMed: 30664915]
- [65]. Davis GE, Senger DR, Endothelial Extracellular Matrix, *Circ. Res.* 97 (2005) 1093–1107. 10.1161/01.RES.0000191547.64391.e3. [PubMed: 16306453]
- [66]. Khoshnoodi J, Pedchenko V, Hudson B, Mammalian Collagen IV, *Microsc. Res. Tech.* 71 (2008) 357–370. 10.1002/jemt.20564. [PubMed: 18219669]

- [67]. Michalski D, Spielvogel E, Puchta J, Reimann W, Barthel H, Nitzsche B, Mages B, Jäger C, Martens H, Horn AKE, Schob S, Härtig W, Increased Immunosignals of Collagen IV and Fibronectin Indicate Ischemic Consequences for the Neurovascular Matrix Adhesion Zone in Various Animal Models and Human Stroke Tissue, *Front. Physiol.* 11 (2020). <https://www.frontiersin.org/articles/10.3389/fphys.2020.575598> (accessed July 6, 2022).
- [68]. Buchtele N, Schwameis M, Gilbert JC, Schörgenhofer C, Jilma B, Targeting von Willebrand Factor in Ischaemic Stroke: Focus on Clinical Evidence, *Thromb. Haemost.* 118 (2018) 959–978. 10.1055/s-0038-1648251. [PubMed: 29847840]
- [69]. Coenen DM, Mastenbroek TG, Cosemans JM, Platelet interaction with activated endothelium: mechanistic insights from microfluidics, *Blood* 130 (2017) 2819–2828. 10.1182/blood-2017-04-780825. [PubMed: 29018081]
- [70]. Li F, Xu D, Hou K, Gou X, Li Y, The role of P2Y12 receptor inhibition in ischemic stroke on microglia, platelets and vascular smooth muscle cells, *J. Thromb. Thrombolysis* 50 (2020) 874–885. 10.1007/s11239-020-02098-4. [PubMed: 32248335]
- [71]. Gawaz M, Neumann FJ, Dickfeld T, Koch W, Laugwitz KL, Adelsberger H, Langenbrink K, Page S, Neumeier D, Schömig A, Brand K, Activated platelets induce monocyte chemotactic protein-1 secretion and surface expression of intercellular adhesion molecule-1 on endothelial cells, *Circulation* 98 (1998) 1164–1171. 10.1161/01.CIR.98.12.1164. [PubMed: 9743506]
- [72]. Ryu JK, McLarnon JG, A leaky blood–brain barrier, fibrinogen infiltration and microglial reactivity in inflamed Alzheimer’s disease brain, *J. Cell. Mol. Med.* 13 (2009) 2911–2925. 10.1111/j.1582-4934.2008.00434.x. [PubMed: 18657226]
- [73]. Kozai TDY, Langhals NB, Patel PR, Deng X, Zhang H, Smith KL, Lahann J, Kotov NA, Kipke DR, Ultrasmall implantable composite microelectrodes with bioactive surfaces for chronic neural interfaces, *Nat. Mater.* 11 (2012) 1065–1073. 10.1038/nmat3468. [PubMed: 23142839]
- [74]. Kozai TDY, Jaquins-Gerstl AS, Vazquez AL, Michael AC, Cui XT, Brain tissue responses to neural implants impact signal sensitivity and intervention strategies, *ACS Chem. Neurosci.* 6 (2015) 48–67. 10.1021/cn500256e. [PubMed: 25546652]
- [75]. Kozai TDY, Marzullo TC, Hooi F, Langhals NB, Majewska AK, Brown EB, Kipke DR, Reduction of neurovascular damage resulting from microelectrode insertion into the cerebral cortex using in vivo two-photon mapping, *J. Neural Eng.* 7 (2010) 046011. 10.1088/1741-2560/7/4/046011. [PubMed: 20644246]
- [76]. Welle CG, Gao Y-R, Ye M, Lozzi A, Boretsky A, Abliz E, Hammer DX, Longitudinal neural and vascular structural dynamics produced by chronic microelectrode implantation, *Biomaterials* 238 (2020) 119831. 10.1016/j.biomaterials.2020.119831. [PubMed: 32045783]
- [77]. Mezger M, Göbel K, Kraft P, Meuth SG, Kleinschmitz C, Langer HF, Platelets and vascular inflammation of the brain, *Hamostaseologie* 35 (2015) 244–251. 10.5482/HAMO-14-11-0071. [PubMed: 25987266]
- [78]. Rawish E, Nording H, Münte T, Langer HF, Platelets as Mediators of Neuroinflammation and Thrombosis, *Front. Immunol.* 11 (2020) 2560. 10.3389/fimmu.2020.548631.
