Efficacy of synovial fluid analysis and synovial biopsy in diagnosing joint pathologies

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Abstract

Introduction: Joint disease is a common orthopaedic problem. They often occur in younger people and tend to be destructive. This can lead to widespread disability and morbidity. Diagnosis is clinical aided with conventional radiological and laboratory investigations. They are sometime equivocal and treatment is empirical and symptomatic. The evaluation of synovial fluid and synovial biopsy should be an important part of investigative procedure in patients presenting with joint effusion.

Materials and Methods: Fifty patients with joint diseases visiting orthopaedic OPD and admitted at orthopaedic wards of BGS Global Institute of Medical Sciences, Bangalore formed the material of present study. Patients were informed about study in all respects and informed written consent was obtained. The period of study was from August 2013 to September 2016. Detailed clinical and radiological screenings were done. This was followed by synovial fluid analysis and closed needle biopsy in each case. The result of this study was then compared with that of previous studies.

Results and analysis: A complete correlation between clinico-radiological, synovial fluid findings and closed needle biopsy for diagnosis of the definite pathology was seen in 34 (68%) cases. In 8 cases (16%) where the clinico-radiological and synovial analyses were equivocal and inconclusive, synovial biopsy only gave conclusive diagnosis of definite pathology. In another 8 cases (16%) the clinical radiological, synovial fluid findings and even the histologic study by closed needle biopsy were inconclusive for any definite disease and were labeled as chronic nonspecific synovitis. These cases were proved chronic nonspecific synovitis also by open biopsy.

Conclusion: Synovial fluid analysis and synovial biopsy will help in coming to a conclusive diagnosis in cases where radiological and laboratory investigations are equivocal. This can be done simultaneously through same site of aspiration with Parker Pearson needle. The significance of the result of the study outweighs the effort of the procedure. Thus it can be stated that evaluation of synovial fluid and synovial biopsy in joint diseases will stimulate its use as routine investigative procedure in the diagnosis of various puzzling joint disorders.

Keywords: Synovial fluid, Joint diseases, Rheumatoid arthritis.

Introduction

There are multiple joint pathologies which present with pain and swelling. Few of these can involve a single or multiple joints. Few of the common joint pathologies are age related osteoarthritis, inflammatory arthritis such as rheumatoid, gouty arthritis, infective arthritic conditions such as septic arthritis and tubercular arthritis. Based on only clinical examination alone, it is very difficult to come to a diagnosis especially when these conditions comes with atypical presentation. In majority of these disorders, laboratory and radiological investigations will not yield much results especially during the initial stages of the disease process. Because of these negative tests, identification of the disease in the initial stages may not be possible which leads to either missing the diagnosis or delay in the diagnosis, which results in substantial destruction of the joints, there by severe loss in functions of the joints.

Most of these diseases can be identified in the initial stages by adding a few more invasive tests such as synovial fluid analysis and synovial tissue biopsy. These two tests as a combined procedure will yield lot of information and will aid in the early diagnosis and there by help in preserving the joint. They also help in the assessment of the patient during follow up and also course of the disease can be evaluated.[1-4] In young adolescent and adult monoarticular involvement of hip or knee with or without constitutional symptoms often poses diagnostic problem between tubercular, rheumatoid and non specific pathology. Similarly in elderly person with bilateral painful swollen stiff knees both rheumatoid and osteoarthrosis are possibilities[5,6] Combined synovial fluid analysis and synovial biopsy have been found more informative to the accuracy of diagnosis than either of them used alone. Major surgeries such as arthroscopic biopsy and open synovial biopsy can be done to obtain the biopsy, but these procedures have got their own disadvantages such as extra hospitalization, morbidity for the patient and also financial burden. The complications of infection and hemorrhage have been over-emphasized but are rarely seen.

Materials and Methods

Fifty patients with joint diseases visiting orthopaedic OPD and admitted at Orthopaedic wards of BGS Global Institute of Medical Sciences, Bangalore formed the material of present study. Patients were

informed about study in all respects and informed written consent was obtained. The period of study was from August 2013 to September 2016.

