

Yoga for Osteoporosis

A Pilot Study

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Context: More than 200 000 000 people suffer from osteoporosis or osteopenia worldwide. An innocuous and inexpensive treatment would be welcome. **Study design:** Serial controlled repeated measure. **Patients:** Nineteen serial patients with osteoporosis or osteopenia, average age 68 years. **Methods:** Qualifying blood and urine tests and dual-energy x-ray absorptiometry (DEXA) scan preceding 10-minute daily yoga. DEXA scan repeated after 2 years. **Outcome Measurement:** Comparison of pre- and postyoga DEXA scans, injuries. **Results:** Yoga practitioners gained 0.76 and 0.93 points for spine and hips, respectively, on the *t* scale when compared with controls ($P = .01$). Five patients with osteopenia were reclassified as normal; 2 patients with osteoporosis are now osteopenic. There were no injuries. **Conclusion:** Yoga appears to be an effective way to build bone mineral density after menopause. **Key words:** *bone mineral density, exercise, osteoporosis, Wolf's law, yoga*

OSTEOPOROSIS and osteopenia are better understood than they were even a decade ago. Yet ancient methods appear applicable to their prevention and cure. We conducted a pilot study using yoga to reduce and ultimately prevent osteopenia and osteoporosis. Many of the world's estimated 200 000 000 sufferers of osteoporosis and osteopenia are unlikely ever to be able to afford either medication for the condition or treatment of the fractures that are their consequence.¹ Those receiving bisphosphonates, by far the most common pharmacological treatment, are at increased risk for gastrointestinal disorders, osteonecrosis, and severe muscle cramps,^{2,3} and while medicines such as loop diuretics strongly promote osteoporosis through calcium loss, calcium itself promotes cardiovascular and cerebrovascular events and sudden death in people older than 75 years.⁴

Yet 55% of everyone older than 50 years will have low bone density,¹ and a woman's

risk of hip fracture is equal to the combined risk of breast, uterine, and ovarian cancer.⁵ Women are as likely to die after a hip fracture as from breast cancer.^{1,3} Men older than 50 years are more likely to contract hip fracture than prostate cancer.^{1,6} Yet a recent "definitive" review of chronic disease in a leading journal does not even mention osteoporosis.⁷

Everett Smith outlined the support for "unusual pulls" bones as a means of building bone strength. In a study of turkey wings published in this journal almost 20 years ago, he outlined this application of Wolff's law: "The architectonic of bone follows the lines of force to which that bone is exposed."^{8,9} Biochemical markers of osteoid synthesis such as 3H-uridine have very persuasively risen in intracellular concentration after as little as 10 seconds of osteocyte compression.¹⁰ Japanese and American studies sending ovariectomized mice into space confirm that gravity, while a ubiquitous and powerful force, is second-best compared to the action of muscles themselves.¹¹ Their point is that muscles are stronger than gravity. One need do no more than lift a finger to prove it.

Tennis players' dominant arms clearly share genetic and nutritional conditions with their contralateral partners, but asymmetrically

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Figure 1. The triangle pose.

increased bone mineral density (BMD) is evident there and in many other examples of response to physical stressors.^{12,13} The often observed fact that yoga practitioners seem to live long and fracture-free lives suggests that the unusual and unusually prolonged pulls they voluntarily self-administer may be a stimulus to bone health.

MATERIALS AND METHODS

Study participants were invited through public announcement and from among our current patients. Inclusion criteria were osteopenia or osteoporosis by dual energy x-ray absorptiometry (DEXA) scan, that is, T-scale values below -1.0 for spine or hip, and commitment to 2 years of daily or near-daily yoga. Exclusion criteria included history of bone disease, such as osteofibrosis cystica or osteomalacia, or metabolic or endocrine disorders specifically affecting bone, as detected by tests listed below, and current pregnancy.

Each patient had BMD tested by DEXA scan within 6 months of joining the study, and once osteoporosis or osteopenia was confirmed, urine was tested for collagen cross-linkage (NTX), and blood was drawn for tests including the following: thyroid stimulating hormone, parathyroid hormone, erythrocyte sedimentation rate, electrolytes and blood chemistry (SMA-18), complete blood cell count (CBC) with sedimentation rate, vitamin D 25-OH, and vitamin D1, 25-d₁ hydroxy.



Figure 2. Downward facing dog was modified when necessary to fit participants' abilities.

