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PARTIAL SYNOVECTOMY OF THE KNEE JOINT

BY

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For more than fifty years synovectomy, either partial or complete, has been performed in cases of chronic hydrops of the knee joint. Only during the past 20-25 years, however, has this operation been used on a large scale, and it has been mainly through the work of *Swett* that synovectomy has become more widely known. Over a number of years a fairly large number of results have been published. On the whole, the results are reported to be good, but in some publications either the time of observation has been too short or the material has been too small to allow a satisfactory estimation of the late results.

Persistent hydrops has been thought to be due either to occlusion of the paths of drainage from the knee joint, or to faulty resorption due to various pathological changes. The aim of synovectomy has been to create new resorption paths. Since drainage takes place mainly through the suprapatellar bursa (*D. H. Kling, Mayeda,* and others) surgery has usually been confined to extirpation of this bursa (partial synovectomy).

A large number of experimental investigations have been made in attempts to throw more light on the problem of disturbed resorption, and a vast literature has been published on the subject. Only publications that can be of interest in the present study will be mentioned here. *Bauer et al., Efskind,* and others found that protein substances are only, or mainly,

resorbed through the lymph channels, whereas the crystalline substances are resorbed through the blood channels (*Efskind, Kuhns*).

Gerota and *Notkins* demonstrated that the possibilities of resorption from the joint are decreased in inflammatory synovitis. *Kuhns* considered that he could show experimentally that the possibilities for the resorption of particles larger than the size of one molecule are diminished in inflammatory changes in the joint, whereas resorption returns to normal when these changes have regressed. A persistent irritative condition causes a decrease in the resorptive function of the lymphatic vessels (*Kuhns*). According to *Efskind,* lymphatic drainage is decreased in pyarthrosis and for a time after total synovectomy. He also believed that there was a transient decrease in the resorption capacity after uncomplicated arthrotomy. Others, e.g. *Rostock,* believe that in empyema of the knee joint there is a rapid increase in the power of resorption, which is more effective than with aseptic exudate. *Efskind* performed clinical resorption experiments with perabrodil and indigo carmine (crystalline substances) and found that their resorption was decreased after total synovectomy and in pyarthrosis. A number of writers (*J. A. Key, W. Bauer et al.*) believe that an active phagocytic resorption of attrition products from the joint cartilage and the synovia occurs. The experimental investigations are less convincing, as they were performed on animals, whose knee joints are neither anatomically nor functionally similar to those in man. Further, the substances used were foreign to the organism and cannot, therefore, be considered to show the physiological conditions in man.

It is probable that hydrops has been regarded too much as a problem of resorption. We have very little definite knowledge of how either the normal synovia is formed or the pathological exudate takes place, but it is just as reasonable to regard a morbid increase of fluid in the joint as the result of an increased rate of formation of joint fluid as of impaired resorption.

Many writers have stressed that at present no definite

rules can be laid down for the indications for synovectomy, and that the cases should be selected carefully (*Allison, Bernstein, Speed, Swett* and others). Since our knowledge of the physiology and pathology of the knee joint is very incomplete, the decision regarding synovectomy must depend entirely on the surgeon's experience and view of the individual case. *Bernstein*'s statement that "no rules can be established for the performance of synovectomy" can be considered as representing the general opinion on the indications for this operation. The results of synovectomy must be judged against this background.

THE WRITER'S MATERIAL[1]

The material reported here consists of 36 partial synovectomies performed on 34 patients (18 males and 16 females). The average age at operation was 35 years. Table I shows the duration of the disease and the observation period.

In order to assess the results found at follow-up examina-

TABLE I

	Polyarthritis 14 patients: 15 synovectomies	Cases of unknown or uncertain origin 20 patients: 21 synovectomies
Average duration of disease before operation	5.0 years	5.6 years
Average age at operation	37.8 years	32.8 years
Average time between operation and follow-up examination	4.4 years	5.9 years

[1] The material derives from the Orthopaedic Clinic (Head: Professor S. Friberg) of Karolinska Institutet, Stockholm, the Orthopaedic Clinic (Head: Professor G. Wiberg) in Lund and from Vanföreanstalten (Head: Dr. H. Camitz, M.D.) in Gothenburg. I wish to express my thanks to the Heads of the respective Hospitals for their kindness in placing the material at my disposal.

tion it is important to try to classify the material according to aetiology. One group, i.e. cases with chronic polyarthritis, can be distinguished from the rest with a fair degree of certainty. The rest are probably heterogeneous as regards aetiology. The aetiology will be considered further when the cases are discussed.

Guinea-pig tests and bacterial cultures of the exudate were done on practically every case, but the results were uniformly negative.

Since the patients came from all parts of the country, it was not possible for the writer to follow-up each case personally. A questionnaire was therefore sent to each patient, the questions being formulated so that there would be no difficulty in giving a correct answer. All except two patients answered. 16 patients were examined personally by the writer, in a few cases on several occasions. Since many of the patients—usually those with polyarthritis—were treated at other hospitals after operation, the statements made in reply to the questionnaire could be checked.

Operative Technique.

Partial synovectomy, consisting of extirpation of the suprapatellar bursa, was performed on all the cases. As several different surgeons operated, the technique was not always uniform in individual details The incision was either a lateral or a medial parapatellar incision. The writer personally prefers the former, which affects the muscle less than the medial incision. With the latter it is impossible to avoid injury to the vastus medialis, which extends further distally than the vastus lateralis.—The suprapatellar bursa can be easily peeled out bluntly, with the exception of the anterior aspect, where it is nearly always closely attached to the tendon of the rectus femoris muscle.

After synovectomy, synovial cells reappear, presumably by metaplasia of the subsynovial tissue components (*Segale, J. A. Key, Walcott* etc.). Regeneration appears to take place fairly rapidly. According to *Segale,* it is completed 21 days after partial synovectomy. *Swett* found in two cases "a re-

TABLE II

Cases With Polyarthritis.

