Differential gene expression changes for complement C1q and C3 after injuries to dorsal and ventral nerve roots

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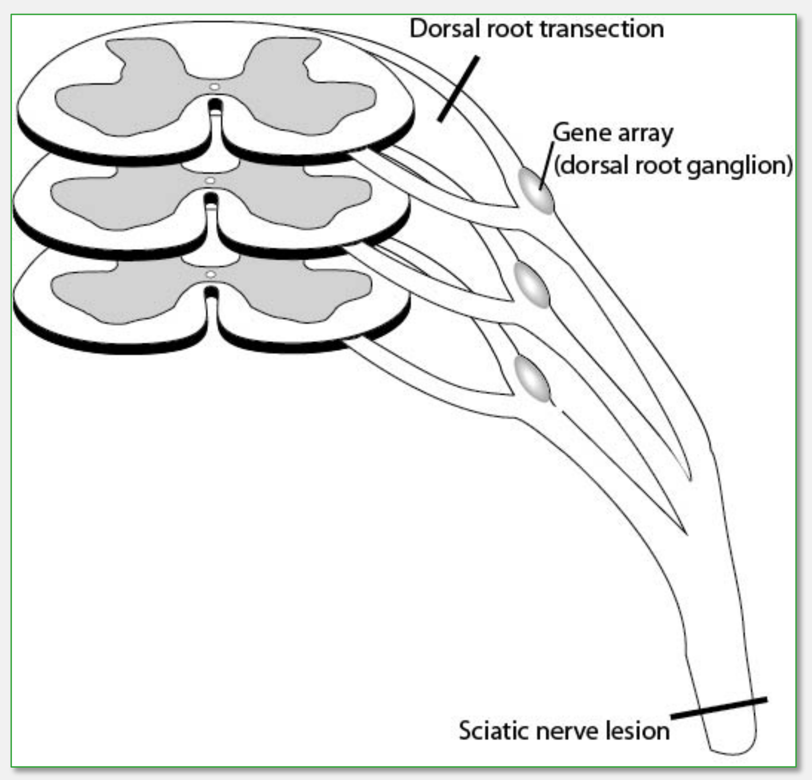
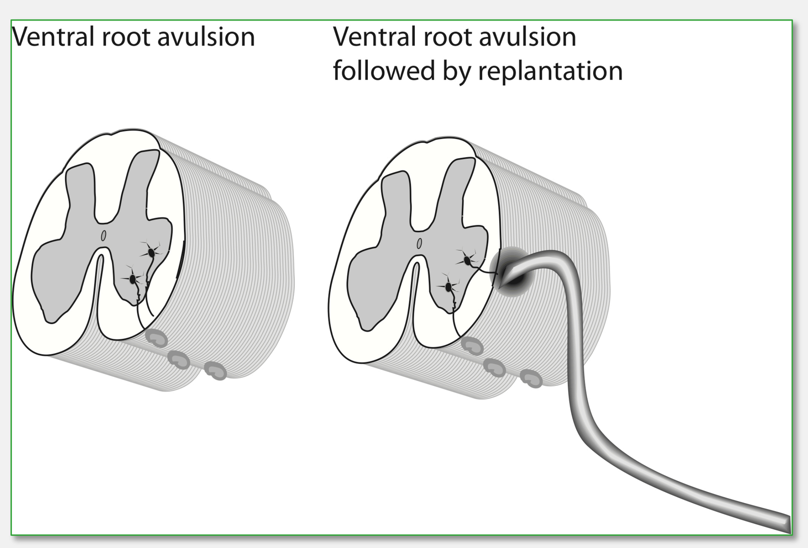
Conclusion

The data suggest that the acute response in genes for complement factors C1q and C3 is different after different nerve root lesions. The ventral root replantation and nerve injuries are followed by a regenerative response while dorsal root transection and ventral root avulsion are examples of non-regenerative conditions.