Only patients with normal laboratory values were then taught a regimen of 10 yoga postures, with frequent adaptations in keeping with the participants' abilities and limitations. The poses taught were the triangle pose (*Trikonasana*), the upward and downward dog poses (*Adho Mukha Svanasana* and *Urdhva Mukha Svanasana*), the bridge and rainbow (*Setu Bandhasana* and *Urdhva Dhanurasana*), 1-legged and 2-legged forward bends with specific personal instruction on keeping the back straight and avoiding kyphosis while doing so (*Janu Sirsasana* and *Paschimottasana*), the boat (*Navasana*), and *Supta Padangusthasana* and 3 twisting poses with straight-back instructions (*Marichyasana*, *Matsyendrasana*, and *Jathara Parivartanasana*) (Figs 1-13).



Figure 3. Upward facing dog.



Figure 4. *Setu Bandhasana*, the backbend done by most study participants.



Figure 7. *Janu Sirsasana*, a forward bend that must be taught individually to avoid spinal damage.



Figure 5. *Urdhva Dhanurasana*, a significantly more challenging backbend often done in considerably adapted (and toned-down) form.



Figure 8. *Paschimottasana*, another forward bend requiring individual attention to avoid injury.



Figure 6. A safer and less extreme version of the back bend used by Mr Iyengar and other yoga masters.



Figure 9. *Navasana*, the boat. Balance and safe strengthening of muscles that stimulate the most vulnerable parts of the spine are the goals here.



Figure 10. *Supta Padangusthasana*. The floor safely supports the spine in this maximally safe version of a forward bend.

Participants were taught simpler alternatives when necessary for safety, for example, modified forward flexion to avoid vertebral fractures,¹⁴ advised to stay in each position for 20 to 30 seconds, and asked to rest for 5 to 10 minutes following the 8- to 10-minute routine. For pictures and more details, see the Web site sciatica.org.

We telephoned the patients periodically to give them encouragement and discuss problems. When we saw that compliance was below 30%, we instituted a newsletter and online notice board.

Patients succeeding in doing yoga consistently for 2 years and controls were then given another DEXA scan. In patients receiving medication such as bisphosphonates, the nomogram for improvement for their partic-



Figure 11. A moderate form of *Marichyasana*.



Figure 12. *Matsyendrasana*.

ular dosage and duration was taken as baseline, and improvement/deterioration only beyond the nomogram's mean was taken as change. In patients receiving medications that had no nomogram and those with multiple previous DEXA scans, projections based on previous data were used to establish the predicted change in BMD, and deviation from that prediction was taken as change due to the study intervention.

RESULTS

A total of 117 patients entered the study between October 10, 2005, and May 2, 2008. There were 9 men in the group, which consisted of 87 people with osteoporosis and 30



Figure 13. *Jathara Parivarthanasana*, a pose that stimulates the spine without exacerbating arthritis of the hips. It can also be done with bent knees.

Table 1. Mean bone mineral density of the spine and hip for intervention patients and controls after and before the intervention

Patient no.	Sex	Age	Bone Mineral Density			
			Spine after	Spine before	Hip after	Hip before
1	F	56	-2.47	-2.7		
2	F	71	0.8	-1	-0.5	-1.2
3	F	60	-0.5	-1.5	-1.2	-1.37
4	F	52	-1.4	-1.9	-0.2	-2
5	M	74	...		-0.3	-1.7
6	F	88	-1.5	-1.7		
7	F	88	-1.6	-1.8		
8	F	61	-2.8	-3.2	-0.8	-1.9
9	F	65	-1.3	-2	-0.7	-1.6
10	F	48	-2.8	-2.6	-2.8	-2.8
11	F	73	-0.4	-1.2		
Average		66.90	-1.4	-1.96	-0.92	-1.8
Standard Deviation (SD)		13.9	1.16	0.7	0.89	0.52
Difference			0.6		0.87	
Controls						
1	M	64	-1.1	-0.5	-2	-2.1
2	F	68	-2.8	-2.8	-1.7	-1.5
3	F	69	-1.2	-1.2	-0.1	-0.4
4	F	52	-1.5	-0.8	-2.3	-1.9
5	F	48	-2.8	-2.8	-2.3	-2.3
6	F	77				
7	F	83	-0.8	-1	-1.8	-1.6
Average		65.86	-1.7	-1.58	-1.7	-1.6
Standard Deviation (SD)			0.88	1.13	0.82	0.67
Difference			-0.12		0.07	

with evidence only of osteopenia. Compliance thus far is poor, with only 31 of 117 patients responding positively to telephone inquiries (26.5%).

To date, 11 patients have completed the 2-year protocol and 7 patients have served as 2-year controls. The mean BMD of the 11 intervention patients has improved well beyond that of the controls (Table 1 and Fig 14).

