Buffalo Concussion Bike Test (BCBT) – Instruction Manual

Purpose

- To investigate exercise tolerance in patients suspected to have a concussion. The information is used to diagnose concussion or to develop sub-threshold aerobic exercise prescriptions for treating PCS.
- To establish return of normal aerobic exercise tolerance after concussion and readiness of the athlete to being the graduated Return to Play program.
- To assess exercise tolerance to aid in differentiating between possible diagnoses for persistent PCS (e.g., concussion, cervical injury, vestibular dysfunction, etc.).
- To establish the patient's prognosis and level of recovery.

Eligibility

- Before beginning the BCBT, participants should be evaluated for medical and physical ability to exercise. Considerations may include (but are not limited to): cardiovascular illness, respiratory dysfunction, serious vestibular/balance problems, motor dysfunction, and certain orthopedic injuries. See Table 1. It is advisable to have participants complete the PAR-Q prior to participation (provided below). Testers should be familiar with Chapter 3 of the ACSM guidelines for exercise testing for more detailed information.
- Do not perform the BCBT if the patient has a history of unstable cardiac or respiratory disease, or has lower extremity or spinal orthopedic pathology that compromises cycling.
- The BCBT is not recommended for patients scoring higher than a 7/10 for symptom severity on a VAS. Attempt to perform the test after a day or two of rest.

Table 1. Contraindications to Exercise Testing

Absolute

- Acute myocardial infarction (within 2 d)
- High-risk unstable angina*
- Uncontrolled cardiac arrhythmias causing symptoms or hemodynamic compromise
- Symptomatic severe aortic stenosis
- Uncontrolled symptomatic heart failure
- Acute pulmonary embolus or pulmonary infarction
- Acute myocarditis or pericarditis
- Acute aortic dissection

Relative†

- Left main coronary stenosis
- Moderate stenotic valvular heart disease
- Electrolyte abnormalities
- Severe arterial hypertension‡
- Tachyarrhythmias or bradyarrhythmias
- Hypertrophic cardiomyopathy and other forms of outflow tract obstruction
- Mental or physical impairment leading to inability to exercise adequately
- High-degree atrioventricular block

*ACC/AHA Guidelines for the Management of Patients With Unstable Angina/Non-ST-Segment Elevation Myocardial Infarction (350) (see Table 17).
†Relative contraindications can be superseded if the benefits of exercise outweigh the risks.
‡In the absence of definitive evidence, the committee suggests systolic blood pressure of >200 mm Hg and/or diastolic blood pressure of >110 mm Hg. Modified from Fletcher et al.[7]

Safety Considerations

- Participants must be dressed for exercise (comfortable clothing, running shoes), wearing any vision or hearing aides (glasses, etc.) and should be hydrated and well rested.
- It is strongly recommended that one or more persons with CPR training be present during testing.
- It is important to engage in casual conversation with the patient during the exercise test to assess his/her confidence level as well as any changes in cognition and communication. As exercise intensifies, observe if the patient is having difficulty communicating, looks suddenly pale or withdrawn, or otherwise appears to be masking serious discomfort.
- Be aware of postural changes (arching the back, leaning head forward).

Preparation

Equipment Requirements

- Recumbent or upright stationary bike capable of maintaining a constant power output or "workload" (measured in Watts) that can be controlled by the participant or test administrator ("Lode" brand ergometer is an example).
- BCBT power output conversion Excel spreadsheet.
- Heart rate monitor (Polar brand recommended).
- Weight scale.
- Borg RPE Scale (Rating of Perceived Exertion) and Symptom Severity VAS (Visual Analogue Scale).
- Test Results Form for monitoring heart rate, changes in RPE and symptoms and relevant observations.
- Chair, water and towel for participant recovery after exercise.

Setup

- Attach hear rate monitoring device according to manufacturer's instructions.
- Post the RPE and concussion symptom VAS scales within comfortable viewing distance of participant while on the bike (it is suggested that participant should **not** have to turn head to view scales).
- Measure the patient's body weight in kilograms (kg) and enter weight in E2 (yellow cell). Formula in the spreadsheet will autofill all values for Power (watts) when body weight is added. Each power output given will correspond to the setting to be used at that minute of exercise.
- Turn on bike and adjust settings so that Power Output can be manually adjusted by the test administrator ("manual" setting on Lode bikes)
- Have the participant sit on the bike and adjust seat to a comfortable resting position. After 4-5 minutes of rest, assess resting heart rate. Avoid allowing participant's knee to go into full extension during pedaling.

