Interval Sport Programs: Guidelines for Baseball, Tennis, and Golf

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INTRODUCTION

Rehabilitation specialists commonly observe upper-extremity injuries in golfers, baseball players, and tennis players. Traditional nonoperative and postoperative rehabilitation programs for these athletes involve a gradual restoration of range of motion (ROM), strength, muscular endurance, dynamic stabilization, and neuromuscular control.[9,10] Upon successful completion of the early phases of the rehabilitation program, a gradual and controlled return to sport activities has been advocated by several authors.[1,2,3,6,9,10,11] The term ''interval sport programs'' has been used to refer to functional rehabilitation guidelines that simulate sport activities. These programs are designed to progressively apply forces to the healing structures and are intended to gradually return the athlete to full athletic competition as quickly and safely as possible. The purpose of this paper is to describe specific interval sport programs currently utilized at our center to return golfers, baseball players, and tennis players to competition following an injury or surgery.

Principles of Interval Sport Programs

Interval sport programs (ISP) are designed to gradually return upper-extremity function after injury or surgery by slowly progressing through graduated sport-specific activities. An athlete can begin an ISP following a satisfactory clinical exam demonstrating full ROM, minimal pain or tenderness, adequate dynamic stabilization, and sufficient strength and muscular endurance.[7,8] The ISP is initiated upon clearance by the athlete's physician to resume sport activities and performed under the supervision of the rehabilitation team (physician, physical therapist, and athletic trainer). Several guidelines are considered in the development of an ISP: (1) return-to-sport activities after injury that include attention to the entire body; (2) a gradual progression of applied forces to lessen the chance of reinjury; (3) proper warm-up and maintenance exercises; and (4) proper biomechanics to minimize the incidence of reinjury.

The ISP is set up to minimize the chance of reinjury and emphasizes warm-up and stretching. Because there is an individual variability in all athletes, there is no set timetable for completion of the program. Variability is based on each athlete's skill level, goals, and injury. It is recommended that the athlete follow the program rigidly, as this will permit the safest return to competition. Highly competitive individuals who wish to return to competition quickly may have the tendency to increase the intensity of the ISP. This may increase the incidence of reinjury and may retard the rehabilitation process.

During the recovery process, the athlete may experience soreness and a dull, diffuse, aching sensation in the muscles and tendons. If sharp pain is experienced, particularly in the joint or point of injury, the athlete is instructed to stop all sport activity until the pain ceases. If pain persists, the athlete needs to undergo a physical assessment.

Rehabilitation Program

The athlete should supplement the ISP with a high-repetition, low-weight exercise program such as

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the Throwers Ten Program.[6,10,11] While the strengthening program should achieve a balance between anterior and posterior shoulder musculature, special emphasis should be given to the posterior rotator cuff and scapular musculature for any strengthening program.[9,10]

The rehabilitation program should follow a sequential order of alternating days.[6] All strengthening, plyometric, and neuromuscular control drills should be performed 3 times per week (with a day off in between) on the same day as the ISP (Table 1). The athlete should warm up, stretch, and perform 1 set of each exercise before the ISP, followed by 2 sets of each exercise after the ISP. This provides an adequate warm-up but also ensures maintenance of necessary ROM and flexibility of the upper extremity. Cryotherapy may be used following the completion of the rehabilitation program to minimize pain and inflammation.

The alternate days are used for lower-extremity, cardiovascular, and core-stability training. In addition, the athlete performs ROM and light strengthening exercises that emphasize the posterior rotator cuff and scapular muscles.[6] The cycle is repeated throughout the week and the seventh day is designated for rest and light ROM and stretching exercises.

Warm-Up

An adequate warm-up is essential before beginning the ISP. The amount of warm-up will vary from person to person; therefore, the athlete should jog or cycle until developing a light sweat, then progress to the flexibility exercises. Because most sport motions involve the entire body, all muscle groups should be stretched prior to the ISP. Capsular stretches and shoulder ROM exercises[6,9,10,11] should be performed as needed before beginning the ISP.