The experimental models:

Dorsal root transection (analysis of dorsal root ganglion = DRG)

Sciatic nerve transection (analysis of DRG)

Ventral root avulsion (analysis of spinal cord ventral horn)

Ventral root avulsion + replantation (analysis of ventral horn)

Introduction

C1q is an initiating protein in the classical complement cascade and is a key element in the inflammatory response to injuries in the nervous system. Interestingly, it has been shown to be expressed by immature neurons and is localized to synapses. Mice that are deficient to C1q or the downstream complement factor C3 show severe defects in elimination of synapses during development (Stevens et al., 2007). This can lead to non-appropriate connections, increased excitatory connectivity and epileptiform activity. Recent in vitro studies indicate that C1q can directly promote neuronal survival (Benoit and Tenner, 2011). In this study we have examined expression changes after injuries to dorsal and ventral roots in 18 adult rats using Affymetrix Rat Gene ST 1.0 arrays.

Material and Methods

The rats were anesthetized by Isoflurane inhalation and the lumbosacral spinal cord was exposed. In six rats, the left L5 ventral root was identified and avulsed by gentle traction of the root. In three of these animals the avulsed ventral root was replanted into the lateral white funiculus (Risling et al., 2011). In 3 other rats the L5 dorsal root was divided 10 mm from the dorsal root entry zone. In 3 other rats the sciatic nerve was transected just below the hamstring branch and 10 mm was resected from the distal stump of the nerve. Six rats were used as controls. After 24 hours survival time the animals were euthanized with 0.5 ml pentobarbital (40 mg/ml) and the inferior vena cava was cut open. Samples from the L5 spinal cord segment were dissected from the animals subjected to ventral root lesion. The L5 dorsal root ganglion used in animals subjected to dorsal root injury or nerve injury. The expression of complement genes in the groups was compared using an unpaired t-test and fold change values.

References

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Stevens B, Allen NJ, Vazquez LE, Howell GR, Christopherson KS, Nouri N, Micheva KD, Mehalow AK, Huberman AD, Stafford B, Sher A, Litke AM, Lambris JD, Smith SJ, John SW, Barres BA (2007) The classical complement cascade mediates CNS synapse elimination. Cell 131:1164-1178.

Results and Conclusions

In dorsal root ganglia from animals subjected to dorsal root transection the signals for complement component 1, q subcomponent, alpha and beta polypeptide and q chain were upregulated compared to both controls and animals subjected to nerve lesion.
Complement C3 was upregulated by more than 500% after dorsal root transection compared to nerve injury.
The same C1q components were found to be upregulated in animals treated by ventral root replantation compared to ventral root avulsion only, whereas the C3 complement was downregulated.

