

Contents

1	Introduction	1
1.1	The Problem	2
1.1.1	Definition of sSMC	2
1.1.2	Nomenclature	3
1.1.3	Shapes of sSMC	3
1.2	Frequency of sSMC	4
1.2.1	Normal Population	4
1.2.2	Healthy Population with Fertility Problems	6
1.2.3	Developmentally and Mentally Retarded Persons	7
1.3	Chromosomal Origin of sSMC	7
1.3.1	sSMC in Individuals with 47 Chromosomes	8
1.3.2	sSMC in Individuals with 46 Chromosomes: Turner Syndrome Karyotype Cases	8
1.3.3	Multiple sSMC	8
1.3.4	Neocentric sSMC	8
1.4	What Are the Effects of sSMC	10
1.4.1	Gain of Copy Number	11
1.4.2	Uniparental Disomy	13
1.4.3	Mosaicism	14
2	Inheritance of Small Supernumerary Marker Chromosomes	17
2.1	De Novo and Familial sSMC	17
2.2	B Chromosomes and sSMC	18
3	Formation of Small Supernumerary Marker Chromosomes	21
3.1	Inverted-Duplication-Shaped sSMC	21
3.1.1	Centromeric Activity of Dicentric sSMC	22
3.2	Centric Minute-Shaped sSMC	23
3.3	Ring-Shaped sSMC	25
3.4	Complex sSMC	26

3.5 Mixtures of Different Shapes	27
3.6 Multiple sSMC	27
3.7 Breakpoint Characteristics of sSMC	28
4 Small Supernumerary Marker Chromosomes in Genetic	
Diagnostics and Counseling	31
4.1 sSMC Diagnostics	31
4.1.1 First Steps: Banding Cytogenetics	31
4.1.2 Molecular Cytogenetics	33
4.1.3 Molecular Genetics	36
4.1.4 How To Characterize an sSMC	37
4.2 Personal Experiences of Patients Receiving the Diagnosis	
sSMC Prenatally	39
4.2.1 Personal Experience 1	39
4.2.2 Personal Experience 2	40
4.2.3 Personal Experience 3	42
4.2.4 Personal Experience 4	45
4.3 sSMC in Genetic Counseling	45
5 Small Supernumerary Marker Chromosomes Known	
To Be Correlated with Specific Syndromes	47
5.1 Emanuel Syndrome	47
5.1.1 Clinical Characteristics	48
5.1.2 Cytogenetic Characteristics	48
5.1.3 Patient Report	48
5.2 Cat Eye Syndrome	52
5.2.1 Clinical Characteristics	52
5.2.2 Cytogenetic Characteristics	53
5.2.3 Patient Reports	54
5.3 Pallister–Killian Syndrome	59
5.3.1 Clinical Characteristics	59
5.3.2 Cytogenetic Characteristics	59
5.3.3 Patient Report	60
5.4 Isochromosome 18p Syndrome	61
5.4.1 Clinical Characteristics	61
5.4.2 Cytogenetic Characteristics	62
5.4.3 Patient Report	62
5.5 Turner Syndrome	65
5.5.1 Clinical Characteristics	65
5.5.2 Cytogenetic Characteristics	65
5.5.3 Patient Report	66

6	Centric Small Supernumerary Marker Chromosomes	69
6.1	Chromosome 1	70
6.1.1	Potentially Non-dose-sensitive Pericentric Region	70
6.1.2	Clinical Signs	71
6.1.3	Mosaicism	72
6.1.4	Uniparental Disomy	72
6.1.5	Case Report	72
6.1.6	Chromosomes 1/5/19	76
6.2	Chromosome 2	76
6.2.1	Potentially Non-dose-sensitive Pericentric Region	76
6.2.2	Clinical Signs	76
6.2.3	Mosaicism	78
6.2.4	Uniparental Disomy	78
6.2.5	Case Report	78
6.3	Chromosome 3	79
6.3.1	Potentially Non-dose-sensitive Pericentric Region	79
6.3.2	Clinical Signs	80
6.3.3	Mosaicism	80
6.3.4	Uniparental Disomy	81
6.4	Chromosome 4	81
6.4.1	Potentially Non-dose-sensitive Pericentric Region	81
6.4.2	Clinical Signs	82
6.4.3	Mosaicism	82
6.4.4	Uniparental Disomy	83
6.5	Chromosome 5	83
6.5.1	Potentially Non-dose-sensitive Pericentric Region	83
6.5.2	Clinical Signs	84
6.5.3	Mosaicism	84
6.5.4	Uniparental Disomy	85
6.5.5	Chromosomes 1/5/19	85
6.6	Chromosome 6	85
6.6.1	Potentially Non-dose-sensitive Pericentric Region	85
6.6.2	Clinical Signs	85
6.6.3	Mosaicism	86
6.6.4	Uniparental Disomy	87
6.6.5	Case Report	87
6.7	Chromosome 7	88
6.7.1	Potentially Non-dose-sensitive Pericentric Region	88
6.7.2	Clinical Signs	89
6.7.3	Mosaicism	90
6.7.4	Uniparental Disomy	90
6.7.5	Case Report	90