Test Protocol

Starting the Test

1. Inform participant about test procedures and what to expect during the BCBT. Review in detail that the purpose is not to "push through" symptoms but honestly report them
2. Explain and demonstrate the RPE and VAS and obtain resting scores. Remind participant that he/she will be asked to rate the exertion and symptoms severity every **2 minutes** during exercise.

The RPE scale is a measure of perceived physical activity. Explain to participants that it is a measure of "how hard you feel like your body is working." Explain the scale's numbers (6-20) and descriptors.

The VAS is a measure of symptom severity ("how good/bad your symptoms are making you feel right now"), and should be distinguished as being distinct from RPE. Explain the scale's numbers (1-10) and pictures (expressions of physical pain).

3. Care should be taken to ensure the bike settings such as seat and handle bar heights are appropriate to the participant. The participant should not assume a standing position at any time during the protocol.
4. Tell the participant to start bike at a RPM of 60. Participant must maintain a relatively consistent pace throughout the test.
5. When participant begins pedaling, adjust power level for Stage 0 (exercise initiation) and ask participant to being pedaling.
6. After two minutes at this power output, adjust power outage for Stage 1 (cell E3). Ask participant to rate exertion and symptom severity. Subjective scores and heart rate (bpm) are recorded. This procedure is repeated every two minutes, with ratings and heart rate being recorded, i.e. stage on the treadmill is 1 minute, but 1 stage on the bike is 2 minutes.

   VAS rating changes should be specifically clarified/noted (for example, if the rating moves from 2 to 3, it should be clarified if this reflects the addition or a new symptom or increased severity of an existing symptom, etc.). Experimenter should also record general observations as a test progresses.

   Once test is terminated (see below), power output is reduced to starting level (Stage 0) for a 2 minute cool-down (if participant is safe to continue). The participant is told to cycle at the slowest RPR (approximately 30 rpm). During tis time, heart rate, RPE and VAS ratings should be reported after 2 minute cool-down.

Terminating the Test

Test continues until:

- Maximum exertion (RPE score of ≥18) is reported **or**

- Test is terminated by experimenter due to a symptom exacerbation that causes significant increase in pain or symptom severity (an increase of 3 or more points on the Likert scale compared with the pre-testing score, or the additions of several new symptoms, or a marked increase in severity of symptoms resulting in difficulty continuing test) **or**
- Experimenter notes a rapid progression of complaints (e.g., headache to searing focal pain), patient appears faint or unsteady or experimenter determines that continuing the test constitutes a significant health risk for the participant, **or**
- Patient reports an inability to continue the test safely.

Outcomes

Diagnosis

- Exercise tolerance with an early symptom-limited threshold is consistent with a diagnosis of concussion in those who are within the acute or subacute recovery phases. In those with persistent PCS, it is consistent with physiological post-concussion disorder as a cause of the symptoms, which is believed to reflect a disturbance of the autonomic control of cerebral blood flow during exercise.

  Patients who have normal exercise tolerance, i.e., they do not have a physiological threshold (they can exercise to RPE ≥18 or HR ≥85% of age-predicted maximum, who stop the test because of exhaustion) have recovered physiologically. They should be evaluated for possible anxiety/depression and/or dysfunction of the cervical spine, the oculomotor and vestibular systems, and/or the temporomandibular region as a cause of persistent symptoms.

Treatment/Return to Play

- On completion of the BCBT, concussion patients may be given an exercise prescription based on 80% of the maximum heart rate achieved at the point of symptom exacerbation. Patients are instructed to obtain a heart rate monitor and to exercise at this level for at least 20 minutes daily without exceeding heart rate constraints. They are instructed to warm up for 5 minutes to the target heart rate, remain there for 20 minutes or until they experience increased symptoms, at which time they should stop. They are instructed to cool down for five minutes. They should attempt the exercise bout at about the same time each day.

  Patients should try to begin by exercising on a stationary cycle to avoid precipitating vestibular symptoms. After a week or two, if they are comfortable, they may exercise by

swimming, walking outside, or on a treadmill or stationary cycling. Resistance training is advised only after return of normal aerobic exercise tolerance.

If any post-concussion symptoms return along the progression, the athlete must return to the previous asymptomatic stage/heart rate prescription and start again.

- Once the patient can exercise to voluntary exhaustion on the BCBT without eliciting symptoms, you may begin the process of returning him/her to play by following the five-step return to play program of the Zurich Consensus Statement.
- Other prescriptions and recommendations will be based on the patient's particular complaints. A patient may be recommended for cervical physical therapy, vestibular physical therapy, vision therapy, cognitive behavioral therapy, or treatment for temporomandibular joint disorders.