History taking, clinical examination and investigation findings were carefully noted according to a set Proforma. Entire clinical history of all the cases, pertaining to various symptoms was taken in relation to duration of the symptoms, its onset and progress of the various symptoms. Detailed clinical examination was done in each case with respect to location, nature and course of the disease. History related to inflammatory arthtitis such as morning stiffness, remissions and exacerbations were noted. Other constitutional symptoms such as fever, weight loss, cough were noted where systemic diseases and infective pathology were suspected. Other history and examination was done to rule out other possible causes of joint pathologies such as:

i. Age related degenerative joint diseases such as osteoarthritis
ii. Infective conditions such as tuberculosis and septic arthitis.
iii. Inflammatory pathologies like rheumatoid arthritis and gout.

Patients were examined for any involvement of other systems and local examination to find out any clue to the diagnosis of the group of conditions said above. In local examination of joints, beside the attitude and deformity if any, evidence of local inflammation like warmth and tenderness, the synovial effusion, synovial thickening were carefully looked for. Any limitation of joint movement, muscle spasm, muscle wasting were carefully observed and noted.

Routine blood investigations to rule out common joint pathologies were done such as levels of erythrocyte sedimentation rates, serum uric acid levels, total counts and differential counts, rheumatoid factor were done for all the patients. Whenever tubercular infection was suspected, investigations such as sputum for Acid Fast Bacilli and Mantoux test were performed. Where ever other foci of infection were suspected elsewhere in the body, necessary tests were performed. X ray of the suspected parts and also x ray chest were routinely performed to rule out tuberculosis and systemic infections.

After thoroughly evaluating the patients, all the patients were subjected for synovial fluid analysis and synovial biopsy and further studies were done based on that.

Procedure of Aspiration of knee joint for synovial fluid analysis and synovial biopsy

All the procedures were performed in the operation theatre. Under aseptic conditions under the effect of local anaesthesia using plain 2% lignocaine, joint was aspirated using supra patellar approach (Fig. 1). Following aspiration of the joint synovial biopsy was carried out using Parker Pearson needle.

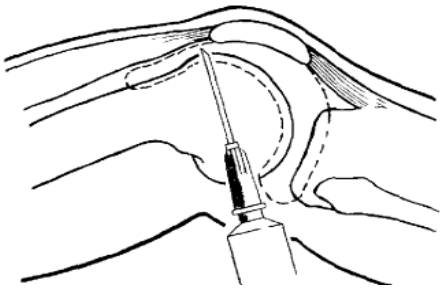

Fig. 1: Technique of arthrocentesis

Results and analysis

Evaluation of synovial fluid and synovial biopsy studies of 50 cases of joint disease treated at BGS Global Institute of Medical Sciences, Bangalore .Following observations were made during the study.

It shows that monoarticular affection is predominant (76%) in joint diseases (Table 1). The invovemnet of knee has been found very common both in monoarticular (65.78%) and polyarticular (75%) arthropathy. Hence knee was subjected to arthrocentesis and synovial biopsy more than other joint (Table 2).

The present study shows that both rheumatoid (28%) and tubercular (26%) were found to be more common. Next common cause of affection of the joint, observed in this study was chronic nonspecific synovitis. Osteoarthritis and pyogenic and traumatic arthritis were found to be less common (Table 3). The polyarticular affection was found mainly due to rheumatoid lesion. Bilateral involvement of wrist was fond only in tuberculosis. In one case with bilateral knee involvement one was found to be tuberculous, in the other knee diagnosis inconclusive. In rheumatoid lesion the polyarticular involvement was found almost double incidence of monoarticular involvement.