6.8	Chromosome 8	93
6.8.1	Potentially Non-dose-sensitive Pericentric Region	93
6.8.2	Clinical Signs	93
6.8.3	Mosaicism	95
6.8.4	Uniparental Disomy	95
6.8.5	Case Report	95
6.9	Chromosome 9	96
6.9.1	Potentially Non-dose-sensitive Pericentric Region	96
6.9.2	Clinical Signs	96
6.9.3	Mosaicism	98
6.9.4	Uniparental Disomy	98
6.9.5	Case Report	98
6.10	Chromosome 10	100
6.10.1	Potentially Non-dose-sensitive Pericentric Region	100
6.10.2	Clinical Signs	100
6.10.3	Mosaicism	101
6.10.4	Uniparental Disomy	101
6.10.5	Case Report	101
6.11	Chromosome 11	104
6.11.1	Potentially Non-dose-sensitive Pericentric Region	104
6.11.2	Clinical Signs	104
6.11.3	Mosaicism	106
6.11.4	Uniparental Disomy	106
6.12	Chromosome 12	106
6.12.1	Potentially Non-dose-sensitive Pericentric Region	106
6.12.2	Clinical Signs	106
6.12.3	Mosaicism	108
6.12.4	Uniparental Disomy	108
6.12.5	Case Report	108
6.13	Chromosome 13	108
6.13.1	Potentially Non-dose-Sensitive Pericentric Region	108
6.13.2	Clinical Signs	109
6.13.3	Mosaicism	109
6.13.4	Uniparental Disomy	110
6.13.5	Chromosomes 13/21	110
6.14	Chromosome 14	110
6.14.1	Potentially Non-dose-sensitive Pericentric Region	110
6.14.2	Clinical Signs	110
6.14.3	Mosaicism	111
6.14.4	Uniparental Disomy	112
6.14.5	Case Reports	112
6.14.6	Chromosomes 14/22	114
6.15	Chromosome 15	115
6.15.1	Potentially Non-dose-sensitive Pericentric Region	115
6.15.2	Clinical Signs	116
6.15.3	Mosaicism	117

6.15.4	Uniparental Disomy	117
6.15.5	Case Reports	118
6.16	Chromosome 16	122
6.16.1	Potentially Non-dose-sensitive Pericentric Region	122
6.16.2	Clinical Signs	122
6.16.3	Mosaicism	123
6.16.4	Uniparental Disomy	123
6.16.5	Case Reports	123
6.17	Chromosome 17	126
6.17.1	Potentially Non-dose-sensitive Pericentric Region	126
6.17.2	Clinical Signs	126
6.17.3	Mosaicism	127
6.17.4	Uniparental Disomy	128
6.17.5	Case Report	128
6.18	Chromosome 18	130
6.18.1	Potentially Non-dose-sensitive Pericentric Region	130
6.18.2	Clinical Signs	131
6.18.3	Mosaicism	132
6.18.4	Uniparental Disomy	132
6.18.5	Case Report	132
6.19	Chromosome 19	132
6.19.1	Potentially Non-dose-sensitive Pericentric Region	132
6.19.2	Clinical Signs	132
6.19.3	Mosaicism	134
6.19.4	Uniparental Disomy	134
6.19.5	Case Report	134
6.19.6	Chromosomes 1/5/19	135
6.20	Chromosome 20	135
6.20.1	Potentially Non-dose-sensitive Pericentric Region	135
6.20.2	Clinical Signs	136
6.20.3	Mosaicism	137
6.20.4	Uniparental Disomy	137
6.20.5	Case Report	137
6.21	Chromosome 21	139
6.21.1	Potentially Non-dose-sensitive Pericentric Region	139
6.21.2	Clinical Signs	140
6.21.3	Mosaicism	141
6.21.4	Uniparental Disomy	141
6.21.5	Case Reports	141
6.21.6	Chromosomes 13/21	144
6.22	Chromosome 22	145
6.22.1	Potentially Non-dose-sensitive Pericentric Region	145
6.22.2	Clinical Signs	145
6.22.3	Mosaicism	146