TABLE 1. Rehabilitation program commonly used for golfers, baseball players, and tennis players.*

Mon, Wed, Fri	Tue, Thu, Sat	Sun
• Throwers Ten†	• LE strengthening	• Light ROM
• Plyometrics	• Cardiovascular	• Stretching
• Neuromuscular control drills	• Core stability	
• Stretching	• Stretching	
• ISP	• Posterior RTC and scapula strengthening‡	

* ISP = interval sport program; LE = lower extremity; RTC = rotator cuff; ROM = range of motion.
† Consists of a set of specific exercises designed to increase strength and flexibility of the upper extremity.[6,10,11]
‡ Strengthening of the posterior rotator cuff and scapular muscles are incorporated on alternating days during the early phases of rehabilitation. As the athlete progresses to more of a maintenance program, these exercises are discontinued on these days.

SPECIFIC INTERVAL SPORT PROGRAMS

Interval Throwing Program

An interval throwing program is used to gradually return baseball pitchers and positional players to competition. The interval throwing program is used for high school, college, and professional baseball players and is divided into 2 phases. Our interval throwing program has been developed based on research conducted in our laboratory quantifying the biomechanics of flat-ground, long-toss, and partial-effort throwing.[4,5]

The interval throwing program is initiated with throwing on flat-ground for approximately 4 to 6 weeks (Table 2). The athlete begins throwing at 13.7 m (45 ft) and gradually progresses to 18.3, 27.4, 36.6, 45.7, and 54.8 m (60, 90, 120, 150, and 180 ft, respectively).

A critical aspect of the interval throwing program is the use of proper throwing mechanics. The use of the "crow hop" method simulates the throwing act, emphasizing proper body mechanics. A pitching coach and sports biomechanist may be valuable allies to the rehabilitation team to ensure the use of proper throwing mechanics. Components of the crow hop method are first a hop, then a skip, followed by the throw. The velocity of the throw is determined by the distance, whereas the ball should be thrown with an arc and have only enough momentum to travel the desired distance.

Using the crow hop method, the athlete should begin warm-up throws at a comfortable distance of approximately 9.1 to 13.7 m (30 to 45 ft) and then progress to the distance indicated for each step of the interval throwing program. The program consists of throwing at each step 2 to 3 times on separate days without pain or symptoms before progressing to the next step. Initially, the athlete will perform 2 sets of 25 throws at the specified distance. Adequate warm-up before each set and a rest of 5 to 10 minutes is encouraged. The amount of throws is then increased to 3 sets of 25 throws at each distance, and finally to the next distance in the sequence. If pain exists at a particular step, the athlete is instructed to return to the previous asymptomatic step and attempt to progress again when symptoms subside.

Positional players are instructed to progress through the entire interval throwing program before beginning position-specific drills. However, pitchers are instructed to progress through 36.6 m (120 ft) of long-toss throwing (phase 1, step 8). At this time, they may opt to continue the normal progression or they may advance to step 14 of phase 1. This step is intended specifically for pitchers and involves 10 to 15 throws at progressive distances of 18.3, 27.4, and 36.6 m (60, 90, and 120 ft, respectively), followed by flat-ground throwing from 18.3 m (60 ft) using nor-