Case	Sex	Age at onset	Age at operation	Time of observation in years	Primary result of operation	Result of operation at follow-up	Comments
1. O.F.N.J. G[1] 12889	♂	27	36	5	Exudate	Exudate	Both knee joints affected. S.R. before op. 5 mm/1 hr. 1 yr. after operation exudate still present. No pain.
2. A.J. G 13190	♀	32	48	5	Exudate	Exudate	Both knee joints affected. S.R. before op. 27 mm/1 hr. 6 mths. after op. exudate still present. Doing full-time housework. No pain.
3. O.F. G 15338	♂	46	51	7	No exudate	No exudate	Most limb joints affected. Unable to return to former work (heavy manual labour).
4.* J.B. G 18602	♂	40	41	9	Exudate	Exudate	The knee joints mainly affected. S.R. before op. 10 mm/1 hr. No pain. Suggestion of flexion contracture.
5. N.N.P. G 24736	♂	19	26	5	Exudate	No exudate	Most limb joints affected. S.R. before op. 30 mm/hr. Pain after operation.
6. S.S.S. G 24083	♀	40	46	7	Exudate	Exudate	Most limb joints affected. S.R. before op. 32 mm/hr. Pain and flexion contracture. 4 yrs. after synovectomy, arthrodesis of the knee joint. Severely invalidized.

TABLE II (cont.)

Case	Sex	Age at onset	Age at operation	Time of observation in years	Primary result of operation	Result of operation at follow-up	Comments
7a. K.G.B. G 27448	♂ Right knee	11	14	5	Exudate	No exudate	Knee and ankle joints affected. S.R. before 1st op. 14 mm/hr. 6 mths. after operation exudate still present in right knee, left knee: N.A.D. No pain.
7b. K.G.B. G 27448	Left knee	»	»	»	Exudate	No exudate	
8. K.L. L 511/40	♀	23	34	5	Exudate	Exudate	Knee joints mainly affected. S.R. before op. 5 mm/1 hr. Intermittent pain.
9. K.G.B. G 29983	♂	31	40	4	Exudate	Exudate	Both knee, hand and ankle joints affected. Pain in knee. Unable to walk without stick.
10. I.L.P. L	♀	21	26	2	Exudate	Exudate	Knee and ankle joints affected. S.R. before op. 25 mm/1 hr. Pain in knee.
11. E.G. L 564/42	♀	31	34	3	No exudate	No exudate	Nearly all limb joints affected. S.R. before op. 56 mm/hr. No pain in knee. *n.b.* Synovectomy + extirpation of the patella.

TABLE II (cont.)

Case	Sex	Age at onset	Age at operation	Time of observation in years	Primary result of operation	Result of operation at follow-up	Comments
12. J.B.B. S 4765/42	♂	51	56	3	No exudate	No follow-up examination	S.R. before op. 15 mm/hr.
13. T.L. L 209/42	♂	27	29	3	No exudate	Exudate	Most limb joints affected. S.R. before op. 72 mm/hr. Pain in operated knee with change in weather. Not working, owing to involvement of other joints.
14.* N.M. L 370/43	♀	50	57	2	No exudate	No exudate	Most limb joints affected. S.R. before op. 8 mm/hr. Discomfort from knee constant after operation.

[1] L and G in the first column denote whether the patient was treated at the Orthopaedic Clinic in Lund or at the Vanföreanstalt in Gothenburg.

* = Follow-up examination made personally by the writer.

placement of synovial membrane with no evidence of scar-tissue" after "several months".

Cases With Chronic Polyarthritis (table II).

This group comprises 14 patients (15 synovectomies). 13 patients (14 synovectomies) were followed up. A detailed account of the cases or case-histories of the individual patients is of little interest; all showed the classical symptoms of polyarthritis. Table II shows some relevant data. Synovectomy had in every case been preceded for many years by various treatments at special hospitals for rheumatic diseases.

If the *primary* results of operation are considered[2], it is found that only 5 of the 15 synovectomied knees became free from exudate. A further 3 cases (amongst them the patient with bilateral hydrops) became free from exudate during the period between operation and follow-up examination, whereas one case, which had primarily been free from exudate had relapsed.

Thus at the *follow-up examination* only 6 cases were free from exudate (one patient was not examined), i.e. approximately 40 per cent. These results agree fairly well with those of *Inge* for synovectomy in chronic polyarthritis. In 26 of *Inge's* cases, which had an average age of 37.1 years at operation and an average observation time of 5.6 years (thus comparable with the material reported here), the results of the operation were good in only 50 per cent of the cases. Other reports point in the same direction (*Boon-Itt, Massarol,* and others).

For many reasons it would seem inadvisable to operate during the active stage of the condition; but in cases of polyarthritis it is difficult to find the best time for synovectomy. The progression and regression of the disease may be followed by the sedimentation rate, and it is tempting to assume that patients who have had a low sedimentation rate for a long time, so that the disease can be presumed to be in a regressive state, would be more suitable subjects for operation than those with high rates, suggesting active infection. Examination of the cases in the present series showed that of the 9 cases *with hydrops* immediately after the operation, 5 had normal or only slightly raised sedimentation rates immediately before operation and 4 had considerably raised rates[3]. Of the 4 cases *without hydrops* immediately after synovectomy, 2 had normal or subnormal rates and 2 very high rates pre-operatively[4]. (In 2 patients the sedimentation rate had not been measured).

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[2] The term "primary results of operation" covers the condition during the months immediately following the operation.

[3] Cases 1, 4, 7a and b and 8, and Cases 2, 5, 6, and 10 respectively.

[4] Cases 12, 14 and 11, 13 respectively.

Follow-up examination showed that of the patients *with hydrops,* 3 had had low sedimentation rates before operation, and 4 had had very high rates. Of the 6 cases which were *free* from exudate at the *follow-up examination,* the sedimentation rate had been normal in 3 and raised in 2 (one case was not re-examined). Although there are only a few cases in each group, the figures show that the *sedimentation rate need not greatly influence the decision regarding synovectomy in cases of chronic polyarthritis.*

The age at onset and duration of the disease showed no appreciable differences in the cases with and without post-operative exudate, nor did the extent of the disease appear to affect the prognosis. Both cases with involvment of only a few joints, and cases in which practically all the joints of the limbs showed pathological changes, were equally represented amongst those with and without post-operative hydrops.

