Head impact of slalom gates on Paralympic Alpine Sit-Skiers - a pilot study

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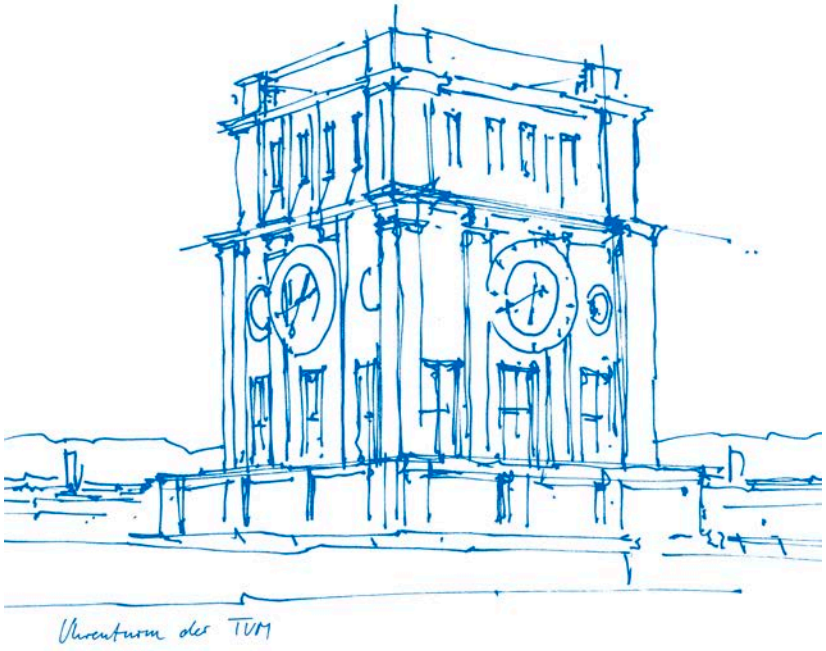
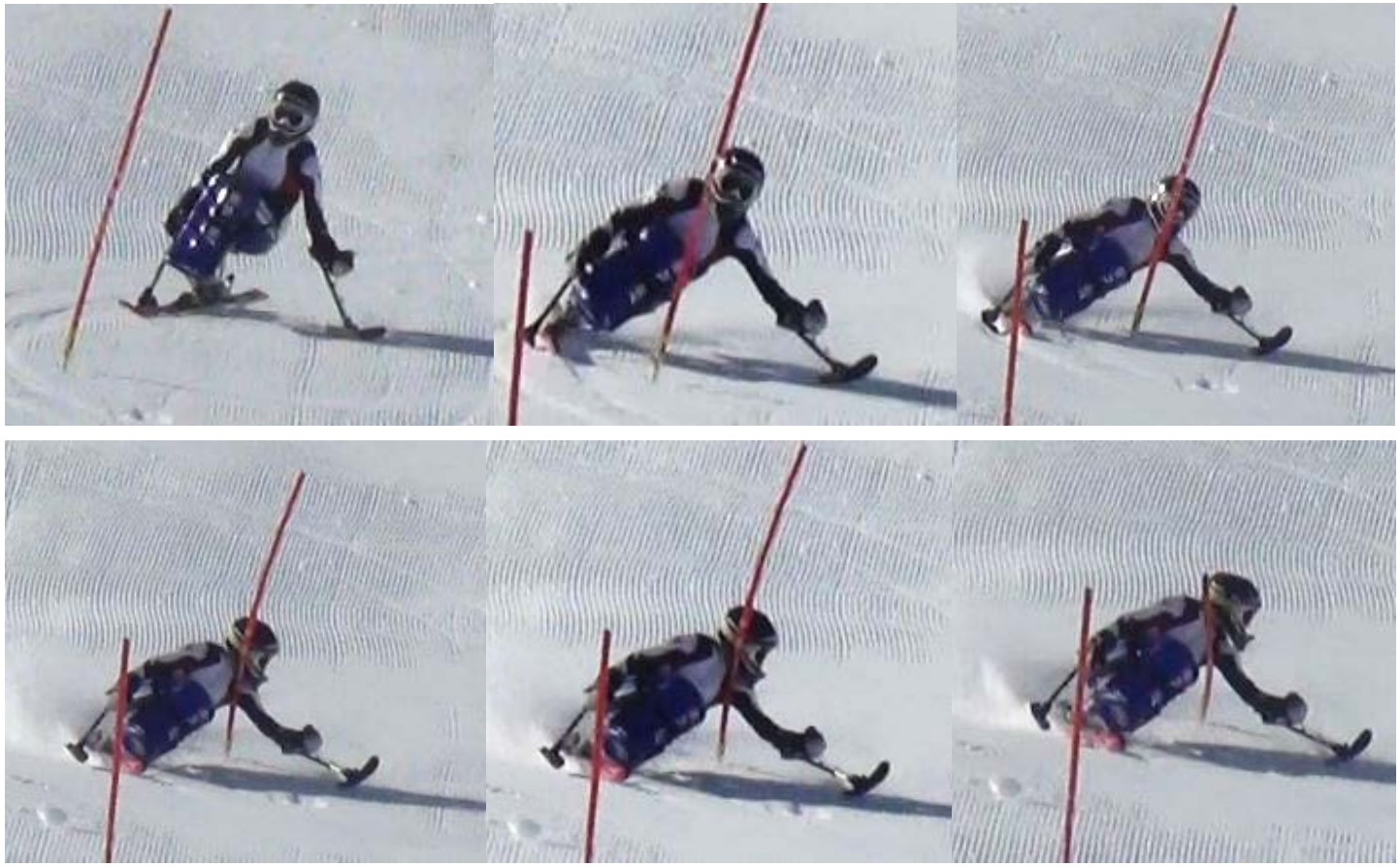