Table 4 shows that rheumatoid arthritis was found in adults and elderly group. In younger age group between 10 – 30 years two cases of rheumatoid lesion observed were of monoarticular lesion. Tuberculosis lesions were seen maximum in the young age group between 10 – 30 years and also in the age group 31 – 50 years. Only one case was seen in 6 years. Chronic nonspecific synovitis was found again mostly in young age group between 10 – 30 years. Pyogenic arthritis was seen both in children and adults. Traumatic arthritis cases were seen in young adults during physical training and sports. Both the cases of gouty arthritis were seen in adults age group 30 – 50 years. Osteoarthritis was of course found in old age group.

Arthrocentesis and closed synovial biopsy using Parker Pearson needle (Fig. 2) and his technique carried out in 50 cases patients of joint diseases. 38 were monoarticular and 12 were polyarticular. The joints were subjected to this procedure of arthrocentesis and

needle biopsy were knees – 33 cases (66%), wrist – 7 cases (14%), hips – 5 cases (10%), elbow -1 case (2%), ankle 1 case (2%), foot – cases (4%) and S.I. Joints – 1 case (2%).

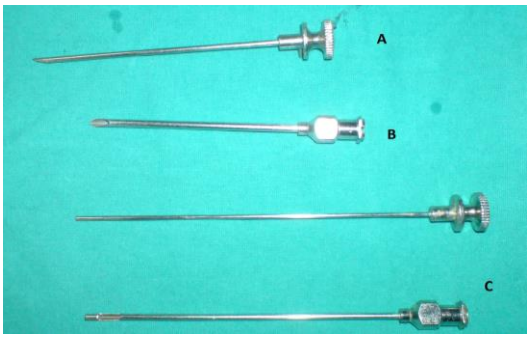

Fig. 2: Parker-Pearson needle used for biopsy

Following are the observations of synovial fluid study and synovial biopsy.Physical properties, biochemical nature (specific gravity, synovial fluid protein in gm% and Blood – synovial fluid sugar difference in mg/100ml) and cytological picture (total WBC/mm^3 and predominant cells) of synovial fluid in joint diseases of different pathology have been shown in table 5, 6 and 7 respectively.

With Parker-Pearson needle and his technique adequate representative synovial tissue for histopathology could be obtained in 45 (90%) out of 50 joints (knee 32, wrist 7, hip 2 out of 5, elbow 1, ankle 1, foot 1, sacro iliac joint 1) (Table 8,9).

Failure in getting adequate synovial tissue in hip cases was due to the joint being deeper and accompanying chronic contracture. In the knee joint case the presence of contracture made difficult to get synovial tissue by needle. In the foot case, needle could not be negotiated (Table 10). In these cases open biopsy by arthrotomy were done.

Histopathological study of synovial tissue obtained by the above said technique proved to confirm the diagnosis after clinical with laboratory and radiological aid and synovial fluid evaluation in 37 out of 50 cases (74%). In rest of 13 cases (26%) the histopahological diagnosis differs from the clinical diagnosis.In these 13 cases (knee 5 out of 32, Hip 4 out of 5, wrist 1 out of 7 and ankle 1) the closed needle histopathological diagnosis were confirmed further by open biopsy through arthrotomy except case No. 7, 12 and 31, where open biopsy were done failing the closed needle biopsy.

Table 1: Showing number of affection of joint disease

	Number	Percentage
Monoarticular	38	76
Polyarticular	12	24
Total	50	100

Table 2: Showing number of monoarticular/polyarticular affection of different joints

S. No.	Joints	Monoarticular involvement (No. of cases)	Polyarticular involvement (No. of cases)
1.	Knee	25 (65.78%)	9 (75%)
2.	Wrist	4 (10.53%)	4 (33.33%)
3.	Hip	5 (13.15%)	1 (8.33%)
4.	Elbow	-	4 (33.33%)
5.	Ankle	1 (2.85%)	1 (8.33%)
6.	Hand	-	5 (41.66%)
7.	Foot	2 (5.26%)	-
8.	Shoulder	-	1 (8.33%)
9.	S.I. joints	1 (2.85%)	-