Unfortunately, the knee joint was examined radiographically before operation in only 6 cases[5]. In case 7, radiography two years before synovectomy showed slight bilateral calcium reduction. There was a primary post-operative exudate in both knees, which was not present at the follow-up examination. Cases 11 and 12 were examined radiographically 2 and 4 years respectively before synovectomy; both had a severe arthrosis deformans with reduced joint space and osteophytes. In case 11 there was never any exudate after operation. Case 12 was not followed up. Cases 8, 9 and 13 (radiography 5, 1 and 2 months respectively before operation) showed moderate arthrosis deformans with insignificant reduction of the joint space. In cases 8 and 9 the exudate persisted after operation, whereas in case 13 there was no primary post-operative exudate although it occurred later.

It is not possible to make any definite statements on the relation between the radiographic picture and the results of synovectomy. However, severe deformans changes present several years before operation need not prevent good results:

[5] Cases 7a and b, 8, 9, 11, 12 and 13.

thus case 11, which had such changes two years before operation had good primary and final results.

It is obvious that post-operative treatment will have a considerable effect on the final result. This is particularly true of cases in which exudate has been present for a long time and has caused reduced function of the knee and atrophy of the quadriceps muscle, with quadriceps insufficiency. Great importance has therefore been attached to beginning quadriceps exercises as early as possible after operation. In 7 cases the knee was immobolized in a circular plaster cast for two weeks after operation, and then the usual physiotherapy was begun. In the remaining cases the knee was not immobilized in a plaster, and physiotherapy was begun 1-2 weeks after operation. However, no conclusion can be made here on the relative advantages of the two methods.

Full flexion and extension was obtained after operation in 5 cases[6]. Of these, 3[7] had 5-10° loss of extension and 20-30° loss of flexion before operation. Thus, the range of movement in these cases was increased after synovectomy. However, *in all the other cases the range of movement was decreased.* In one case (Case 11) this might be explained by the fact that the patella was also excised at the time of the synovectomy. In all the remaining cases there was 5-10° loss of extension for six months to one year after the operation, though there had been full extension before operation. 3 of the 5 cases with satisfactory range of movement had been in plaster after the operation.

In judging the patient's disability after the operation, one must recognize that polyarthritis in its more pronounced forms is a very disabling disease. In the 6 cases[8] in which the patient was nearly or completely disabled, nearly all the joints of the limbs were involved. In the remaining cases the disease was localized to a few joints and was usually milder.

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[6] Cases 1, 7a and b, 8 and 14.

[7] Cases 1, 8 and 14.

[8] Cases 3, 5, 6, 9, 11 and 13.

The excised synovia was examined histologically in every case. The histological picture was uniform and showed the usual signs of a chronic inflammation without specific changes.

Thus, the results are extremely capricious, and synovectomy should only be used sparingly in patients with chronic polyarthritis, and then only in cases where the course of the disease has been mild, only a few joints have been affected, and the patient is not an invalid. *The marked tendency of the disease to relapse is presumably the cause of the relatively poor results of partial synovectomy in patients suffering from polyarthritis.*

Cases With an Uncertain or Unknown Origin (Table III).

This group, which for the sake of brevity will be called here "the hydrops group", comprises 21 synovectomies performed on 20 patients (10 males and 10 females). Tables I and III show the duration of the disease, the average age at operation and the length of the observation period.

As mentioned earlier, this group is aetiologically very heterogeneous. In addition, the treatment has varied; in 9 cases pathological patellar cartilage was excised as well as synovia.

The patients in the hydrops group had as a rule no discomfort from the joint. Some of them said that the exudate increased on exertion, but most said that it had remained unchanged for a long period. There was full range of movement, and the patients were to a great extent able to carry out their usual work. As in the previous group various kinds of conservative treatment had been attempted without success. In addition, in most cases the joint had been aspirated repeatedly.

Trauma was stated to have caused the exudate in 7 cases (Cases 1-7 in table III), the exudate being said to have followed a definite trauma and persisted until operation. However, the diagnosis of "traumatic synovitis" should be made with some reserve, since, even though it certainly occurs, it is always possible that changes were already present, though

TABLE III

Hydrops of Uncertain or Unknown Origin.

The cases marked with • were examined by the writer.

Case	Sex	Age at onset	Age at operation	Time of observation	Primary result of operation	Result of operation at follow-up	Comments
1.* O.S.V.K. S 4226/37	♀	26 yrs.	29 yrs. Synovectomy + chondrectomy (right knee) 31 ½ yrs. Extirpation of patella (right knee)	10 yrs.	Exudate	(No exudate)	1½ years after operation constant discomfort since operation. 2½ yrs. after first operation: excision of patella: much cartilage on patella lacking. 1944 (7 yrs. after synovectomy) polyarthritis after scarlatina with involvement of operated knee amonst other joints. Follow-up examination: subjective discomfort, 5-10 degrees flexion contracture. Some hydrops. *Radiography*, before op.: N.A.D.; at follow-up examination; severe arthrosis deformans.
2.* K.V.S. S 34109	♀	19 yrs.	23 yrs. Synovectomy + chondrectomy (left knee)	11 yrs.	No exudate	No exudate	One knee becomes slightly tired. Otherwise no symptoms. Marked subpatellar crepitations. Otherwise N.A.D. *Radiography*, before op.: slight decalcification; at follow-up examination: N.A.D.
3.* E.A.P. S 5145/40	♀	34 yrs.	36 yrs. Synovectomy + chondrectomy (right knee)	5 yrs.	No exudate	No exudate	No symptoms or signs. *Radiography*, before op.: N.A.D. Follow-up examination: slight accentuation of the joint contours.

TABLE III (cont.)