Differences in blocking slalom gates

Critical situations

Gate contact – not always in control



Research Question

The subject of **mild traumatic brain injury (mTBI) and sub-concussive trauma** due to **repetitive lower intensity impacts** receives increasing attention in research due to a high number of athletes affected by late damage to their brains in the sports of e.g. football, rugby, boxing (Galgano et al. 2016).

In skiing context:

- How high is the impact of Slalom gates in a standard Slalom?
- Is impact influenced by the properties of gate-material (mass)?

→ different pole diameters

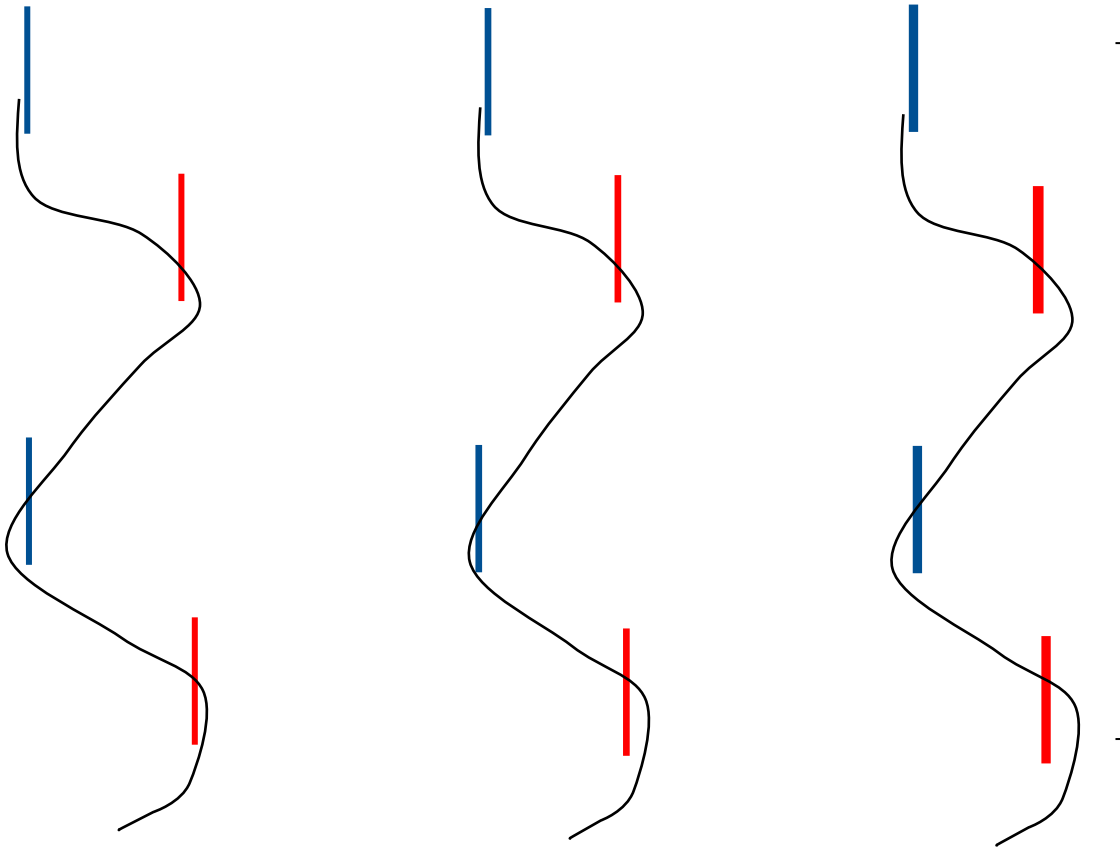
The aim of the study was to quantify gate impact of slalom gates on the Sit-skiers' heads.