TABLE 2. Interval throwing program for baseball players: phase 1.*

45-Ft Phase	60-Ft Phase	90-Ft Phase	120-Ft Phase
Step 1: A) Warm-up throwing B) 45 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 45 ft, 25 throws	Step 3: A) Warm-up throwing B) 60 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 60 ft, 25 throws	Step 5: A) Warm-up throwing B) 90 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 90 ft, 25 throws	Step 7: A) Warm-up throwing B) 120 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 120 ft, 25 throws
Step 2: A) Warm-up throwing B) 45 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 45 ft, 25 throws F) Rest 5–10 min G) Warm-up throwing H) 45 ft, 25 throws	Step 4: A) Warm-up throwing B) 60 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 60 ft, 25 throws F) Rest 5–10 min G) Warm-up throwing H) 60 ft, 25 throws	Step 6: A) Warm-up throwing B) 90 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 90 ft, 25 throws F) Rest 5–10 min G) Warm-up throwing H) 90 ft, 25 throws	Step 8: A) Warm-up throwing B) 120 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 120 ft, 25 throws F) Rest 5–10 min G) Warm-up throwing H) 120 ft, 25 throws
150-Ft Phase		**180-Ft Phase**	
Step 9: A) Warm-up throwing B) 150 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 150 ft, 25 throws	Step 11: A) Warm-up throwing B) 180 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 180 ft, 25 throws	Step 13: A) Warm-up throwing B) 180 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 180 ft, 25 throws F) Rest 5–10 min G) Warm-up throwing H) 180 ft, 20 throws I) Rest 5–10 min J) Warm-up throwing K) 15 throws, progressing from 120 to 90 ft	Note: All throws should be on an arc with a crow hop. Warm-up throws consist of 10 to 20 throws at approximately 30 ft. Throwing program should be performed every other day, 3 times per week unless otherwise specified by a physician or rehabilitation specialist. Perform each step _____ times before progressing to next step.
Step 10: A) Warm-up throwing B) 150 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 150 ft, 25 throws F) Rest 5–10 min G) Warm-up throwing H) 150 ft, 25 throws	Step 12: A) Warm-up throwing B) 180 ft, 25 throws C) Rest 5–10 min D) Warm-up throwing E) 180 ft, 25 throws F) Rest 5–10 min G) Warm-up throwing H) 180 ft, 25 throws	Step 14: Return to respective position or progress to step 14 below.	
Flat-Ground Throwing for Baseball Pitchers			
Step 14: A) Warm-up throwing B) 60 ft, 10–15 throws C) 90 ft, 10 throws D) 120 ft, 10 throws E) 60 ft (flat-ground) using pitching mechanics, 20–30 throws		Step 15: A) Warm-up throwing B) 60 ft, 10–15 throws C) 90 ft, 10 throws D) 120 ft, 10 throws E) 60 ft (flat-ground) using pitching mechanics, 20–30 throws F) 60–90 ft, 10–15 throws G) 60 ft (flat-ground) using pitching mechanics, 20 throws	
Progress to phase 2: throwing off the mound			

* 45 ft = 13.7 m; 60 ft = 18.3 m; 90 ft = 27.4 m; 120 ft = 36.6 m; 150 ft = 45.7 m; 180 ft = 54.8 m.

mal pitching mechanics, thereby initiating throws on a straight line without an arc and crow hop.

After the pitcher can perform phase 1 without symptoms, he is ready to progress to phase 2: throwing off the mound (Table 3). Just as the advancement to this phase was gradual and progressive, so must the return to unrestricted pitching follow the same principles. The length of phase 2 is determined specifically for each athlete. A pitcher should first throw only fastballs at 50% effort, and progress to 75% and 100% effort. The use of a radar gun may be helpful to assist in effort control.

Phase 2 of the interval throwing program begins by using the 36.6-m (120-ft) step of phase 1 as a warm-up. The pitcher then throws 15 throws off the mound using full wind-up pitching mechanics at 50% effort. As the player progresses through phase 2, the number of pitches as well as the percent effort of throwing is gradually advanced until the athlete is allowed to pitch light batting practice. At this time, the player may start more stressful pitches such as breaking balls, as well as the initiation of simulated games.

In the event that an injury occurs during the competitive season, an abbreviated interval throwing program is used in conjunction with a rehabilitation program (Table 4). The program is designed to expediently return the athlete to competition within 21 days.

Little League Interval Throwing Program

The little league interval throwing program (Table 5) parallels the previously outlined interval throwing program in providing the youth baseball player with

TABLE 3. Interval throwing program, phase 2: throwing off the mound.*†

Stage 1: Fastballs Only		
Step 1:	A)	Interval throwing‡
	B)	15 throws, 50%
Step 2:	A)	Interval throwing‡
	B)	30 throws, 50%
Step 3:	A)	Interval throwing‡
	B)	45 throws, 50%
Step 4:	A)	Interval throwing‡
	B)	60 throws, 50%
Step 5:	A)	Interval throwing‡
	B)	70 throws, 50%
Step 6:	A)	45 throws, 50%
	B)	30 throws, 75%
Step 7:	A)	30 throws, 50%
	B)	45 throws, 75%
Step 8:	A)	10 throws, 50%
	B)	65 throws, 75%
Stage 2: Fastballs Only		
Step 9:	A)	60 throws, 75%
	B)	15 throws, batting practice
Step 10:	A)	50–60 throws, 75%
	B)	30 throws, batting practice
Step 11:	A)	45–50 throws, 75%
	B)	45 throws, batting practice
Stage 3		
Step 12:	A)	30 throws, 75%
	B)	15 throws, 50%, begin breaking balls
	C)	45–60 throws, batting practice, fastball only
Step 13:	A)	30 throws, 75%
	B)	30 breaking balls, 75%
	C)	30 throws, batting practice
Step 14:	A)	30 throws, 75%
	B)	60–90 throws, batting practice, gradually increase breaking balls
Step 15:	A)	Simulated game: progressing by 15 throws per workout (pitch count)

* Represents percentage effort.
† All throwing off the mound should be done in the presence of a pitching coach or sport biomechanist to stress proper throwing mechanics (use speed gun to aid in effort control).
‡ Use interval throwing 120-ft (36.6-m) phase as warm-up.