The patients doing 10 minutes of yoga daily showed an increase in spine BMD equivalent to 0.563 units on the T-scale; their hip BMD increased to 0.867 units. Control values were -0.12 and -0.07 for spine and hip, respectively, over the 2-year study period. Although the number of patients who have completed the study at this point are insufficient for rigor-

ous statistical analysis, there are strong trends worthy of note: People doing yoga have improved their spinal T-scores by an average of 0.69 T-score units and their hip T-scores by 0.87 T-score units in 2 years.

Because of the small number of patients in the control group, we analyzed these results by comparing them with the null hypothesis, that yoga did not improve bone density. This is a strong condition, because, in fact, in patients older than 30 years, BMD actually declines without any treatment. This is what has been revealed thus far in our group overall. Using 1-tailed *t* tests, the DEXA scan results from only 11 patients proved significant, $P < .01$ for both the spine and the hip (Table 2).

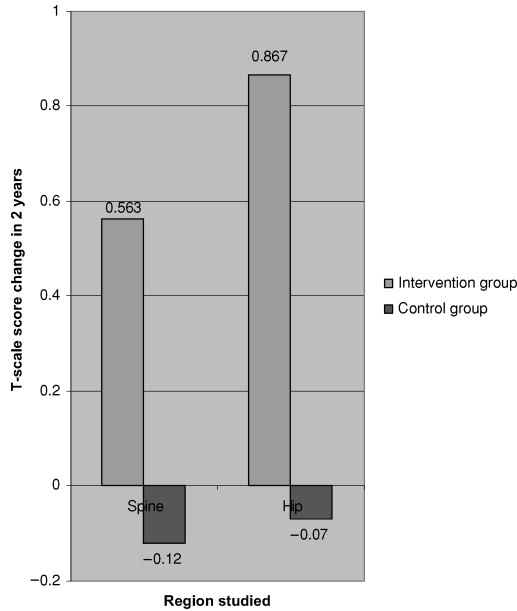


Figure 14. Changes in T-scores in yoga group versus control over two years.

We will certainly continue our study. Still, these early findings are encouraging.

DISCUSSION

The value of a low-cost and healthful means of combating osteoporosis is considerable. While bisphosphonate use is associated with gastrointestinal toxicity, jaw and other sites of osteonecrosis, severe and sometimes irreversible leg cramps and bone pain, and other side-effects, yoga injuries are uncommon¹⁵ and nearly always minor. Yoga has been shown to reduce back pain, arthritis, and anxiety and to improve gait, neural plasticity associated with motor learning, all capacities that mitigate against the falls that produce osteoporotic fractures.¹⁵⁻²¹

This study will continue until a statistically significant internal sample is reached. Assuming for the moment that the results obtained so far are borne out, we may draw optimistic conclusions: There is no tachyphylaxis known with yoga, no law of diminishing returns that is well known with bisphosphonates and some other medicines. The

Table 2. The DEXA scan results for spine and hip bone mineral density for intervention patients

Patient no	Spine difference	Hip difference
1	0.23	
2	1.8	0.7
3	1	0.17
4	0.5	1.8
5		1.4
6	0.2	
7	0.2	
8	0.4	1.1
9	0.7	0.9
10	-0.2	0
11	0.8	
Average	0.56	0.87
SD	0.56	0.65
<i>t</i> test statistic	3.20	3.50
<i>P</i> < .01, %	99.46	99.36

effects of yoga are therefore likely to be additive: 6 years are likely to yield 3 times the benefit seen after 2 years. At that rate, a person with osteopenia (T-score of -1.0 to -2.5) or minimal osteoporosis (T-score of -2.5) will have spine and hip BMD that is neither osteoporotic nor osteopenic within 6 years of a quiet, costless, and virtually riskless practice of 10 min/d.

Because of confounding factors such as calcification of the aorta and osteoarthritis of its many joints, the spine’s T-score is a less reliable indicator of total bone mass than is the hip’s T-score. In this pilot study, the hip BMD increased 54% more than the spine BMD, lending further credence to the efficacy of yoga in building bone.

THE TROUBLE WITH THIS STUDY

This study focuses on the currently standard measure of bone strength, BMD as determined by the DEXA scan. But bones are not solid; they have a varying delicate internal structure of struts and crosspieces that also contributes to their overall resistance

to fracture, known as bone quality. The quality is a function of both the BMD and the structure of trabecular bone, inner elements that span bones' interior to support the cortical bone that forms the hardened outer region of most bones. Bone quality contributes an estimated 40% to 60% of bones' abilities to withstand traumatic stress. Bone biopsy and noninvasive techniques such as micro-magnetic resonance imaging and super-computer imaging are currently in the mid-stage of development; before long, they will add to our understanding of bone strength and what activities or medications are most effective in creating and sustaining it.