Methods

25 mm Ø

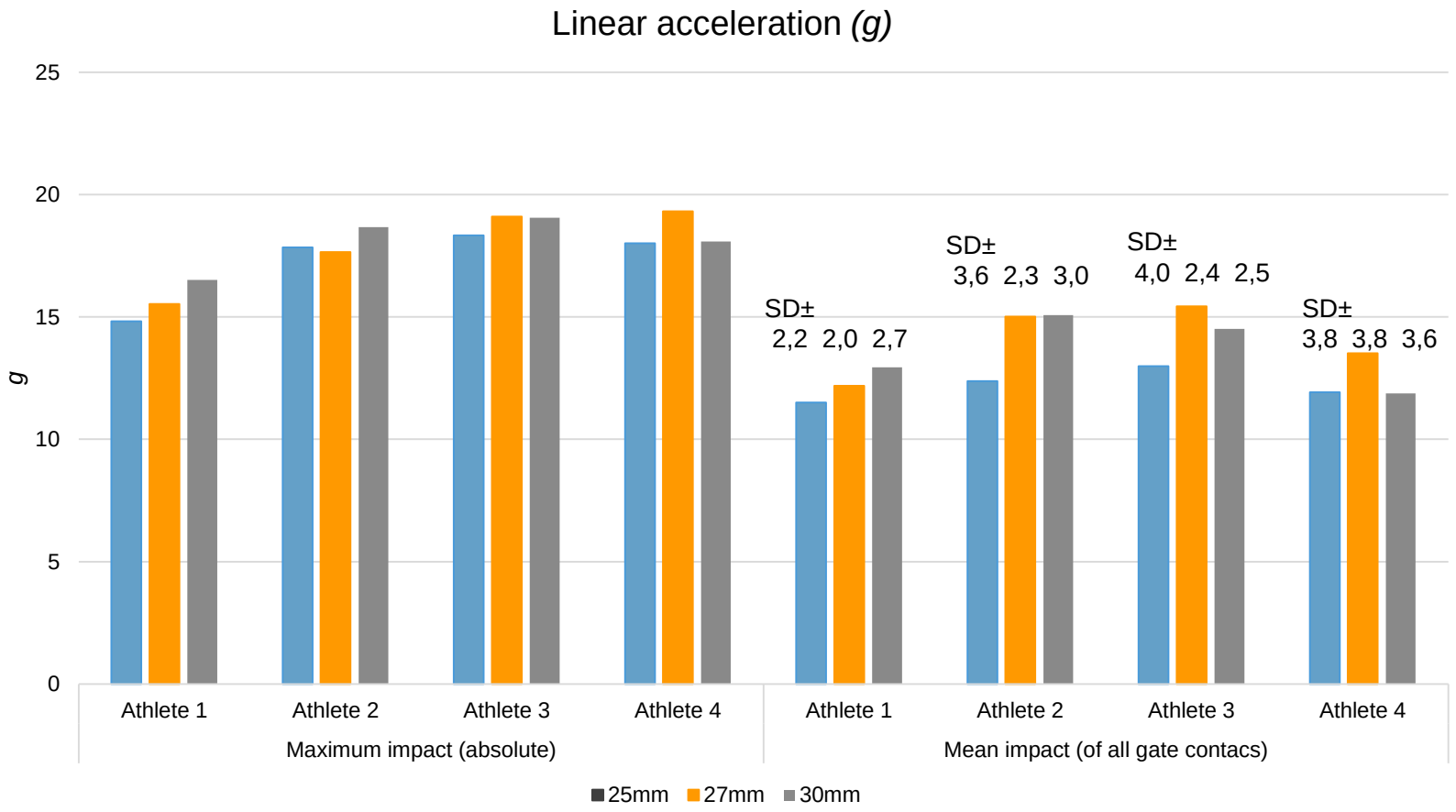
27 mm Ø

30 mm Ø



- 25 gates
- 4 athletes
- One run / athlete/ condition
- 3 axial accelerometer and gyroscope
- Fixed to the helmet
- Gyroscope based turn separation and point of contact definition
- Data processing and all calculation performed using Matlab