- [79]. Bouchard BA, Shatos MA, Tracy PB, Human Brain Pericytes Differentially Regulate Expression of Procoagulant Enzyme Complexes Comprising the Extrinsic Pathway of Blood Coagulation, *Arterioscler. Thromb. Vasc. Biol.* 17 (1997) 1–9. 10.1161/01.ATV.17.1.1. [PubMed: 9012630]
- [80]. Eddleston M, de la Torre JC, Oldstone MB, Loskutoff DJ, Edgington TS, Mackman N, Astrocytes are the primary source of tissue factor in the murine central nervous system. A role for astrocytes in cerebral hemostasis., *J. Clin. Invest.* 92 (1993) 349–358. 10.1172/JCI116573. [PubMed: 8326003]
- [81]. Shattil SJ, Newman PJ, Integrins: dynamic scaffolds for adhesion and signaling in platelets, *Blood* 104 (2004) 1606–1615. 10.1182/blood-2004-04-1257. [PubMed: 15205259]
- [82]. Anderson JM, Rodriguez A, Chang DT, Foreign body reaction to biomaterials, *Semin Immunol* 20 (2008) 86–100. [PubMed: 18162407]
- [83]. Zhang J-J, Gao X-F, Ge Z, Tian N-L, Liu Z-Z, Lin S, Ye F, Chen S-L, High platelet reactivity affects the clinical outcomes of patients undergoing percutaneous coronary intervention, *BMC Cardiovasc. Disord.* 16 (2016) 240. 10.1186/s12872-016-0394-0. [PubMed: 27894260]

- [84]. Summers PM, Hartmann DA, Hui ES, Nie X, Deardorff RL, McKinnon ET, Helpern JA, Jensen JH, Shih AY, Functional deficits induced by cortical microinfarcts, *J. Cereb. Blood Flow Metab.* 37 (2017) 3599–3614. 10.1177/0271678X16685573. [PubMed: 28090802]
- [85]. Williamson MR, Franzen RL, Fuertes CJA, Dunn AK, Drew MR, Jones TA, A Window of Vascular Plasticity Coupled to Behavioral Recovery after Stroke, *J. Neurosci.* 40 (2020) 7651–7667. 10.1523/JNEUROSCI.1464-20.2020. [PubMed: 32873722]
- [86]. Lake EMR, Bazzigaluppi P, Mester J, Thomason LAM, Janik R, Brown M, McLaurin J, Carlen PL, Corbett D, Stanisz GJ, Stefanovic B, Neurovascular unit remodelling in the subacute stage of stroke recovery, *NeuroImage* 146 (2017) 869–882. 10.1016/j.neuroimage.2016.09.016. [PubMed: 27664828]
- [87]. Buzsáki G, Large-scale recording of neuronal ensembles, *Nat. Neurosci.* 7 (2004) 446–451. 10.1038/nn1233. [PubMed: 15114356]
- [88]. Henze DA, Borhegyi Z, Csicsvari J, Mamiya A, Harris KD, Buzsáki G, Intracellular Features Predicted by Extracellular Recordings in the Hippocampus In Vivo, *J. Neurophysiol.* 84 (2000) 390–400. 10.1152/jn.2000.84.1.390. [PubMed: 10899213]
- [89]. Merlini M, Rafalski VA, Rios PE, Mucke L, Nelson RB, Fibrinogen Induces Microglia-Mediated Spine Elimination and Cognitive Impairment in an Alzheimer’s Disease Model Genetic inhibition of fibrinogen-CD11b binding improves cognition in AD mice, *Neuron* 101 (2019). 10.1016/j.neuron.2019.01.014.