CONCLUSIONS

This pilot study tends to give support to the hypothesis that practicing yoga for as little as 8 to 10 minutes daily will raise T-scale ranking in older patients.

We are currently beginning a second trial that we believe will be safer than the first, though the first trial has had no fractures or other mishaps to date. We are supplying a 10-minute video along with entrance to the study. It is possible that we will be able to non-invasively examine bone quality in this study as well. Those interested should communicate with us through our Web site sciatica.org.

REFERENCES

- Iqbal MM. Osteoporosis: epidemiology, diagnosis and treatment. *South Med J*. 2000;93(1):2-18.
- Loud KJ, Gordon CM. Adolescent bone health. *Arch Pediatr Adol Med*. 2006;160(10):1026-1032.
- Cooper C. The crippling consequences of fractures and their impact on quality of life. *Am J Med*. 1997;103:12S-17S; discussion 17S-19S.
- Sorensen HT, Christensen S, Mehnert FE, et al. Use of bisphosphonates among women and risk of atrial fibrillation and flutter: population based case-control study. *BMJ*. 2008;336:813-826.
- National Osteoporosis Foundation. <http://www.nof.org/osteoporosis/facts.htm>. Accessed 2006.
- MacLean C, Newberry S, Maglione M, et al. Systematic review: comparative effectiveness of treatments to prevent fractures in men and women with low bone density or osteoporosis. *Ann Intern Med*. 2008;148:197-213.
- Anderson GE, Chu E. Expanding priorities—confronting chronic disease in countries with low income. *N Engl J Med*. 2006;356(3):209-211.
- Lanyon LE. Osteoporosis and exercise. *Top Geriatr Rehabil*. 1989;4(2):12-24.
- Wolff J. *The Law of Bone Transformation*. Berlin, Germany: A Hirschwald; 1892.
- Pead MJ, Suswillo R, Skerry TM, Vedi S, Lanyon LE. Increased 3H-uridine levels in osteocytes following a single short period of dynamic bone loading in vivo. *Calcif Tissue Int*. 1988;43:93-97.
- Kumei Y, Morita S, Nakamura H, et al. Osteoblast responsiveness to 1-alpha-dihydroxyvitamin D₃ during spaceflight. *Ann N Y Acad Sci*. 2004;1030:121-124. doi: 10.1196/annals.1299.087.
- Jovanović JD, Jovanović ML. Biomechanical model of vertebra based on bone remodeling. *Med Biol*. 2004;11(1):35-39. UC 617-089.843:616.711:611.018.4:612.017.
- Rubin CT, Lanyon LE. Regulation of bone formation by applied dynamic loads. *J Bone Joint Surg*. 1984;66A:397-402.
- Sinaki M, Mikkelsen BA. Postmenopausal spinal osteoporosis: flexion versus extension exercises. *Arch Phys Med Rehabil*. 1984;65(10):593-596.
- Sherman KJ, Cherkin DC, Erro J, Miglioretti DL, Deyo RA. Comparing yoga, exercise, and a self-care book for chronic low back pain: a randomized trial. *Ann Intern Med*. 2005;143:849-856.
- Williams KA, Petronis J, Smith D, et al. Effect of Iyengar yoga therapy for chronic low back pain. *Pain*. 2005;115(1/2):107-117.
- Deckro GR, Ballinger KM, Hoyt M, et al. The evaluation of a mind/body intervention to reduce psychological distress and perceived stress in college students. *J Am Coll Health*. 2002;50(6):281-287.
- Haslock I, Monro R, Nagarathna R, Nagendra HR, Raghuram NV. Measuring the effects of yoga in rheumatoid arthritis. *Br J Rheumatol*. 1994;33(8):787-788.
- Kolasinski SL, Tsai AG, Garfinkel M, Metz M, VanDyke A, Schumacher J. Iyengar yoga for treating symptoms of osteoarthritis of the knees: a pilot study. *J Altern Complement Med*. 2005;11(4):689-693.
- DiBenedetto M, Innes KE, Taylor AG, et al. Effect of a gentle Iyengar yoga program on gait in the elderly: an exploratory study. *Arch Phys Med Rehabil*. 2005;86:1830-1837.
- Telles S, Hanumanthaiah BH, Nagarathna R, Nagendra HR. Plasticity of motor control systems demonstrated by yoga training. *Indian J Physiol Pharmacol*. 1994;38(2):143-144.