Case	Sex	Age at onset	Age at operation	Time of observation	Primary result of operation	Result of operation at follow-up	Comments
4. K.E.L. S 2020/40	♂	24 yrs.	27 yrs. Synovectomy (left knee)	3 yrs.	Exudate	No exudate	No symptoms or signs. *Radiography*, before op.: N.A.D.
5.* D.V. S 879/40	♀	30 yrs.	31 yrs. Synovectomy (right knee) 33 yrs. New synovectomy (right knee)	4 yrs.	Exudate	(No exudate)	For 2 yrs. after second synovectomy intermittent exudate lasting for 2-3 days with intervals of 2 weeks free from symptoms. No connexion with menstruation. Then free from symptoms for 1 yr. following x-ray treatment, but the same symptoms appeared in the non-operated knee. *Radiography*, before op.: and at follow-up: N.A.D. Follow-up examination: no pathological signs or symptoms.
6.* S.B.A. S 3491/37	♂	20 yrs.	25 yrs. Synovectomy (right knee)	5 yrs.	No exudate	No exudate	At age of 20, biopsy arthrotomy right knee. 2-3 yrs. after synovectomy, discomfort from knee. Follow-up examination: for last 2 yrs. no symptoms. Plays games. Signs: slight quadriceps atrophy, otherwise N.A.D. *Radiography*, before op.: N. A. D.; at follow-up examination: moderate arthrosis deformans.
7. J.S. L 298/42	♂	35 yrs.	36 yrs. Synovectomy (right knee)	3 yrs.	No exudate	No exudate	No symptoms or signs. *Radiography*, before op.: arthrosis deformans; 1 yr. later, considerable progression of this condition.

TABLE III (cont.)

Case	Sex	Age at onset	Age at operation	Time of observation	Primary result of operation	Result of operation at follow-up	Comments
8. E.A.B. S 31219	♂	31 yrs.	37 yrs. Synovectomy + chondrectomy (right knee)	7 yrs.	No exudate	No exudate	Pain at times. Marked subpatellar crepitations. *Radiography*, before op.: diffuse decalcification in right knee. Left knee N.A.D.
9.* H.E.A. S 4958/40	♂	49 yrs.	51 yrs. Synovectomy (left knee)	6 yrs.	No exudate	No exudate	No symptoms. Knee slightly deformed with some thickening of the capsule. Subpatellar crepitations. *Radiography*, before op.: slight decalcification; at follow-up examination: fairly severe arthrosis deformans.
10. N.Ch.K. S 1139/40	♂	18 yrs.	26 yrs. Synovectomy (left knee)	5 yrs.	Exudate	Exudate	No pain. Repeated exudate after puncture after operation. *Radiography*, before op.: N.A.D.
11.* K.E.P. S 2834/40	♂	35 yrs,	36 yrs. Synovectomy + chondrectomy (right knee)	7 yrs.	No exudate	No exudate	At age of 20, op. for free joint bodies in right knee. Knee felt somewhat weaker after op. Otherwise no symptoms. Signs: subpatellar crepitations. Full extension, 90 degrees flexion. *Radiography*, before op.: slight arthrosis deformans + osteochondritis dessicans + free body in subpatellar bursa; at follow-up examination: considerable arthrosis deformans.

TABLE III (cont.)

Case	Sex	Age at onset	Age at operation	Time of observation	Primary result of operation	Result of operation at follow-up	Comments
12. I.V.L. S 3430/39	♀	26 yrs.	27 yrs. Synovectomy (right knee)	4 yrs.	No exudate	No follow-up examination	At age of 23, excision of R. medial meniscus. *Radiography*, before op.: slight diffuse decalcification.
13.* T. H. L 485/42	♂	24 yrs.	25 yrs. Synovectomy (left knee)	3 yrs.	No exudate	No exudate	Exudate in the unoperated knee about 6 mths. after synovectomy. At present no signs or symptoms in right knee. *Radiography*, before op.: and at follow-up examination: N.A.D.
14.* Hj. M. L V:C:273	♂	58 yrs.	59 yrs. Synovectomy + chondrectomy (right knee)	2 yrs.	Exudate	No exudate	Pain in knee after operation, otherwise N.A.D. *Radiography*, before op.: and at follow-up examination: arthrosis deformans.
15.* K.G.J. S 1817/38	♂	32 yrs.	36 yrs. Synovectomy (left knee)	7 yrs.	Exudate	(No (exudate	At age of 32 op. for meniscus injury, left knee. Subsequently, intermittent hydrops, first in left knee and later also in right. Only 6 yrs. after synovectomy exudate disappeared following injections of gold salts. Follw-up examination: no pain or other symptoms. *Radiography*, before op.: N.A.D.; at follow-up examination: thinning in foci of the middle part of the medial tibial condyle.

TABLE III (cont.)

Case	Sex	Age at onset	Age at operation	Time of observation	Primary result of operation	Result of operation at follow-up	Comments
16a. K.T.Ö. S 1096/37	♀	22 yrs.	29 yrs. Synovectomy + chondrectomy (left knee)	8 yrs.	No exudate	No exudate	Intermittent pain in knee joints. Otherwise no symptoms or signs. *Radiography*, before op.: very slight deformans changes.
16b. S 1096/37	♀	22 yrs.	30 yrs. Synovectomy + chondrectomy (right knee)	7 yrs.	No exudate	No exudate	
17.* R.L.S. S 5382/41	♀	30 yrs.	31 yrs. Synovectomy (left knee)	5 yrs.	No exudate	No exudate	Follow-up examination: no symptoms. Signs: considerable subpatellar crepitations. *Radiography*, before op.: slight decalcification; at follow-up examination: slight signs of arthrosis deformans.
18.* E.K.R. S 1975/41	♀	25 yrs.	35 yrs. Synovectomy (right knee)	6 yrs.	No exudate	No exudate	For a year or two after operation continuous pain in knee, and at times swelling after exertion. Follow-up examination: no symptoms. Signs: a few subpatellar crepitations, otherwise N.A.D. Large exudate in the unoperated knee. *Radiography*, before op.: very slight diffuse decalcification.

TABLE III (cont.)

Case	Sex	Age at onset	Age at operation	Time of observation	Primary result of operation	Result of operation at follow-up	Comments
18.* (cont.)							Resorption experiments with perabrodil showed considerably retarded resorption from the right knee; at follow-up, moderate arthrosis deformans
19.* A.M.D. S 3180/37	♀	20 yrs.	35 yrs. Synovectomy + chondrectomy (left knee)	10 yrs.	No exudate	No exudate	Follow-up examination: No symptoms. Subpatellar crepitations. Otherwise N.A.D. *Radiography*, before op.: moderate decalcification in patches. Slight accentuation of the joint contours; at follow-up examination: very slight deformans changes.
20.* M.H.P. S 875/43	♀	15 yrs.	25 yrs. Synovectomy (right knee)	5 yrs.	No exudate	No exudate	Follow-up examination: no symptoms. Free movement. Considerable subpatellar crepitations. *Radiography*, before op.: diffuse decalcification; at follow-up: arthrosis deformans. Recently, synovectomy of left knee. Signs of slight chondromalacia of the patella. Biopsy: synovitis dechondrodetritica.