TABLE 4. Short-duration interval throwing program.*

Day 1:	A) 45 ft, 30 throws B) 60 ft, 30 throws	**Day 11:**	A) 60 ft, 50 throws B) 90 ft, 20 throws C) 120 ft, 60 throws D) 60 ft, 20 throws
Day 2:	A) 45 ft, 45 throws B) 60 ft, 45 throws	**Day 12:**	A) Rest
Day 3:	A) 60 ft, 125 throws	**Day 13:**	A) 60 ft, 100 throws B) Bullpen pitching, fastballs only, 25 pitches, 75% effort
Day 4:	A) 60 ft, 85 throws B) 90 ft, 30 throws C) 60 ft, 20 throws	**Day 14:**	A) 45 ft, 50 throws B) 90 ft, 30 throws C) 120 ft, 20 throws D) 45 ft, 50 throws
Day 5:	A) Rest	**Day 15:**	A) 60 ft, 100 throws B) Bullpen pitching, fastballs and change-ups, 35 pitches, 80% effort
Day 6:	A) 60 ft, 100 throws B) 90 ft, 30 throws C) 60 ft, 20 throws	**Day 16:**	A) Rest
Day 7:	A) 60 ft, 50 throws B) 90 ft, 50 throws C) 60 ft, 50 throws	**Day 17:**	A) 60 ft, 100 throws B) Bullpen pitching, all pitches, 45 pitches, 100% effort
Day 8:	A) 60 ft, 50 throws B) 90 ft, 50 throws C) 120 ft, 25 throws D) 60 ft, 20 throws	**Day 18:**	A) 45 ft, 50 throws B) 90 ft, 30 throws C) 120 ft, 20 throws D) 45 ft, 50 throws
Day 9:	A) Rest	**Day 19:**	A) Simulated game, 25 pitches
Day 10:	A) 60 ft, 50 throws B) 90 ft, 20 throws C) 120 ft, 50 throws D) 60 ft, 20 throws	**Day 20:**	A) 45 ft, 50 throws B) 90 ft, 30 throws C) 120 ft, 20 throws D) 45 ft, 50 throws
		Day 21:	A) Game, 25–35 pitches

* 45 ft = 13.7 m; 60 ft = 18.3 m; 90 ft = 27.4 m; 120 ft = 36.6 m.

a graduated progression of throwing distances. Alterations are made based on the size of little league fields and the distance from home plate to the mound, compared to high school and adult playing situations. Similar warm-up and flexibility exercises are incorporated. The little league player begins throwing with a warm-up consisting of lobbing the ball 4.6 to 6.1 m (15 to 20 ft). The player then performs 2 sets of 25 throws at 9.1 m (30 ft) with a 15-minute rest in between. As the athlete progresses, 3 sets of 25 throws are initiated. The little league player progresses from 9.1 to 13.7, 18.3, and 27.4 m (30 to 45, 60, and 90 ft, respectively), and follows with positional drills and pitching off the mound similar to phase 2 of the interval throwing program.

Interval Tennis Program

The interval tennis program (Table 6) is used for athletes returning to racquet sports such as tennis and racquetball. The same general principles of any ISP should be followed before initiating the interval tennis program.

The interval tennis program is divided into approximately 4 to 6 weeks of progressive participation. Proper biomechanics should be emphasized including a full follow-through of each shot. The first 2 weeks involve a gradual progression of forehand and backhand shots, applying 50% effort during week 1 and 75% effort during week 2. If the athlete can tolerate the latter, the athlete may progress to serving the ball at 50% effort during weeks 3 through 4. At weeks 4 through 6, the athlete may progress to full-