Table 3: Showing variety of joint diseases

S. No.	Name of disease	Number of cases		
		Monoarticular (A)	Polyarticular (B)	Total (A+B)
1.	Rheumatoid arthritis	5 (10%)	9 (18%)	14 (28%)
2.	Tubercular arthritis	12 (24%)	1 (2%)	13 (26%)
3.	Chr. nonspecific synovitis	8 + 2*		10 (20%)
4.	Septic arthritis	4 (8%)		4 (8%)
5.	Osteoarthritis	3 (6%)		3 (6%)
6.	Traumatic arthritis	4 (8%)		4 (8%)
7.	Gouty arthritis	2 (4%)		2 (4%)
Total				50 (100%)

Table 4: Showing age distribution pattern in different joint diseases

S. No.	Joint disease	No. of cases	Age in years range			
			0 – 10	11 – 30	31 – 50	Above 50
1.	Rheumatoid arthritis	14	-	2	7	5
2.	Tubercular arthritis	13	1	9	3	-
3.	Chr. Nonspecific synovitis	10	1	7	2	-
4.	Septic arthritis	4	2	2	-	-
5.	Traumatic arthritis	4	-	1	3	-
6.	Osteoarthritis	3	-	-	1	2
7.	Gouty arthritis	2	-	-	2	-

Table 5: Showing physical properties of synovial fluid in normal and diseased joints

No.	Disease	Volume in ml.	Appearance color/clarity	Viscosity	Mucin Clot test	Fibrin Clot	Specific gravity
1.	Normal	3.5ml	Straw/ clear	High	Good	-	1014-1020
2.	Rheumatoid Arthritis	Variable	Yellowish to Greenish/ Cloudy	Low	Fair to Poor	+	1019-1025
3.	Tubercular	Moderate Increase	Yellow/ turbid	Low	Poor	+	1020-1026
4.	Chronic nonspecific	Moderate Increase	Yellowish/ Clear	Low	Fair to Good	+/-	1014-1018
5.	Septic arthritis	Abundant	Yellow, Grey/ turbid	Low	Very Poor	+	1025-1028
6.	Osteoarthritis	Scanty	Pale/ Clear	High	Good	-	1014-1016
7.	Traumatic arthritis	Variable	Hemorrhagic or Xanthochromic	High	Good	-	1015-1018
8.	Gouty arthritis	Variable	Yellowish/ Cloudy	Low	Fair	+	1018-1022
9.	Alkaptonuria	Variable	Turns to black on standing			-	
10.	pseudogout	Variable	Yellow, milky		Firm to friable		

Table 6: Showing cytological appearance of normal and diseased joints

S. No.	Condition	Total WBC count / mm	Predominant cell %
1.	Normal synovial fluid	200	Mixed cell with poly, Lympho Mono Poly less 12 (25%)
2.	Rheumatoid arthritis	8500 – 14500	Poly 65 to 80%
3.	Tubercular arthritis	5000 – 12000	Lymph 60 to 80% with Monocytes
4.	Chr. nonspecific arthritis	500 – 12000	Variable from poly to lymphocyte
5.	Septic arthritis	14000 – 22000	Polymorph 80 to 95%
6.	Osteoorthrosis	200 – 500	Variable, poly – lymph
7.	Gouty arthritis	10000 – 13500	Poly 60 to 80%

Table 7: Showing protein content of synovial fluid and blood – synovial fluid glucose difference in various joint diseases

S. No.	Condition	No.	Protein gm%	Blood – synovial fluid glucose level difference mg%
1.	Normal synovial fluid		1.5 – 2.5	< 10
2.	Rheumatoid arthritis	13	3.5 – 6.4	>20 <30
3.	Tuberculous arthritis	14	4 – 6.8	>20 <35
4.	Chr. nonspecific synovitis	10	2 – 3	>10 <16
5.	Septic arthritis	4	5 – 7	>40 <60
6.	Osteoorthrosis	3	2	<10
7.	Traumatic arthritis	4	2 – 2.5	<10
8.	Gouty arthritis	2	5	>20 <25

