PRESSURE-POSITION RELATIONS IN THE GLENOHUMERAL JOINT

T. LIND, P. J. H. BLYME, H. H. STRANGE-VOGNSEN, J. BAGGER

The intra-articular pressures in the glenohumeral joint in different positions were measured in 12 cadaveric shoulders. The lowest pressure was found in abduction combined with traction. A significant rise in pressure was seen in positions combining flexion or abduction with rotation. The injected volume to produce a certain pressure as well as the maximum pressure attained in each shoulder showed great variation. These factors are important considerations for immobilization of the shoulder and manipulation during arthroscopy.

Keywords : glenohumeral joint ; intra-articular pressure.
Mots-clés : articulation gléno-humérale ; pression intra-articulaire.

The intra-articular pressure in the glenohumeral joint has been described in relation to increasing volumes during arthrography (1, 4), and in relation to movements in isolated planes (2, 5). Manipulation of the glenohumeral joint during arthroscopy or immobilization in a fixed sling moves the joint in more than one plane.

The purpose of this study was to measure the pressure changes in the glenohumeral joint in combined planes of motion and to clarify the significance of intra-articular effusion on these pressure changes.

MATERIAL AND METHODS

The material consisted of 10 cadaveric shoulders with no history of previous shoulder disease. Two were omitted because of early extravasation due to rupture.

The pressure was recorded using a simple water manometer system attached to a 1.4-mm cannula through a 3-way stopcock. The cannula was introduced anteriorly approximately 1 cm lateral and distal to the coracoid process. Starting pressure was 10 cm H_2O (7.4 mm Hg) in the first series ans 20 cm H_2O (14.7 mm Hg) in the second. Each series consisted of pressure recordings in 6 shoulders. The neutral position was defined as one of 10° of abduction and 0° flexion and rotation. The glenohumeral pressure in neutral position was checked between each measurement to ensure the correct level. At the end of the recordings the pressures were to be within the range of 5 cm H_2O compared with the initial pressures. The different joint positions are listed in table I. The traction applied was 5 kg.

Mean values and the first and third quartiles were used for the statistical description. The Wilcoxon rank sum test was applied for statistical analysis.

RESULTS

The recordings and statistical calculations appear in table I. The relative pressure changes are almost identical in the two series. Flexion combined with internal rotation produces a significant rise in intra-articular pressure. Traction and traction combined with abduction significantly lowered the intra-articular pressure.

An injected volume of 8 to 15 ml of saline produced the initial pressure of 10 cm H_2O, whereas 12 to 24 ml was necessary to achieve 20 cm H_2O. This change produced an increase of 1.7 (1.4 to 2.2) times the measured pressures in the first series.

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Table I. — Pressure-position relations in the glenohumeral joint
Pressure recorded in cm H_2O

	Pressure				Pressure			
	1. Initial pressure = 10 cm H_2O				2. Initial pressure = 20 cm H_2O			
Position	Median	1. and 3. quartile	Range	Wilcoxon[a] p (two-tailed)	Median	1. and 3. quartile	Range	Wilcoxon p (two-tailed)
Neutral	10.0	9.8-11.5	9-13		20.0	18.5- 20.3	17- 21	
Traction	6.5	4.8- 8.0	4- 8	0.03	14.0	12.5- 14.0	11- 14	0.03
90° IR[b] + 20° F[c]	33.5	26.0-50.0	23-80	0.03	58.5	51.8- 84.3	45-112	0.03
60° Abduction	8.5	5.5-10.8	4-13	0.13	14.5	11.5- 17.3	4- 21	0.06
60° A[d] + Traction	8.0	5.0- 8.8	2-11	0.03	13.0	9.0- 15.3	3- 19	0.03
A + 45° ER[e]	13.5	10.0-19.3	7-26	0.19	26.0	18.8- 35.5	12- 43	0.15
A + 45° IR	15.0	8.8-32.0	8-59	0.22	32.0	21.5- 42.8	20- 57	0.03
A + max. IR	35.0	24.8-67.5	24-75	0.03	65.0	42.0- 78.0	30- 81	0.03
Flexion 45°	18.0	11.5-29.0	10-35	0.06	26.5	23.8- 29.5	20- 31	0.03
Flexion 90°	28.0	14.5-70.8	14-81	0.12	46.0	41.0- 55.0	41- 55	0.25
Extension 45°	28.5	22.3-45.3	14.58	0.03	46.5	36.3- 51.8	31- 57	0.03
Extension 70°	63.5	54.5-75.3	53-82	0.03	87.0	73.5-116.0	57-119	0.03

[a] Significance level : 0.05 ; [b] Internal rotation ; [c] Flexion ; [d] Abduction ; [e] External rotation.