TABLE 5. Little league interval throwing program.*

	30-Ft Phase		45-Ft Phase
Step 1:	A) Warm-up throwing B) 30 ft, 25 throws C) Rest 15 min D) Warm-up throwing E) 30 ft, 25 throws	**Step 3:**	A) Warm-up throwing B) 45 ft, 25 throws C) Rest 15 min D) Warm-up throwing E) 45 ft, 25 throws
Step 2:	A) Warm-up throwing B) 30 ft, 25 throws C) Rest 10 min D) Warm-up throwing E) 30 ft, 25 throws F) Rest 10 min G) Warm-up throwing H) 30 ft, 25 throws	**Step 4:**	A) Warm-up throwing B) 45 ft, 25 throws C) Rest 10 min D) Warm-up throwing E) 45 ft, 25 throws F) Rest 10 min G) Warm-up throwing H) 45 ft, 25 throws
	60-Ft Phase		**90-Ft Phase**
Step 5:	A) Warm-up throwing B) 60 ft, 25 throws C) Rest 15 min D) Warm-up throwing E) 60 ft, 25 throws	**Step 7:**	A) Warm-up throwing B) 90 ft, 25 throws C) Rest 15 min D) Warm-up throwing E) 90 ft, 25 throws
Step 6:	A) Warm-up throwing B) 60 ft, 25 throws C) Rest 10 min D) Warm-up throwing E) 60 ft, 25 throws F) Rest 10 min G) Warm-up throwing H) 60 ft, 25 throws	**Step 8:**	A) Warm-up throwing B) 90 ft, 20 throws C) Rest 10 min D) Warm-up throwing E) 60 ft, 20 throws F) Rest 10 min G) Warm-up throwing H) 45 ft, 20 throws I) Rest 10 min J) Warm-up throwing K) 45 ft, 15 throws

* 30 ft = 9.1 m; 45 ft = 13.7 m; 60 ft = 18.3 m; 90 ft = 27.4 m.

TABLE 6. Interval tennis program.*

	Monday	Wednesday	Friday
Week 1	12 FH 8 BH 10-min rest 13 FH 7 BH	15 FH 8 BH 10-min rest 15 FH 7 BH	15 FH 10 BH 10-min rest 15 FH 10 BH
Week 2	25 FH 15 BH 10-min rest 25 FH 15 BH	30 FH 20 BH 10-min rest 30 FH 20 BH	30 FH 25 BH 10-min rest 30 FH 25 BH
Week 3	30 FH 25 BH 10 SR 10-min rest 30 FH 25 BH 10 SR	30 FH 25 BH 15 SR 10-min rest 30 FH 25 BH 15 SR	30 FH 30 BH 15 SR 10-min rest 30 FH 15 SR 10-min rest 30 FH 30 BH 15 SR
Week 4	30 FH 30 BH 10 SR 10-min rest Play 3 games 10 FH 10 BH 5 SR	30 FH 30 BH 10 SR 10-min rest Play set 10 FH 10 BH 5 SR	30 FH 30 BH 10 SR 10-min rest Play 1.5 sets 10 FH 10 BH 3 SR

* SR = serves; FH = forehand shots; BH = backhand shots.

effort forehand and backhand shots and serves at 75% effort. Playing is initiated by progressing from 3 games to 1.5 sets. Upon completion of the interval tennis program, the athlete may begin playing full matches as tolerated.

Interval Golf Program (IGP)

The IGP (Table 7) follows a progression of approximately 5 weeks. Shots involving full golf swings are initiated using a progression from short irons (wedges, 9-iron, and 8-iron), medium irons (7-iron, 6-iron, and 5-iron), long irons (4-iron, 3-iron, and 2-iron), fairway woods (5-wood and 3-wood), to the driver to allow the progression of force production. The golfer is encouraged to begin using each club with a tee to avoid the deleterious forces that may be produced during a divot. Swings are initiated at partial effort and progressed to full effort as tolerated.

The first week begins with light putting and chipping drills and progresses to light short-iron shots by the end of the week. Medium irons are initiated during week 2 while the number of shots is increased. Putting and chipping are performed throughout to allow for an active period of rest between sets of iron shots. Long irons are begun at the beginning of week 3, followed by the initiation of fairway woods. Again, the number of shots using each iron and wood is progressed, until the use of the driver is initiated at week 4. If the golfer progresses through the IGP without complaints, 9 holes of golf are allowed at the end of week 4 and increased to 18 holes by the end of the fifth week. As with any ISP, proper biomechanics are essential throughout the progression.