(No exudate) means that the exudate disappeared only a long time after the operation.

S, L and G in the first column denote whether the patient was treated at the Orthopaedic Clinic of the Karolinska Institutet in Stockholm, the Orthopaedic Clinic in Lund or at Vanföreanstalten in Gothenburg.

symptomless. It is well known that even a minor injury can cause severe symptoms in a joint which is the site of a pathological lesion. Such a joint is always more affected by trauma than one which is healthy. The course of a traumatic synovitis is briefly the following. After the injury hyperaemia of the synovia develops, and there is extravasation of plasma with passage of the leucocytes out of the blood vessels into the joint cavity (*Leriche* and *Policard, Policard, D. H. Kling, Smillie,* etc.). According to *Kling,* slight but repeated trauma can be an important factor in the development of changes in the joints. With the raised intra-articular pressure caused by the exudate, the lymphatic vessels can become obliterated (*Smillie*). The joint fluid becomes more acid, and colloids, particularly fibrin, are precipitated (*Smillie*). Secondary atrophy of the quadriceps muscle occurs, and the resulting insufficiency of the quadriceps function may increase the trauma to the joint on walking; this, in its turn, can give rise to increased exudation, etc.

Radiographic evidence of arthrosis deformans was found *at the time of synovectomy* in case 7, but in more of the other cases in which trauma was stated to be the cause of the exudate did the radiographs show any changes.

In 2 cases (Cases 8 and 9) the hydrops was intermittent. Table III shows that the condition had persisted for 6 and 2 years respectively before the synovectomy, occurring in case 8 at intervals of 6 months to 1 year, and in case 9 for 1-2 weeks at intervals of 4-6 weeks[9]. Two further cases, namely cases 5 and 15, may also be mentioned here.

Case 5 had intermittent hydrops for six years after a second synovectomy. When it had regressed, intermittent hydrops developed in the other, previously healthy knee. Case 15 was operated for a meniscus lesion; intermittent hydrops developed after the operation, first in the operated knee and later in the other (v. table III).

[9] Several writers (*Kahlmeter,* and others) consider that the intervals should usually be closer for a definite diagnosis of intermittent hydrops. It is therefore questionable whether Case 8 should be included.

In the literature, intermittent hydrops is said to be uncommon. *Lovèn* (1934) published a report of 70 cases from the literature, and added 2 of his own. *Kahlmeter,* who stressed the rarity of the condition, found 23 cases, or 2 per cent, among a large series of cases with pathological joint changes. Its aetiology is unknown. Infections, endocrine disturbances, metabolic disturbances, angioneuroses (in analogy with Quincke's oedema), allergic disturbances, arthrosis deformans, etc. have been postulated as possible aetiological factors. A variety of treatments have therefore been suggested. In addition to internal treatment and physiotherapy, x-ray treatment has been recommended. *Berger* reported a case which became entirely free from symptoms following "allergic treatment". Synovectomy has been performed in some cases. *Mandl* and *Krida* each reported 2 cases. In one of *Mandl*'s cases the exudate returned after synovectomy, though at longer intervals; in the other it disappeared altogether. Both *Krida*'s patients were free from exudate after operation.—Cases 8 and 9 of this paper were free from exudate after synovectomy.

In the remaining 11 cases (12 synovectomies), i.e. cases 10-20 in table III, the exudate occurred without any demonstrable cause. Of these cases, 9 became *primarily* free from exudate and 10 were free at the *follow-up examinations.*

Thus, in the hydrops group, consisting of 21 cases of synovectomy, exudate was present *primarily* after operation in 6 cases and at the *follow-up examination* in 1 case (case 10). In 4 cases[10], however, its disappearance cannot be attributed to the synovectomy, since it persisted for a long time after the operation. There are thus altogether 5 cases with unrelieved hydrops out of 20 synovectomies (1 had no follow-up examination), *i.e. 75 per cent were free from exudate.*

Table IV shows the radiographic findings in the entire hydrops group before synovectomy, and in those radiographed both before operation and at follow-up. It is seen that at the follow-up examination no less than 10 of the patients showed

[10] Cases 1, 5, 6 and 15.

TABLE IV

Results of Radiographic Examination of the »Hydrops Group« (21 Synovectomies; table III).

	Before synovectomy	Follow-up radiography (14 cases)	
		Before synovectomy	After synovectomy
No radiographic changes	8[a]	6[d]	4[g]
Calcium reduction	7[b]	5[e]	—
Arthrosis deformans...	6[c]	3[f]	10[h]
	21	14	14

a) Cases 1, 3, 4, 5, 6, 10, 13 and 15.
b) Cases 2, 8, 9, 12, 17, 18 and 20.
c) Cases 7, 11, 14, 16 a and b, and 19.
d) Cases 1, 3, 5, 6, 13 and 15.
e) Cases 2, 9, 17, 18 and 20.
f) Cases 11, 14 and 19.
g) Cases 2, 5, 13 and 15 (in Case 15 foci of thinning of unknown origin in the tibial condyle.
h) Cases 1, 3, 6, 9, 11, 14, 17, 18, 19 and 20.

radiographic evidence of arthrosis deformans, and that in 7 of them these changes had appeared during the period between the operation and the later examination.