- [90]. Profaci CP, Munji RN, Pulido RS, Daneman R, The blood–brain barrier in health and disease: Important unanswered questions, *J. Exp. Med.* 217 (2020) e20190062. 10.1084/jem.20190062. [PubMed: 32211826]
- [91]. Denorme F, Martinod K, Vandenbulcke A, Denis CV, Lenting PJ, Deckmyn H, Vanhoorelbeke K, Meyer SFD, The von Willebrand Factor A1 domain mediates thromboinflammation, aggravating ischemic stroke outcome in mice, *Haematologica* 106 (2021) 819–828. 10.3324/haematol.2019.241042. [PubMed: 32107335]
- [92]. Abrahamson EE, Ikomomic MD, Brain injury-induced dysfunction of the blood brain barrier as a risk for dementia, *Exp. Neurol.* 328 (2020) 113257. 10.1016/j.expneurol.2020.113257. [PubMed: 32092298]
- [93]. Härtig W, Mages B, Aleithe S, Nitzsche B, Altmann S, Barthel H, Krueger M, Michalski D, Damaged Neocortical Perineuronal Nets Due to Experimental Focal Cerebral Ischemia in Mice, Rats and Sheep, *Front. Integr. Neurosci.* 11 (2017). <https://www.frontiersin.org/articles/10.3389/fint.2017.00015> (accessed July 6, 2022).
- [94]. Jaquins-Gerstl A, Michael AC, Comparison of the brain penetration injury associated with microdialysis and voltammetry, *J. Neurosci. Methods* 183 (2009) 127–135. 10.1016/j.jneumeth.2009.06.023. [PubMed: 19559724]
- [95]. Kim Y-T, Hitchcock RW, Bridge MJ, Tresco PA, Chronic response of adult rat brain tissue to implants anchored to the skull, *Biomaterials* 25 (2004) 2229–2237. 10.1016/j.biomaterials.2003.09.010. [PubMed: 14741588]
- [96]. Shen W, Das S, Vitale F, Richardson A, Ananthakrishnan A, Struzyna LA, Brown DP, Song N, Ramkumar M, Lucas T, Cullen DK, Litt B, Allen MG, Microfabricated intracortical extracellular matrix-microelectrodes for improving neural interfaces, *Microsyst. Nanoeng.* 4 (2018) 1–15. 10.1038/s41378-018-0030-5. [PubMed: 31057891]
- [97]. Eles JR, Vazquez AL, Kozai TDY, Cui XT, Meningeal inflammatory response and fibrous tissue remodeling around intracortical implants: An in vivo two-photon imaging study, *Biomaterials* 195 (2019) 111–123. 10.1016/j.biomaterials.2018.12.031. [PubMed: 30634095]
- [98]. Esquibel CR, Wendt KD, Lee HC, Gaire J, Shoffstall A, Urdaneta ME, Chacko JV, Brodnick SK, Otto KJ, Capadona JR, Williams JC, Eliceiri KW, Second Harmonic Generation Imaging of Collagen in Chronically Implantable Electrodes in Brain Tissue, *Front. Neurosci.* 14 (2020). <https://www.frontiersin.org/articles/10.3389/fnins.2020.00095> (accessed August 10, 2022).
- [99]. Butson CR, Maks CB, McIntyre CC, Sources and effects of electrode impedance during deep brain stimulation, *Clin. Neurophysiol. Off. J. Int. Fed. Clin. Neurophysiol.* 117 (2006) 447–454. 10.1016/j.clinph.2005.10.007.

- [100]. Otto KJ, Johnson MD, Kipke DR, Voltage pulses change neural interface properties and improve unit recordings with chronically implanted microelectrodes, *IEEE Trans. Biomed. Eng.* 53 (2006) 333–340. 10.1109/TBME.2005.862530. [PubMed: 16485763]
- [101]. Cody PA, Eles JR, Lagenaur CF, Kozai TDY, Tracy X Cui, Unique electrophysiological and impedance signatures between encapsulation types: An analysis of biological Utah array failure and benefit of a biomimetic coating in a rat model, *Biomaterials* 161 (2018) 117–128. 10.1016/j.biomaterials.2018.01.025. [PubMed: 29421549]
- [102]. Dias DO, Göritz C, Fibrotic scarring following lesions to the central nervous system, *Matrix Biol.* 68–69 (2018) 561–570. 10.1016/j.matbio.2018.02.009.
- [103]. Induction of Type IV Collagen and Other Basement-Membrane-Associated Proteins after Spinal Cord Injury of the Adult Rat May Participate in Formation of the Glial Scar | Elsevier Enhanced Reader, (n.d.). 10.1006/exnr.2001.7800.
- [104]. Schachtrup C, Ryu JK, Helmrick MJ, Vagena E, Galanakis DK, Degen JL, Margolis RU, Akassoglou K, Development/Plasticity/Repair Fibrinogen Triggers Astrocyte Scar Formation by Promoting the Availability of Active TGF- $\alpha$ fter Vascular Damage, (2010). 10.1523/JNEUROSCI.0137-10.2010.
