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Editorial Comment

What is new in neuro-musculoskeletal interactions: From medical myths to YouTube

F. Rauch

Genetics Unit, Shriners Hospital for Children, Montreal, Canada

Bending bone belief blasted

Bending bone belief? Chances are that you have never come across this particular creed. In fact, a quick Google search only yields a single entry on this topic – even the Flat Earth Society has 115,000 entries. And yet, the bending bone belief apparently has many followers in the bone community. Sverdlova et al, the authors behind the single Google entry on the bending bone belief, define it as a 'belief that along with some compression, long bones are subjected to large bending moments, which produce high tensile loading'[1]. As such, the bending bone belief is the more general version of what might be called the 'tensile trabecula tradition', the century-old legend about tensile trabeculae that some scientists claim to have spotted in the proximal femur – a bone that during locomotion supposedly bends like a loaded crane.

However, as Sverdlova et al note, if a bone was predominantly loaded by bending, with tension on one side and compression on the other, then you should find a neutral axis somewhere in the middle. The bone would be essentially unloaded at the neutral axis, which would lead to disuse osteoporosis. This would result in quite oddly shaped bones. Sverdlova et al therefore propose that the architecture of bones, muscles and ligaments actually ensures that bending is minimized.

Based on this idea, the authors built a finite element model of the muscle forces around the proximal femur which predicts a bone that has no unloaded material in the cross-sections of the diaphysis. A strong point of the model is that the estimated stress distribution in the cortex corresponds to the material density distribution in the bone. Such a model may not immediately change clinical practice but, as the authors note, when dealing with situations like bone injuries or bone implants, it might be useful to start out with a realistic idea about the forces acting on the bones.

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Corresponding author: Frank Rauch, M.D., Shriners Hospital for Children, 1529 Cedar Avenue, Montreal, Qc H3G 1A6, Canada
E-mail: frauch@shriners.mcgill.ca

Fall risk accelerometry

Accelerometers are all the rage in neuro-musculo-skeletal research. Probably their most popular application is to count steps and estimate physical activity. More sophisticated devices serve as 'pocket gait labs' that determine things like walking speed and step length. Assessment of fall risk seems to become another potential application of advanced accelerometers. Narayanan et al examined a simple series of tests ('Timed Up-and-Go Test', the 'Alternate-Step Test', 'Sit-to-Stand With Five Repetitions') that people could do at home while wearing an accelerometer[2]. The accelerometer data are used to extract a large number of measures, such as the time it takes to perform each sub-task of these tests. These data are combined into a predictive model, which in a group of 68 elderly subjects was shown to correlate with a clinically determined gold standard for fall risk, the so-called physiological profile assessment. It still remains to be seen whether this accelerometer-based approach predicts actual falls.

A different path was taken by Weiss et al[3]. These authors used an accelerometer to identify 'near-falls'. The rationale behind this is that near-falls 'predict' falls and occur more frequently than falls. They tested their method by making healthy subjects stumble while walking on a treadmill. A number of parameters were extracted from the accelerometer reading, the best of which had >85% sensitivity and specificity to identify near-falls.

Let us assume that such home-based accelerometer measurements eventually identify people who are at risk of falling. Does this mean that in future elderly subjects will have to fiddle with tri-axial accelerometers, laptop computers and Bluetooth connections to provide their doctor with those data? Not necessarily. As is the case with many other problems of modern life, smart-phones may be the solution. These devices typically have a built-in accelerometer (which is how the phone knows whether you hold it vertically or horizontally) and they are obviously able to transmit data. It appears that until now smart-phone accelerometry has not been used to predict fall risk or to identify near-falls. However, the smart-phone seems to be smart enough to detect real falls.

Sposaro et all have devised an ominously-named smart-phone application, the iFall[4]. This application continuously monitors the smart-phone accelerometer data to detect patterns that resemble a fall. When the program suspects that a fall has occurred, it asks the user to confirm that everything is ok. If the user does not respond, the phone automatically calls the faller's social contacts. What if people do not know where the fall victim is? No problem. The GPS data from the smart-phone tells the social contacts where to find the potentially injured person. A limitation of this method presumably is that the smart-phone can do these things only if the faller has not smashed it during the fall.