Table 8: breakdown of successful closed synovial needle biopsy – 45 out of 50 cases (90%) according to joints and joints diseases

S. No.	Joints	No. of cases	Breakdown according to diseases
1.	Knee	32	Rheumatoid arthritis 7 Tuberculous arthritis 9 Chr. nonspecific synovitis 8 Septic arthritis 2 Osteoarthrosis 2 Traumatic arthritis 4
2.	Wrist	7	Rheumatoid arthritis 3 Tuberculos arthritis 4
3.	Hip	2	Rheumatoid arthritis 1 Septic arthritis 1
4.	Ankle	1	Rheumatoid arthritis 1
5.	Elbow	1	Gouty arthritis 1
6.	Foot (1st MP joint)	1	Gouty arthritis 1
7.	Sacroiliac joint	1	Septic arthritis 1
Total		45	45

Table 9: Showing breakdown of 45 successful closed needle synovial biopsy in joint diseases

S. No.	Joint diseases	Total No. of cases	Percentage
1.	Rheumatoid arthritis	13	26.66
2.	Tuberculous arthritis	13	31.11
3.	Chr. nonspecific synovitis	8	17.77
4.	Septic arthritis	4	8.88
5.	Osteoarthrosis	2	4.44
6.	Traumatic arthritis	4	8.88
7.	Gouty arthritis	1	2.22

Table 10: Showing location of 5 cases of failure

Location	Number cases
Hip joint diseases (case No.7, 12, 31)	3
Foot (case No.9)	1
Knee joint (Case No.39)	1

Discussion

Diseases affecting the joints are quite common scenario in orthopaedic practice. These disorders may involve either a single joint or multiple joints. Many a times these diseases will not present in a classical manner. It will be very difficult to come to a single diagnosis based only on clinical or in association laboratory or radiological investigations. Most of the times laboratory and radiological investigations are equivocal and may not help much in coming to a conclusive diagnosis. Adding invasive procedures such as synovial fluid analysis and synovial biopsy helps to come to a conclusive diagnosis. Literature analysis also establishes the fact that simple procedures such as synovial fluid analysis and synovial biopsy are very important tools in finalizing the diagnosis.[7-9]

Most common diseases seen were inflammatory conditions such as rheumatoid arthritis and infective pathology such as tuberculosis. Following that, chronic non specific synovitis, osteoarthritis and septic arthritis are next common in that order. In general, inflammatory arthritis such as rheumatoid will have involvement of multiple joints, whereas age related arthritis will show bilateral presentation. Remaining disorders generally present with single joint involvement. Outcomes of our study are comparable with the studies of other authors such as Saxena et al, Bhatia et al[10], Chaturvedi et al[11], Singhal O et al[2], Venkataraman et al.[1] (Table 11).

Table 11: No of cases in Different joint diseases

	Present study	Venkataraman et al	Singhal O et al.	Vijay P. M. et al[12]
Rheumatoid arthritis	14	8	14	4
Tubercular arthritis	13	6	13	15
Chr. nonspecific	10	18*	11**	59

synovitis				
Septic arthritis	4	2	3	5
Traumatic arthritis	4	4	4	-
Osteoarthrosis	3	4	3	-
Gouty arthritis	2	1	2	-
T0tal	50	43	50	83

When our study was compared with the studies made previously in the literature, a good percentage of conclusive diagnosis could be made when synovial fluid analysis and synovial biopsy studies were cobined together with laboratory and radiological investigations in various joint pathologies. Many a times x rays and lab investigations, will not yield any outcome. In all these cases it is the synovial fluid analysis and biopsy which helps us to arrive at a diagnosis.