If the subjective résults in the cases with and without arthrosis deformans are compared, it is found that out of the first group only cases 1 and 14 had symptoms, and the other 7 had no symptoms from the operated knee at the follow-up examination. Nevertheless, as has already been mentioned, cases 1 and 14 occupy to some extent a unique position, since case 1 had developed a polyarthritis after and case 14 already had a fairly severe arthrosis deformans before operation. In case 18 the hydrops disappeared only two years after synovectomy and cannot, therefore, be included among those free from symptoms. *It can thus be stated that arthrosis deformans, which radiographically has developed after synovectomy, need not be accompanied by any symptoms.*

As regards the relation between the radiographic changes before and exudate after synovectomy only 3 of the 8 cases *without* radiographic changes before had no exudate after operation. Patients with rarefaction or with arthrosis deformans were free from exudate with one exception (Case 14). Although the number of cases in each group is small, it is impossible not to be struck by the fact that *the cases with exudate after operation were mainly from the group without pre-operative radiographic changes.*—If the *late results of* synovectomy are related to *the radiographic picture at the follow-up examination,* it is seen that of the 14 cases thus examined synovectomy did not have the desired result in 4, of whom 2 (Cases 1 and 6) had arthrosis deformans, 1 (Case 5) no radiographic changes and 1 (Case 15) thinning of the medial condyle of the tibia. Of the 9 remaining cases without exudate, 8 had arthrosis deformans at the follow-up examination[11]. In 3 of these[12], the disease had already been present before operation. *It is thus evident that although radiographic signs of arthrosis deformans developed after synovectomy, no exudate occurred.*

It has already been mentioned that in a number of cases chondrectomy was performed in addition to synovectomy. This combined operation was carried out on altogether 9 patients[13], or nearly half the cases in the hydrops group. All except 1 (Case 2) of the 6 synovectomy + chondrectomy cases who were radiographed at the follow-up examination had arthrosis deformans. Case 1 must nevertheless be excluded for the aforementioned reasons. It is true that in case 14 the condition was already present before synovectomy, but the changes seen on the radiographs at the follow-up showed such appreciable progression that the inclusion of the case is justified. Of the 8 cases on whom synovectomy was performed alone, who were examined radiographically at the follow-up, only 3 (Cases 9, 17 and 18) had arthrosis deformans.

[11] Cases 3, 9, 11, 14, 17, 18, 19 and 20.

[12] Cases 11, 14 and 19.

[13] Cases 1, 2, 3, 8, 11, 14, 16a, 16b and 19.

TABLE V

Cases Treated by Intramuscular Drainage.

(All from the Orthopaedic Clinic in Lund)[1].

Case	Sex	Age at onset	Age at operation	Time of observation	Primary result of operation	Result of operation at follow-up	Comments
1. L. D. 179/36	♂	43 yrs.	44 yrs. Intra-muscular drainage (right knee)	12 yrs.	Exudate	No exudate	Approx. 10 yrs. before operation the patient had transient discomfort from right knee on one or two occasions. Post-operative x-ray treatment. Follow-up examination: no discomfort from knee. Subpatellar crepitations. *Radiography*, before op.: N.A.D.; at follow-up examination: severe arthrosis deformans right knee, left N.A.D.
2. G. L. B. 135/37	♀	21 yrs.	29 yrs. Intra-muscular drainage + chondrectomy (left knee)	11 yrs.	No exudate	No exudate	Follow-up examination: no subjective symptoms. Objective symptoms: considerable subpatellar crepitations in left knee, none in right. *Radiography*, before op.: N.A.D.; at follow-up examination: N.A.D.
3. M. N. 191/37	♂	41 yrs.	41 yrs. Intra-muscular drainage + chondrectomy (right knee)	10 yrs.	Exudate	No exudate	Exudate after trauma in right knee at 38 yrs. Then free from symptoms until 41, when exudate after new trauma. Operation only 2 mths. later. Follow-up examination: subpatellar crepitations right, somewhat less left knee. *Radiography*, before op.: N.A.D.; at follow-up examination: N.A.D.

TABLE V (cont.)

Case	Sex	Age at onset	Age at operation	Time of observation	Primary result of operation	Result of operation at follow-up	Comments
4. S. M. 196/37	♀	21 yrs.	22 yrs. Intra-muscular drainage	10 yrs.	Exudate	No exudate	Exudate in connexion with trauma, also gonorrhoea. Probably a gonococcal arthritis. No fever. Follow-up examination: Knee swells on exertion. Otherwise no symptoms. No signs. *Radiography*, before op.: N.A.D.; at follow-up examination: arthrosis deformans.
5. J. J. 201/37	♂	34 yrs.	36 yrs. Intra-muscular drainage + excision of medial meniscus (left knee)	10 yrs.	No exudate	No exudate	Exudate in connexion with trauma, when the previously undiagnosed meniscus injury was also found. Follow-up examination: no sypmtoms or signs. *Radiography*, before op.: Some calcium atrophy; at follow-up examination: arthrosis deformans.
6. S. H. R. 232/37	♀	26 yrs.	27 yrs. Intra-muscular drainage + chondrectomy (left knee)	10 yrs.	No exudate	No exudate	Exudate without known cause. Follow-up examination: no symptoms or signs. *Radiography*, before op.: N.A.D.; at follow-up examination: slight arthrosis deformans.
7. K. O. 792/38	♂	21 yrs.	21 yrs. Intra-muscular drainage (left knee)	9 yrs.	Exudate	No exudate	Exudate without known cause. Follow-up examination: no symptoms or signs. *Radiography*, before op.: N.A.D.; at follow-up examination: N.A.D.

TABLE V (cont.)

Case	Sex	Age at onset	Age at operation	Time of observation	Primary result of operation	Result of operation at follow-up	Comments
8. R. H. 312/38	♀	41 yrs.	41 yrs. Intramuscular drainage + chondrectomy (left knee)	9 yrs.	No exudate	No exudate	Exudate without known cause. Follow-up examination: no symptoms or signs. *Radiography*, before op.: N.A.D.; at follow-up examination: N.A.D.

[1] I wish to express my thanks to Docent Folke Ståhl, Lund, for his help in the clinical and radiological examinations of these patients.

Cases 9 and 18, however, also had changes in the patellar cartilage, though these were so mild that chondrectomy was not considered to be indicated. The difference in the frequency of arthrosis deformans is evident. Nevertheless, the numbers in both groups are too small to allow any comparisons to be made, particularly since only in 4 of the cases treated by synovectomy alone was it noted in the report of the operation that the patellar cartilage had been inspected. No mention was made of its condition in the remaining cases.