Physical Activity Readiness Questionnaire (PAR-Q)

Questions: Yes or No

1. Has your doctor ever said that you have a heart condition and that you should only perform physical activity recommended by a doctor?
2. Do you feel pain in your chest when you perform physical activity?
3. In the past month, have you had chest pain when you were not performing any physical activity?
4. Do you lose your balance because of dizziness or do you ever lose consciousness?
5. Do you have a bone or joint problem that could be made worse by a change in your psychical activity?
6. Is your doctor currently prescribing any medication for your blood pressure or for a heart condition?
7. Do you know or any other reason why you should not engage in physical activity?
   If you have answered "Yes" to one or more of the above questions, consult your physician before engaging in physical activity. Tell your physician which questions you answered "Yes" to. After a medical evaluation, seek advice from your physician on what type of activity is suitable for your current condition.

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Buffalo Concussion Bike Test (BCBT) Weight to Power/Watt Conversion Table

	Weight in KG																	
Minute	**35**	**37.5**	**40**	**42.5**	**45**	**47.5**	**50**	**52.5**	**55**	**57.5**	**60**	**62.5**	**65**	**67.5**	**70**	**72.5**	**75**	**77.5**
0	18	19	20	21	23	24	25	26	28	29	30	31	33	34	35	36	38	39
2	22	24	26	27	29	30	32	34	35	37	39	40	42	43	45	47	48	50
4	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61
6	32	35	37	39	42	44	46	49	51	53	55	58	60	62	65	67	69	72
8	37	40	43	45	48	51	53	56	59	61	64	67	69	72	75	77	80	83
10	42	45	48	51	54	57	60	63	66	69	73	76	79	82	85	88	91	94
12	47	51	54	57	61	64	68	71	74	78	81	84	88	91	95	98	101	105
14	52	56	60	63	67	71	75	78	82	86	90	93	97	101	104	108	112	116
16	57	61	65	69	74	78	82	86	90	94	98	102	106	110	114	118	123	127
18	62	67	71	76	80	84	89	93	98	102	107	111	116	120	124	129	133	138
20	67	72	77	81	86	91	96	101	105	110	115	120	125	129	134	139	144	149
22	72	77	82	88	93	98	103	108	113	118	124	129	134	139	144	149	154	160
24	77	83	88	94	99	105	110	116	121	127	132	138	143	149	154	160	165	171
26	82	88	94	100	105	111	117	123	129	135	141	146	152	158	164	170	176	181
28	89	95	101	108	114	120	127	133	139	146	152	158	165	171	177	184	190	196
30	92	98	105	112	118	125	131	138	144	151	158	164	171	177	184	190	197	204

	Weight in KG																
Minute	**80**	**82.5**	**85**	**87.5**	**90**	**92.5**	**95**	**97.5**	**100**	**102.5**	**105**	**107.5**	**110**	**112.5**	**115**	**117.5**	**120**
0	40	41	43	44	45	46	48	49	50	51	53	54	55	56	58	59	60
2	51	53	55	56	58	59	61	63	64	66	67	69	71	72	74	75	77
4	63	65	67	69	71	73	74	76	78	80	82	84	86	88	90	92	94
6	74	76	79	81	83	86	88	90	92	95	97	99	102	104	106	109	111
8	85	88	91	93	96	99	101	104	107	109	112	115	117	120	123	125	128
10	97	100	103	106	109	112	115	118	121	124	127	130	133	136	139	142	145
12	108	111	115	118	122	125	128	132	135	138	142	145	149	152	155	159	162
14	119	123	127	131	134	138	142	146	149	153	157	160	164	168	172	175	179
16	131	135	139	143	147	151	155	159	163	167	172	176	180	184	188	192	196
18	142	147	151	155	160	164	169	173	178	182	187	191	195	200	204	209	213
20	153	158	163	168	173	177	182	187	192	197	201	206	211	216	220	225	230
22	165	170	175	180	185	191	196	201	206	211	216	221	227	232	237	242	247
24	176	182	187	193	198	204	209	215	220	226	231	237	242	248	253	259	264
26	187	193	199	205	211	217	222	228	234	240	246	252	258	263	269	275	281
28	203	209	216	222	228	235	241	247	254	260	266	273	279	285	292	298	304
30	210	217	223	230	236	243	250	256	263	269	276	282	289	295	302	309	315

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4225 Genesee St. Suite 400| Cheektowaga, NY 14225 |ubortho.com | 716-204-3200 | fax 716-204-4061

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