Naib and Broderick[13] et al showed good association and efficacy when synovial fluid analysis and synovial biopsy was additionally added together with other parameters (Table 12). It could be due to the following factors.

a. Viscometer was used for assessing the viscocity levels, which yielded better results.
b. The study sample was of bigger size.
c. The experience which authors had in the field was more

Table 12: Showing overall results of correlation between clinical diagnosis and diagnosis after synovial fluid study

Authors	Clinical diagnosis No. of cases	Diagnosis after synovial fluid study	
		No. of cases	Percentage
Naib (1973)	66	66	100
Borderick et al (1976)	126	122	96.88
Saxena et al (1980)	42	32	76.2
Bhatia et al(1981)	76	68	87.5
Present series	50	37	74

When our study was compared with earlier studies in the literature, it was comparable and we could come to a conclusion that synovial biopsy is one of the important diagnostic test which should be in the armory of orthopaedic surgeons because it is more specific in diagnosing various joint pathologies. Also closed synovial biopsy is more than sufficient in obtaining synovial tissue for test than open arthrotomy or arthroscopic procedures, where in surgical complications and extra hospitalization is required.

Parker Pearson needle is used in our study for obtaining synovial biopsy in our cases, it is evident that it is a good equipment than other biopsy needles in obtaining synovial tissue for biopsy. In few of our cases it was difficult to obtain synovial tissue because of the contracture around the knee and hips as experienced in the present study and also in the series of Schumaker and Kulka.[4]

In our study series, there were 50 cases of various joint pathologies, synovial fluid analysis and histological examination after synovial biopsy in all cases together with radiological and lab investigations, proved to be of important diagnostic value in as many as thirty four out of fifty patients in the study sample (Table 13). Of the remaining sixteen cases (32%), eight patients no histological diagnosis could be made and were termed under the group of non specific Synovitis. In these eight patients, in three cases, clinical, lab and x ray and synovial fluid tests and biopsies did not yield any conclusive diagnosis. In the other 5 cases (Table 18) who were diagnosed as tubercular (2 out 0f 5) and Rheumatoid (3 out of 5), histologic examination revealed no evidence of these disease or any definite disease and hence also labeled as chronic nonspecific synovitis. In rest of 8 cases where the clinical diagnosis were different and synovial fluid findings were equivocal, histologic examination of closed needle biopsied synovium alone gave the conclusive diagnosis (Table 13).

Table 13: Shows successful closed needle biopsy in different series

Authors	Success rate (Percentage %)
Polly & Bickel (1951)	87.2
Rosenthal H S (with Vimsilvermann needle) (1959)	60
Wilkinson M and jones B (with Harefield Needle) (1963)	77

Schumacher H and Kulka P (with Parker Pearson needle) (1972)	92
Varma et al (with Parker Pearson needle) (1983)	100
Present study with Parker Pearson needle	90

Results of our study after comparing with the previous studies in the literature, confirm that synovial fluid analysis and synovial biopsy is an important diagnostic tool adjunct to routine laboratory and radiological investigations in coming to a conclusive various joint pathologies. At times synovial biopsy alone gives the conclusive diagnosis.

No complications like infection, intra-articular haemorrhage were observed in the present series. In series of Schumacher and Kulka, they observed, only in one case, complication of painful swelling of ankle presumably due to intra-articular haemorrage developed 2 to 3 hours after biopsy. In addition to the disease found in the present series, synovial analysis and synovial biopsy may be diagnostic in pseudogout (Chondrocalcinosis), Reiter's disease, Sarcoidosis, Pigmented villonodular synovitis, Gaucher's disease, Amyloidosis, Synovial sarcoma.

Conclusion

Various joint diseases e.g. rheumatoid arthritis, tubercular arthritis, septic arthritis, gouty arthritis, osteoarthrosis can be diagnosed by synovial fluid study and synovial biopsy.The physical, biochemical and cytological properties of synovial fluid are more or less specific to particular group of diseases.The procedure is reliable, simple, safe and inexpensive.It may help in better understanding of the pathophysiology of various diseases.Synovial fluid aspiration and synovial biopsy, both these procedures can be done simultaneously trough the same site of aspiration by the same needle.

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