Results

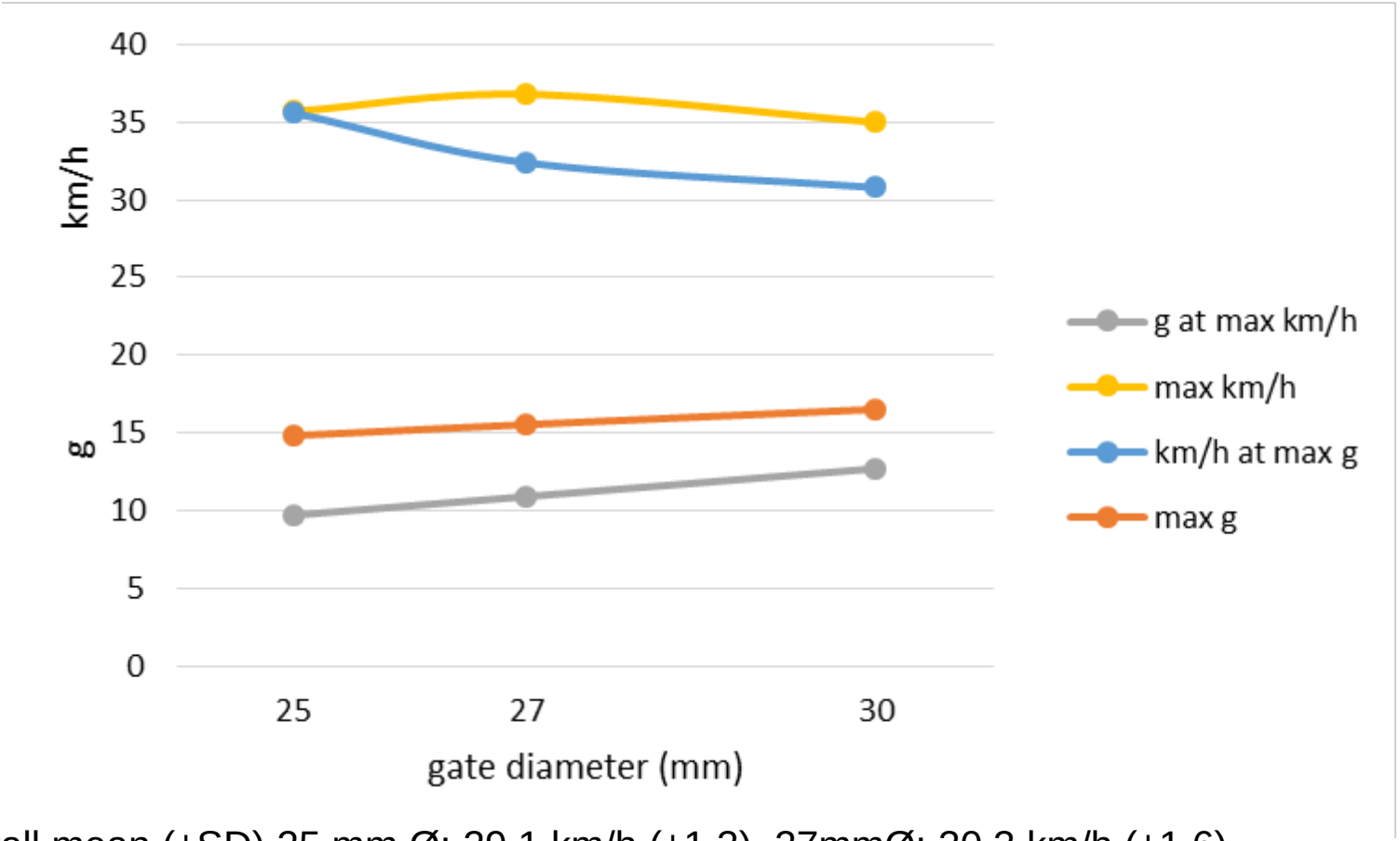

Linear acceleration (g)
25
20
15
10
5
0
g
SD±
2,2 2,0 2,7
SD±
3,6 2,3 3,0
SD±
4,0 2,4 2,5
SD±
3,8 3,8 3,6
Athlete 1
Athlete 2
Athlete 3
Athlete 4
Maximum impact (absolute)
Athlete 1
Athlete 2
Athlete 3
Athlete 4
Mean impact (of all gate contacs)
25mm
27mm
30mm

Results

		Rotatory acceleration (rad/s²)			
A 1		Maximum rad/s² (absolute)	Mean rad/s² (number of gate contacts)	Number of gate contacts	Mean rad/s² of highest 3 impacts
	25 mm	43,7	14,7	20	42,6
	27 mm	44,9	18,3	18	40,0
	30 mm	44,6	18,7	19	38,4
A 2		Maximum rad/s² (absolute)	Mean rad/s² (number of gate contacts)	Number of gate contacts	Mean rad/s² of highest 3 impacts
	25 mm	27,1	11,0	22	22,5
	27 mm	33,0	20,3	20	32,2
	30 mm	36,1	16,9	18	33,2
A 3		Maximum rad/s² (absolute)	Mean rad/s² (number of gate contacts)	Number of gate contacts	Mean rad/s² of highest 3 impacts
	25 mm	25,1	11,1	21	24,1
	27 mm	26,7	11,1	17	22,6
	30 mm	42,2	15,3	16	30,2
A 4		Maximum rad/s² (absolute)	Mean rad/s² (number of gate contacts)	Number of gate contacts	Mean rad/s² of highest 3 impacts
	25 mm	40,3	14,3	16	33,6
	27 mm	47,0	22,3	14	43,6
	30 mm	42,0	12,9	14	34,2

A 1 - A 4 : Athlete 1-4

Maximum velocity, maximum g?



Overall mean (±SD) 25 mm Ø: 29.1 km/h (±1.3). 27mmØ: 30.3 km/h (±1.6).
30 mmØ: 29.5 km/h (±1.6).

Reports from other sport disciplines

Table 1. High school football and college head impact frequency and magnitude

	Total Season Impacts	Impacts per Player per Season	Linear Acceleration, g	Rotational Acceleration, rad/s^2	Most Frequent Impact Location