6.22.4	Uniparental Disomy	146
6.22.5	Case Reports	146
6.22.6	Chromosomes 14/22	146
6.23	X Chromosome	147
6.23.1	Potentially Non-dose-sensitive Pericentric Region	147
6.23.2	Clinical Signs	147
6.23.3	Mosaicism	148
6.23.4	Uniparental Disomy	148
6.23.5	Case Report	148
6.24	Y Chromosome	150
6.24.1	Case Report	150
6.25	Centric sSMC of Unknown Origin	150

7 Neocentric Small Supernumerary Marker Chromosomes

by Chromosome	151
7.1 Chromosome 1: Neocentrics	152
7.1.1 Balanced Situation	153
7.1.2 Unbalanced Situation	153
7.2 Chromosome 2: Neocentrics	153
7.2.1 Balanced Situation	153
7.2.2 Unbalanced Situation	154
7.3 Chromosome 3: Neocentrics	154
7.3.1 Balanced Situation	154
7.3.2 Unbalanced Situation	154
7.3.3 Case Report	155
7.4 Chromosome 4: Neocentrics	157
7.5 Chromosome 5: Neocentrics	158
7.6 Chromosome 6: Neocentrics	158
7.6.1 Balanced Situation	158
7.6.2 Unbalanced Situation	159
7.7 Chromosome 7: Neocentrics	159
7.8 Chromosome 8: Neocentrics	160
7.9 Chromosome 9: Neocentrics	160
7.9.1 Balanced Situation	160
7.9.2 Unbalanced Situation	160
7.10 Chromosome 10: Neocentrics	161
7.10.1 Balanced Situation	161
7.10.2 Unbalanced Situation	161
7.11 Chromosome 11: Neocentrics	161
7.11.1 Balanced Situation	162
7.11.2 Unbalanced Situation	162
7.12 Chromosome 12: Neocentrics	162
7.13 Chromosome 13: Neocentrics	162
7.13.1 Balanced Situation	163
7.13.2 Unbalanced Situation	163
7.14 Chromosome 14: Neocentrics	164

7.15	Chromosome 15: Neocentrics	164
7.15.1	Balanced Situation	164
7.15.2	Unbalanced Situation	165
7.16	Chromosome 16: Neocentrics	165
7.17	Chromosome 17: Neocentrics	166
7.18	Chromosome 18: Neocentrics	166
7.19	Chromosome 19: Neocentrics	166
7.20	Chromosome 20: Neocentrics	167
7.21	Chromosome 21: Neocentrics	167
7.22	Chromosome 22: Neocentrics	167
7.23	X Chromosome: Neocentrics	167
7.24	Y Chromosome: Neocentrics	168
7.25	Neocentric sSMC of Unknown Origin	168
8	Multiple Small Supernumerary Marker Chromosomes	169
8.1	Case Reports	169
9	Small Supernumerary Marker Chromosomes Additionally to Other Chromosomal Rearrangements	175
9.1	Numerical Aberrations	175
9.1.1	TS Karyotype	175
9.1.2	Gain of Gonosomes	176
9.1.3	Trisomy 21	176
9.1.4	Other Autosomal Gain	176
9.2	Structural Aberrations	176
9.2.1	Microdeletions	176
9.2.2	McClintock Mechanism	177
9.2.3	Other Structural Chromosomal Rearrangements	177
9.3	Molecular Aberrations	178
10	Complex Small Supernumerary Marker Chromosomes	179
11	Small Supernumerary Marker Chromosomes and Tumors	181
Appendix: Patient Organizations in Connection with Small Supernumerary Marker Chromosomes		183
A1	Rare Chromosome Disorder Support Groups	183
A1.1	Unique: Rare Chromosome Disorder Support Group	183
A1.2	Contact a Family: for Families with Disabled Children	184
A1.3	LEONA: Verein für Eltern chromosomal geschädigter Kinder e.V.	184
A1.4	Valentin APAC	185
A1.5	Unique Danmark	185
A1.6	Chromosome Disorder Outreach	185

A1.7 Asociația Prader Willi din România	186
A1.8 Living with Trisomy	186
A1.9 National Organization for Rare Disorders	186
A2 Chromosome-Specific Support Groups	186
A2.1 Chromosome 7	187
A2.2 Chromosome 9	188
A2.3 Chromosome 11	188
A2.4 Chromosome 12	189
A2.5 Chromosome 14	190
A2.6 Chromosome 15	190
A2.7 Chromosome 16	194
A2.8 Chromosome 17	194
A2.9 Chromosome 18	195
A2.10 Chromosome 20	196
A2.11 Chromosome 21	197
A2.12 Chromosome 22	197
A2.13 X and Y Chromosomes	198
Glossary	199
Chromosomes and Nomenclature	199
Alphabetic List of Terms	200
References	205
Index	217