- [105]. Litvinov RI, Weisel JW, Not fibrin(ogen), but fibrinogen or fibrin, *Blood* 126 (2015) 1977–1978. 10.1182/blood-2015-08-662551. [PubMed: 26494920]
- [106]. Petersen MA, Ryu JK, Chang K-J, Rowitch DH, Chan JR, Correspondence KA, Fibrinogen Activates BMP Signaling in Oligodendrocyte Progenitor Cells and Inhibits Remyelination after Vascular Damage, (2017). 10.1016/j.neuron.2017.10.008.
- [107]. Adhami F, Liao G, Morozov YM, Schloemer A, Schmithorst VJ, Lorenz JN, Dunn RS, Vorhees CV, Wills-Karp M, Degen JL, Davis RJ, Mizushima N, Rakic P, Dardzinski BJ, Holland SK, Sharp FR, Kuan C-Y, Cerebral Ischemia-Hypoxia Induces Intravascular Coagulation and Autophagy, *Am. J. Pathol.* 169 (2006) 566–583. 10.2353/ajpath.2006.051066. [PubMed: 16877357]
- [108]. Abbadessa G, Miele G, Di Pietro A, Sparaco M, Palladino R, Armetta I, D'Elia G, Trojsi F, Signoriello E, Lus G, Lavorgna L, Bonavita S, Multiple sclerosis and genetic polymorphisms in fibrinogen-mediated hemostatic pathways: a case-control study, *Neurol. Sci.* 43 (2022) 2601–2609. 10.1007/s10072-021-05608-1. [PubMed: 34561786]
- [109]. Lee NJ, Ha S-K, Sati P, Absinta M, Luciano NJ, Lefevre JA, Schindler MK, Leibovitch EC, Ryu JK, Petersen MA, Silva AC, Jacobson S, Akassoglou K, Reich DS, Spatiotemporal distribution of fibrinogen in marmoset and human inflammatory demyelination, *Brain* 141 (2018) 1637–1649. 10.1093/brain/awy082. [PubMed: 29688408]
- [110]. Thompson CH, Saxena A, Heelan N, Salatino J, Purcell EK, Spatiotemporal patterns of gene expression around implanted silicon electrode arrays, *J. Neural Eng.* 18 (2021) 045005. 10.1088/1741-2552/abf2e6.
- [111]. Hermann JK, Lin S, Soffer A, Wong C, Srivastava V, Chang J, Sunil S, Sudhakar S, Tomaszewski WH, Protasiewicz G, Selkirk SM, Miller RH, Capadona JR, The Role of Toll-Like Receptor 2 and 4 Innate Immunity Pathways in Intracortical Microelectrode-Induced Neuroinflammation, *Front. Bioeng. Biotechnol.* 6 (2018). <https://www.frontiersin.org/articles/10.3389/fbioe.2018.00113> (accessed February 13, 2023).
- [112]. Popa M, Tahir S, Elrod J, Kim SH, Leuschner F, Kessler T, Bugert P, Pohl U, Wagner AH, Hecker M, Role of CD40 and ADAMTS13 in von Willebrand factor-mediated endothelial cell-platelet-monocyte interaction, *Proc. Natl. Acad. Sci. U. S. A.* 115 (2018). 10.1073/pnas.1801366115.
- [113]. Gao C, Wang H, Wang T, Luo C, Wang Z, Zhang M, Chen X, Tao L, Platelet regulates neuroinflammation and restores blood-brain barrier integrity in a mouse model of traumatic brain injury, *J. Neurochem.* 154 (2020) 190–204. 10.1111/jnc.14983. [PubMed: 32048302]
- [114]. Li W, Liu D, Xu J, Zha J, Wang C, An J, Xie Z, Qiao S, Astrocyte-Derived TNF- $\alpha$ -Activated Platelets Promote Cerebral Ischemia/Reperfusion Injury by Regulating the RIP1/RIP3/AKT Signaling Pathway, *Mol. Neurobiol.* (2022). 10.1007/s12035-022-02942-z.

- [115]. Biran R, Martin DC, Tresco PA, Neuronal cell loss accompanies the brain tissue response to chronically implanted silicon microelectrode arrays, *Exp. Neurol.* 195 (2005) 115–126. 10.1016/j.expneurol.2005.04.020. [PubMed: 16045910]

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