Considerable variation is present regarding the maximum pressure attained in each shoulder, which varied from 3 to 8 times the initial pressure.

DISCUSSION

The results of this study regarding the pressure changes in isolated planes of motion are similar to those found by Eyring & Murray (2), who used almost the same technique.

The greatest increases in pressure were recorded in the different combined planes of motion where the course of the glenohumeral ligaments (6) and the posterior capsule causes a tightening. In the anesthetized and relaxed patient similar pressure changes presumably will take place during arthroscopy. The initial position of abduction and traction is seen to be optimal. There is a noteworthy steep pressure rise during rotational manipulation, and this pressure rise is highly dependent on the initial filling volume. Resnik *et al.* (4) showed that the maximum volume of injected fluid in cadaveric glenohumeral joints prior to rupture varied from 29 to 90 ml. These results and our data indicate the differences in capsular compliance and the difficulty in predicting the risk of rupture and extravasation of fluid in the surrounding tissue during arthroscopy.

In accordance with Eyring & Murray (4), the position of minimum pressure was found to be one of approximately 30 to 40° of abduction and neutral flexion and rotation.

Placing the extremity in a fixed sling causes a significant rise in pressure which, depending on the amount of glenohumeral effusion, could exceed the arteriolar pressure and thereby compromise blood flow (3). In this respect it is important to note that the recorded rise in pressure is greater for a given volume of injected fluid during in vivo measurements (1, 4, 5).

REFERENCES

1. Björkenheim J. M., Paavolainen P., Ahovou J., Slätis P. The intra-articular pressure during shoulder arthrography. A diagnostic aid in rotator cuff tear. Acta Orthop. Scand., 1987, 58, 128-129.
2. Eyring E. J., Murray W. R. The effect of joint position on the pressure of intra-articular effusion. J. Bone Joint Surg., 1964, 46-A, 1235-1241.
3. Lucht U., Bünger C., Krebs B., Hjermind J., Bülow J. Blood flow in the juvenile hip in relation to changes of

the intra-articular pressure. An experimental investigation in dogs. Acta Orthop. Scand., 1983, 54, 182-187.
4. Resnik C. S., Fronek J., Frey G., Gershuni D., Resnik D. Intra-articular pressure determination during glenohumeral joint arthrography. Preliminary investigation. Invest. Radiol., 1984, 19, 45-50.
5. Shibata Y. Intra-articular pressure of the glenohumeral joint during movement. Igaku Kenkyu (Jap.), 1987, 54, 177-201.
6. Turkel S. J., Panio M. W., Marshall J. L., Girgis F. G. Stabilizing mechanisms preventing anterior dislocation of the glenohumeral joint. J. Bone Joint Surg., 1981, 63-A, 1208-1217.

SAMENVATTING

T. LIND, P. J. H. BLYME, H. H. STRANGE-VOGNSEN en J. BAGGER. Intra-articulaire druk in het schoudergewricht volgens de stand.

De intra-articulaire druk van het gleno-humeraal gewricht werd in verschillende standen gemeten, op 12 lijken.
De laagste druk werd gevonden bij abductie, samen met tractie. De druk steeg opmerkelijk bij flexie of abductie, geassocieerd aan rotatie. Het volume dat moest ingebracht worden om een zekere druk te bekomen en de maximaal gemeten druk, varieerden aanzienlijk bij elke schouder. Deze gegevens zijn belangrijk bij de keuze van een immobilisatiestand of bij arthroscopische manipulaties.

RÉSUMÉ

T. LIND, P. J. H. BLYME, H. H. STRANGE-VOGNSEN et J. BAGGER. Étude de la pression intra-articulaire dans l'articulation gléno-humérale en fonction de la position.

La pression intra-articulaire dans l'articulation gléno-humérale, dans différentes positions, a été mesurée sur 12 spécimens cadavériques. La pression la plus basse fut constatée en abduction combinée à la traction. Une augmentation de pression a été observée dans les positions associant la flexion ou l'abduction à la rotation.
Le volume à injecter pour obtenir une certaine pression, ainsi que le degré de pression maximale obtenue dans chaque articulation, ont été très variables. Ces facteurs sont importants dans le choix des positions d'immobilisation de l'épaule et lors des manipulations arthroscopiques.