Toys for researchers

Smart-phones are not the only gadgets that are making their way into biomedical science. Game consoles, in particular the Nintendo Wii, are also stirring researchers' interest. One accessory device is the Wii Balance Board, a basic force plate that transmits data wirelessly to the Wii video gaming console. There, 'center of pressure' measures are calculated from the balance board signal. This information can be used to control exciting games – or for somewhat more staid but potentially useful scientific applications.

One of the potential medical applications of the Wii Balance Board is to use it for … balance tests, you guessed it. How good can a $100 toy force plate be? Clark et al pursued this question and compared the results of standing balance tests on the Wii Balance Board with those of a $18,000 laboratory-grade force platform[5]. It turns out that the Wii Balance Board overestimates the center of pressure path length (the usual measure of force plate balance tests) by up to 15%, but that the two devices had similarly good reproducibility. The authors conclude that the Wii Balance Board is a suitable standing balance assessment tool for the clinical setting. The little snag in this study is that the authors used their own custom-made software to interpret the data that are beamed from the Wii Balance Board. It is not yet clear whether the balance test that comes with the regular Wii gaming software is as useful as the author's own program.

The Wii Balance Board may not only be a useful diagnostic device, but in combination with those video games could help to treat balance disorders, as some case reports suggest[6,7]. Promotional material on YouTube even states that Wii games will help to increase bone density (http://www.youtube.com/watch?v=cj1QIhIZRuo), but there do not seem to be any data to support this claim.

Talking of YouTube, there may be more fruitful uses for this video clip site than watching promotional videos about gaming consoles. Indeed, YouTube is a bonanza for traumatologists, as the site contains a virtually unlimited amount of videos that show people having accidents. Such videos are not to everyone's taste, but they can help with the study of fracture mechanisms, as shown in a proof-of-principle study by Kwon et al[8]. They scanned YouTube.com for videos of accidents leading to ankle fractures. The individuals who had posted the video clips were contacted in order to obtain radiographs. After watching about 1000 video clips and contacting 240 people, Kwon et al eventually ended up with radiographs from 12 ankle fractures. Certainly not an impressively large yield, but at least a start for a fledgling approach. They found that in about half the cases the fracture mechanism shown on the video did not correspond to the one that was expected from the radiographs, according to standard textbooks. The authors conclude that YouTube has a promising future ... in the study of fracture mechanisms.

References

1. Sverdlova NS, Witzel U. Principles of determination and verification of muscle forces in the human musculoskeletal system: Muscle forces to minimise bending stress. J Biomech 2010;43:387-96.
2. Narayanan MR, Redmond SJ, Scalzi ME, Lord SR, Celler BG, Lovell Ast NH. Longitudinal falls-risk estimation using triaxial accelerometry. IEEE Trans Biomed Eng 2010;57:534-41.
3. Weiss A, Shimkin I, Giladi N, Hausdorff JM. Automated detection of near falls: algorithm development and preliminary results. BMC Res Notes 2010;3:62.
4. Sposaro F, Tyson G. iFall: an Android application for fall monitoring and response. Conf Proc IEEE Eng Med Biol Soc 2009;2009:6119-22.
5. Clark RA, Bryant AL, Pua Y, McCrory P, Bennell K, Hunt M. Validity and reliability of the Nintendo Wii Balance Board for assessment of standing balance. Gait Posture 2010;31:307-10.
6. Clark R, Kraemer T. Clinical use of Nintendo Wii bowling simulation to decrease fall risk in an elderly resident of a nursing home: a case report. J Geriatr Phys Ther 2009;32:174-80.
7. Shih CH, Shih CT, Chu CL. Assisting people with multiple disabilities actively correct abnormal standing posture with a Nintendo Wii balance board through controlling environmental stimulation. Res Dev Disabil 2010;31:936-42.
8. Kwon JY, Chacko AT, Kadzielski JJ, Appleton PT, Rodriguez EK. A novel methodology for the study of injury mechanism: ankle fracture analysis using injury videos posted on YouTube.com. J Orthop Trauma 2010;24:477-82.