SUMMARY

In using an ISP in conjunction with a structured rehabilitation program, the athlete should be able to return to full competition status. The general guidelines and specific programs outlined are used to minimize the chance of reinjury and to facilitate the return of function and confidence in the athlete. The program and its progression should be modified to meet the specific needs of each individual athlete. A comprehensive program consisting of a proper maintenance rehabilitation program incorporating strengthening, flexibility, plyometric, dynamic stabilization, and neuromuscular controls drills, as well as appropriate warm-up procedures and biomechanics, is essential in returning athletes to competition as quickly and safely as possible.

TABLE 7. Interval golf program.*

	Monday	Wednesday	Friday
Week 1	10 putts 10 chips 5-min rest 15 chips	15 putts 15 chips 5-min rest 25 chips	20 putts 20 chips 5-min rest 20 putts 20 chips 5-min rest 10 chips 10 short irons
Week 2	20 chips 10 short irons 5-min rest 10 short irons 15 medium irons (5-iron off tee)	20 chips 15 short irons 10-min rest 15 short irons 15 chips Putting 15 medium irons	15 short irons 20 medium irons 10-min rest 20 short irons 15 chips
Week 3	15 short irons 20 medium irons 10-min rest 15 short irons 15 medium irons 5 long irons 10-min rest 20 chips	15 short irons 15 medium irons 10 long irons 10-min rest 10 short irons 10 medium irons 5 long irons 5 wood	15 short irons 15 medium irons 10 long irons 10-min rest 10 short irons 10 medium irons 10 long irons 10 wood
Week 4	15 short irons 15 medium irons 10 long irons 10 drives 15-min rest Repeat	Play 9 holes	Play 9 holes
Week 5	Play 9 holes	Play 9 holes	Play 18 holes

* Chips = pitching wedge; short irons = wedge, 9-iron, 8-iron; medium irons = 7-iron, 6-iron, 5-iron; long irons = 4-iron, 3-iron, 2-iron; woods = 3-wood, 5-wood; drives = driver.

REFERENCES

1. Axe MJ, Snyder-Mackler L, Konin JG, Strube MJ. Development of a distance-based interval throwing program for little-league-aged athletes. *Am J Sports Med.* 1996;24:594–602.
2. Axe MJ, Wickham R, Snyder-Mackler L. Data-based interval throwing programs for little league, high school, college, and professional baseball pitchers. *Sports Med Arthrosc Rev.* 2001;9:24–34.
3. Ellenbecker TS, Mattalino AJ. *The Elbow in Sport: Injury, Treatment, and Rehabiliation.* Champaign, IL: Human Kinetics; 1997.
4. Fleisig GS, Escamilla RF, Barrentine SW, Zheng N, Andrews JR. Kinematic and kinetic comparison of baseball pitching from a mound and throwing from flat ground. *Twentieth Annual Meeting of the American Society of Biomechanics.* Atlanta, GA: American Society of Biomechanics; 1996:153–154.
5. Fleisig GS, Zheng, Barrentine SW, Escamilla RF, Andrews JR, Lemak LJ. Kinematic and kinetic comparison of full-effort and partial-effort baseball pitching. *Twentieth Annual Meeting of the American Society of Biomechanics.* Atlanta, GA: American Society of Biomechanics; 1996:155–156.
6. Wilk KE, Andrews JR, Arrigo CA, et al. *Preventive and Rehabilitative Exercises for the Shoulder and Elbow.* 6th ed. Birmingham, AL: American Sports Medicine Institute; 2001.
7. Wilk KE, Andrews JR, Arrigo CA, et al. The strength characteristics of the internal and external rotator muscles in professional baseball pitchers. *Am J Sports Med.* 1993;21:61–69.
8. Wilk KE, Arrigo CA, Andrews JR. The abductor and adductor strength characteristics of professional baseball pitchers. *Am J Sports Med.* 1995;23:307–311.
9. Wilk KE, Arrigo CA. Current concepts in the rehabilitation of the athlete shoulder. *J Orthop Sports Phys Ther.* 1993;18:365–378.
10. Wilk KE, Reinold MM, Andrews JR. Postoperative treatment principles in the throwing athlete. *Sports Med Arthrosc Rev.* 2001;9:69–95.
11. Wilk KE, Reinold MM, Dugas JR, Andrews JR. Rehabilitation following thermal-assisted capsular shrinkage of the glenohumeral joint: current concepts. *J Orthop Sports Phys Ther.* 2002;32:268–292.