Football					
College	3312-90,054[20,21,34,62]	223-1354[16,20,47]	20-35[16,28,47,62]	1187-6990[22,34,59]	Top[47]
High school	413-652[8,60-63]	413-652[8,60-63]	21-27[13,14,43]	Up to 7701[9,63]	
Youth	748-11,978 [18,24,51,68]	106.9-252 [18,23,24,51,68]	16-22[18,23,48,55,68]	4-12,322[18,51]	Top, front, back[24,51]
Ice hockey					
College	28,178			1187-6990.5[22,34,59]	Top[47]
Male	15,281	347[7]	31.2[65]-43.7[7]	2,881.0[65]-4,764[7]	
Female	12,897	179.2[7]	28.54[65]-44.9[7]	1,766.8[65]-3,709[7]	
High school and youth	12,253[49]	223[49]	18.4[49]-35g[53]	1,464.5[49]	Side[49]

Williams, R et al. (2016) Head Impact Measurement Devices. Sports health 8(3):271

Discussion

Do we need to be concerned?

- All results remained below reported values measured during attested concussive events presented in a recent review of Williams et al. (2016)
- However, a threshold or number of impacts for sub-concussive events is still lacking (Tong et al. 2015).
- Test device mounted to the helmet might return higher values than actually impacting ones on the brain are.

Further investigations with sensors fixed to the head and more participants would deliver a more detailed picture.

Conclusion

- No benchmark in number and intensity of impact which can clearly predict any potential late damage

- Reducing gate diameter or using more protective gear in order to reduce impact ??

OR

- preventing gate impact to the head in the first place ??

→ Designing a protective piece of equipment equivalent to pole guards

Thank you!

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