Actually, little is known of whether the cartilaginous changes precede or follow the exudate. The general opinion appears to be that the cartilaginous changes are primary, and the exudate secondary to them (*Läwen*, and others). Under normal conditions, suspended attrition products from the joint cartilage are present in the synovia (*Hammar*, *Meyer*, *Key*, and others). In pathological conditions there is increased attrition of the cartilage, and an increased overflow of the particles into the synovial joint. These particles are absorbed by the synovial membrane. According to *Hultén* and *Gellerstedt*, the synovial membrane then responds with hyperaemia, and increased formation of connective tissue causes thickening of the capsule (synovitis chondrodetritica). In their opinion, the improvement after chondrectomy depends on a reduction of

the excess of attrition products and thereby removal of the cause of the synovial irritation. The present writer was, however, unable to find, in a number of cases[14] of severe malacic changes in the patellar cartilage, any changes in the synovial membrane like those described by *Hultén* and *Gellerstedt*. The aetiology af the irritation phenomenon in the joint need not be a synovitis chondrodetritica in every case. On the other hand, synovitis chondrodetricitica with considerable swelling of the synovial membrane and even macroscopic oedema in the subsynovial tissue was found in one case[15], in which the only cartilaginous change was a small focus of softening within the medial surfaces of the patella, without other changes in the cartilage. These observations suggest that *Hultén* and *Gellerstedt*'s explanation of the origin of the synovial irritation is not generally applicable. Although no major general conclusions can be drawn from these observations in individual cases, it nevertheless appears that the synovial reaction bears no direct relation to the degree of change in the cartilage.

There are, however, many cases of chondromalacia of the patella—and those reported here undoubtedly belong to this category—in which one is more inclined to consider the cartilaginous changes in the patella as part of a general disturbance of the normal physiology of the joint than as an otherwise isolated phenomenon. In such cases, exudate was the first clinical sign, and there is nothing to contradict the assumption that, as regards time, the exudate is actually primary to the changes in the cartilage. It is possible that the presence in a joint over a long period of a fluid which is both quantitatively, and probably even qualitatively, in respect of both its chemical composition and physical properties, pathological, can contribute to or hasten the onset of degenerative cartilaginous changes. The fact already mentioned that exudate was present mainly in those cases in which there

[14] From the Orthopaedic Clinic in Lund. Case sheets 947/45, 145/46, 159/46, 252/46, 746/46, 1295/46.

[15] v. Case 20, Table III.

were no demonstrable changes, supports this assumption. Neither the duration of the disease up to the time of synovectomy nor the length of the period of observation, appear to affect the occurrence of arthrosis deformans. Nor is there any reason for presuming that the synovectomy per se could cause the deformans changes.

In all cases, the excised synovia was examined histologically and showed the same uniform picture as in the cases with polyarthritis, i.e. that of chronic synovitis. The results of other laboratory investigations—sedimentation rate, Wasserman reaction, tests on guinea-pigs with the exudate, etc.—were normal.

Great importance has been accorded in some quarters to the possibilities afforded by radiographic investigations of resorption. In two cases (Cases 6 and 18) from the present material attempts were made before the synovectomy to determine the rate of resorption from the knee joint. Perabrodil, a crystalline substance, was used. In case 6, where only the affected knee was examined, all contrast had disappeared from the joint after 4 hours. In case 18, both knees were studied. It was then found that after 2 hours a considerable amount of the contrast medium remained in the right, affected knee, while in the left, normal knee most of it was resorbed after 1 hour, and the rest after 2 hours. Thus there was retarded resorption in the affected knee joint as compared with the healthy one. Unfortunately, no resorption experiments were made after synovectomy.

In another case, however, which is not included in the present material, since the operation was performed fairly recently, this examination was made. The case presents some interesting aspects, and an account of it is therefore given in the following[16]. A 27-year old woman had a partial synovectomy in February 1947 after having exudate in the right knee continuously for 10 years. It may be of interest to note that she suffered from psoriasis. Contrast examination with pera-

[16] From the Orthopaedic Clinic in Lund.

brodil before synovectomy showed considerably *more rapid* resorption from the right, affected knee than from the left. Two months after synovectomy the examination was repeated, and the rate of resorption was found to be the same in both knees. At this time there was still exudate in the right knee. Thus in this case synovectomy was followed by a reduced rate of resorption. This agress well with the results obtained by *Efskind,* who pointed out that the resorption capacity decreases after synovectomy and even after simple arthrotomy.

It is thus seen that of the 2 hydrops cases 1 had retarded and 1 accelerated resorption from the affected knee. In the former, (Case 18) histology showed severe fibrous thickening of the capsule wall with a plentiful formation of new vessels. In the latter, histology showed a non-specific synovitis with formation of new vessels and an infiltration of round cells round them.

The experimental studies already mentioned have shown that crystalline substances are resorbed through the blood vessels. In the two cases reported here there was plentiful new formation of vessels in the subsynovial tissue. In case 18 there was also a fibrous thickening of the capsule, which might have decreased the possibilities of resorption. The results of the investigation in the second case could be explained by the fact that the very vascular subsynovial membrane, which would facilitate resorption from the affected knee, was reduced by the operation. The synovectomy might by this reasoning be thought to have been contra-indicated in this instance. However, it must be remembered that parabrodil is a substance foreign to the organism, and the results of resorption experiments cannot answer the question whether synovectomy should or should not be performed. Further, they give no information about the absorption through the lymphatic system. Too little is yet known about the ways and means of resorption of a number of the substances composing the exudate in the knee joint.

Another operation than synovectomy has been suggested

for chronic hydrops of the knee joint, i.e. so-called intramuscular drainage (*Läwen*). Table V shows that this operation was performed in 8 cases. Although they fall outside the scope of the present paper they are mentioned as they have some points of interest. It is scarcely possible to make any direct comparison between them and the patients treated by synovectomy, since the two groups differ in one or two respects. Synovectomy was only performed when the condition had lasted over five years, while the average duration in the cases treated by intramuscular drainage was only just over one year. The observation period, however, was almost twice that of the synovectomy patients, i.e. approximately 10 years. 4 of them had a primary exudate, but at the follow-up examination all were free from it. In 4 cases (Cases 1, 4, 5 and 6) arthrosis deformans was found at follow-up. *Efskind's* theory that chronic hydrops of unknown origin must be due to an increased production of joint fluid makes him regard fenestration of the capsule as an irrational operation in these cases. The cases mentioned here—which belong to the category "hydrops of unknown origin" with the reservations regarding traumatic exudate already mentioned—do not support his view.