DR=dorsal root transection
SN=sciatic nerve transection
Contr=control

SN Intenstity	DR Intenstity	Contr Intenstity	SN vs contr foldchange	DR vs contr foldchange	SN vs DR foldchange	
452,5	463,1	393,5	1,15	1,18	-1,02	complement component (3b/4b) receptor 1-like
194,7	181,4	188,0	1,04	-1,04	1,07	complement component 1, q subcomponent binding protein
97,1	84,7	78,9	1,23	1,07	1,15	complement component 1, q subcomponent-like 1
29,6	27,9	29,3	1,01	-1,05	1,06	complement component 1, q subcomponent-like 2
97,0	105,6	98,4	-1,01	1,07	-1,09	complement component 1, q subcomponent-like 3
61,6	62,8	66,8	-1,09	-1,06	-1,02	complement component 1, q subcomponent-like 4
118,7	172,5	108,6	1,09	1,59	-1,45	complement component 1, q subcomponent, alpha polypeptide
86,8	139,5	73,7	1,18	1,89	-1,61	complement component 1, q subcomponent, beta polypeptide
127,7	239,4	110,2	1,16	2,17	-1,87	complement component 1, q subcomponent, C chain
313,1	407,7	304,3	1,03	1,34	-1,30	complement component 1, r subcomponent
32,6	39,4	30,7	1,06	1,28	-1,21	complement component 1, r subcomponent-like
189,6	262,8	149,6	1,27	1,76	-1,39	complement component 1, s subcomponent
50,3	70,9	51,9	-1,03	1,36	-1,41	complement component 2
49,2	209,1	39,4	1,25	5,31	-4,25	complement component 3
46,3	78,9	41,9	1,11	1,88	-1,70	complement component 3a receptor 1
31,0	29,8	27,6	1,12	1,08	1,04	complement component 4 binding protein, alpha
24,2	20,7	21,2	1,14	-1,02	1,17	complement component 4 binding protein, beta
157,7	299,2	159,0	-1,01	1,88	-1,90	complement component 4, gene 2
30,0	30,7	31,5	-1,05	-1,02	-1,02	complement component 5
26,2	32,6	20,2	1,29	1,61	-1,24	complement component 6
220,6	335,1	166,5	1,33	2,01	-1,52	complement component 7
23,6	20,1	21,1	1,12	-1,05	1,17	complement component 8, alpha polypeptide
22,5	22,0	20,9	1,08	1,05	1,02	complement component 8, beta polypeptide
82,3	82,1	76,5	1,08	1,07	1,00	complement component 8, gamma polypeptide
19,9	19,1	18,8	1,06	1,02	1,04	complement component 9
48,1	38,7	44,1	1,09	-1,14	1,24	complement component factor h-like 1
35,6	40,0	42,2	-1,19	-1,06	-1,12	complement factor D (adipsin)
29,1	42,8	34,5	-1,18	1,24	-1,47	complement factor H
248,0	419,8	266,8	-1,08	1,57	-1,69	complement factor H
117,4	101,5	86,8	1,35	1,17	1,16	complement factor I

contr vs replant	contr vs avuls	replant vs avuls	
1,00	1,02	1,02	complement component 1, q subcomponent-like 2
0,83	0,82	0,99	complement component 1, q subcomponent-like 3
1,43	1,13	0,79	complement component 1, q subcomponent-like 4 (predicted)
1,33	0,38	0,28	complement component 1, q subcomponent, alpha polypeptide
1,34	0,33	0,24	complement component 1, q subcomponent, beta polypeptide
1,74	0,25	0,14	complement component 1, q subcomponent, C chain
4,95	1,21	0,24	complement component 1, q subcomponent, receptor 1
1,14	0,54	0,48	complement component 1, r subcomponent
1,37	1,53	1,11	complement component 1, r subcomponent-like
0,87	0,75	0,86	complement component 1, s subcomponent
2,71	0,69	0,26	complement component 2
0,52	0,75	1,44	complement component 3
6,09	0,32	0,05	complement component 3a receptor 1
1,21	1,05	0,87	complement component 4 binding protein, alpha
0,90	1,13	1,27	complement component 4 binding protein, beta
0,71	0,53	0,74	complement component 4a
1,19	0,91	0,76	complement component 5
2,09	1,41	0,67	complement component 6
0,84	0,84	1,00	complement component 7
0,78	1,04	1,33	complement component 8, alpha polypeptide (predicted)
1,27	1,51	1,19	complement component 8, beta polypeptide
0,97	1,12	1,15	complement component 8, gamma subunit
0,67	1,18	1,77	complement component 9
1,51	0,47	0,31	complement component factor H
1,78	0,72	0,40	complement component factor H
1,96	0,45	0,23	complement component factor H
0,88	1,06	1,20	complement component factor h-like 1
1,75	1,42	0,81	complement factor D (adipsin)
1,07	1,25	1,16	complement factor I
1,63	0,70	0,43	complement factor properdin
1,13	1,66	1,48	complement receptor 2 (predicted)

Many proteins that first were identified in the immune system have been shown to be expressed in the developing and adult nervous system. Proteins like complement C1q and C3 have been shown to contribute to modification of synaptic connections (Boulanger, 2009). Synaptic elimination is one component in the injury response and it should not be excluded that these early changes in C1q and C3 expression could contribute to the differential outcome of such nerve root injuries.

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