To sum up the results of partial synovectomy: *Of 34 cases who were examined at the follow-up 21 were free from exudate, i.e. just over 60 per cent.* The results were poorer in the polyarthritis cases than in those with exudate of other origins (40 and 75 per cent respectively free from exudate). Many authors definitely warn against synovectomy in cases of polyarthritis (*Bernstein,* and others), whereas others do not regard it (*Allison, Boon-Itt, Inge, Massoro, Speed, Swett,* etc.) as a contra-indication.

The results reported in the present paper appear to agree with those of other writers (*Bernstein, Boon-Itt, Jones, Massoro, Speed, Swett,* and others). It is, however, frequently impossible to make a direct comparison between the different series. Thus, for example, the cases reported here differ from those of some other writers as regards operative technique,

the duration of observation, etc., so that the results are probably not comparable.

SUMMARY

The writer reports 36 partial synovectomies performed on 34 patients. Fifteen of the synovectomies (14 patients) were performed on cases of chronic polyarthritis (v. table II); the exudate in the remaining cases ("hydrops group") was of uncertain or unknown origin (v. table III). Table 1 shows the duration of the disease, age at operation, etc. After operation only 6 of the polyarthritis cases and 15 of the hydrops cases were free from exudate.

In respect of patients with polyarthritis, the value of the sedimentation rate in deciding the most suitable time for the operation is discussed. It was found, however, that cases with very high sedimentation rates during the period immediately preceding synovectomy do not necessarily have poorer results than cases with a lower sedimentation rate.

The use of synovectomy in patients with polyarthritis should be limited and the cases carefully selected.

In the "hydrops group" trauma was believed to have caused the exudate in 7 cases. In 2 cases there was typical intermittent hydrops. 10 out of the 14 cases who were examined radiographically at follow-up examination showed arthrosis deformans. The development of this condition is not necessarily accompanied by any symptoms nor does it favour the onset of hydrops. The reason for the relatively large number of deformans changes is discussed.

Finally, 8 cases treated by intramuscular drainage are reported: all were free from exudate at the follow-up examination. Arthrosis deformans was present in 4 cases.

RESUME

L'auteur rapporte 36 synovectomies partielles pratiquées sur 34 malades. Quinze de ces synovectomies (14 malades)

ont été pratiquées sur des cas de polyarthrite chronique (voir tableau II) l'exsudat des autres cas .("groupe hydropique") étant d'origine incertaine ou inconnue (voir tableau III). On voit au tableau I la durée de la maladie, l'âge des malades au moment de l'opération, etc. Après l'opération, c'est seulement dans 6 des cas polyarthritiques et 15 des cas hydropiques que l'on n'a pas trouvé d'exsudat.

Quand il s'agit de malades souffrant de polyarthrite, la valeur du taux de la sédimentation pour décider du moment le plus propice à l'opération est discutée. On a trouvé, en effet, que l'on n'obtient pas nécessairement des résultats moins favorables dans des cas ayant un taux très élevé de sédimentation durant la période précédant immédiatement la synovectomie que dans ceux ayant un taux de sédimentation plus faible.

L'usage de la synovectomie chez les malades souffrant de polyarthrite doit être limité et les cas minutieusement sélectionnés.

Dans le "groupe hydropique", on croit que ce sont des traumatismes qui ont provoqué l'exsudat dans 7 cas. Dans 2 cas il s'agissait d'hydropisie intermittente typique. 10 cas sur 14 ont été examinés à la radiographie et les examens ultérieurs ont montré des processus d'arthrosis deformans. Le développement de ceux-ci n'est pas nécessairement accompagné de symptômes et ne favorise pas l'attaque hydropique. La raison du nombre relativement élevé des modifications déformantes est discutée.

Enfin, 8 cas traités par drainage intramusculaire sont rapportés: il n'y avait d'exsudat chez aucun d'entre eux à la réexamination. On a constaté l'arthrosis deformans dans 4 cas.

ZUSAMMENFASSUNG

Der Verfasser berichtet über 36 patielle Synovektomien, die an 34 Patienten ausgeführt wurden. 15 der Synovektomien (14 Patienten) wurden in Fällen chronischer Polyarthritis ausgeführt (sieh tabelle II). Das Exudat in den übrigen Fällen

(„Hydrops Gruppe") war von ungewissem oder unbekanntem Ursprung (sieh tabelle III). Tabelle I zeigt die krankheitsdauer, das Alter bel der Operation, etc. Nach der Operation waren nur 6 der Polyarthritis Fälle und 15 der „Hydrops" Fälle frei von Exudat.

Mit Hinsicht auf die Polyarthritis-Patienten wird der Wert der Senkungsgeschwindigkeits zur Feststellung des günstigsten Zeitspunktes für die Operation, diskutiert. Man fand jedoch dass Fälle mit sehr hoher Senkung während des der Synovektomie unmittelbar voran gehenden Periode nicht notwendigerweise schlechtere Resultate aufweisen als Fälle mit niedriger Senkung.

Die Anwendung der Synovektomie bei Patienten mit Polyarthritis sollte eine begrenzte sein und die Fälle sollten sorgfältig ausgewählt werden.

In der „Hydrops" Gruppe hatte ein Trauma das Exudat wahrscheinlich in 7 Fällen hervorgerufen. In zweien handelte es sich um einen typischen intermittierenden Hydrops. 10 von den 14 Fällen zeigten bei der Nachuntersuchung röntgenologisch arthrosis deformans. Die Entwicklung dieses Zustandes ist nicht notwendigerweise von Symptomen begleitet, noch begünstigt sie die Entstehung eines Hydrops. Der Grund für die relativ grosse Zahl der deformierenden Veränderungen wird besprochen.

Zuletzt werden 8 Fälle besprochen die mit intramiskulärer Drainage behandelt wurden. Alle waren frei von Exudat bei der Nachuntersuchung. Arthrosisdeformans war in 4 Fällen vorhanden.

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